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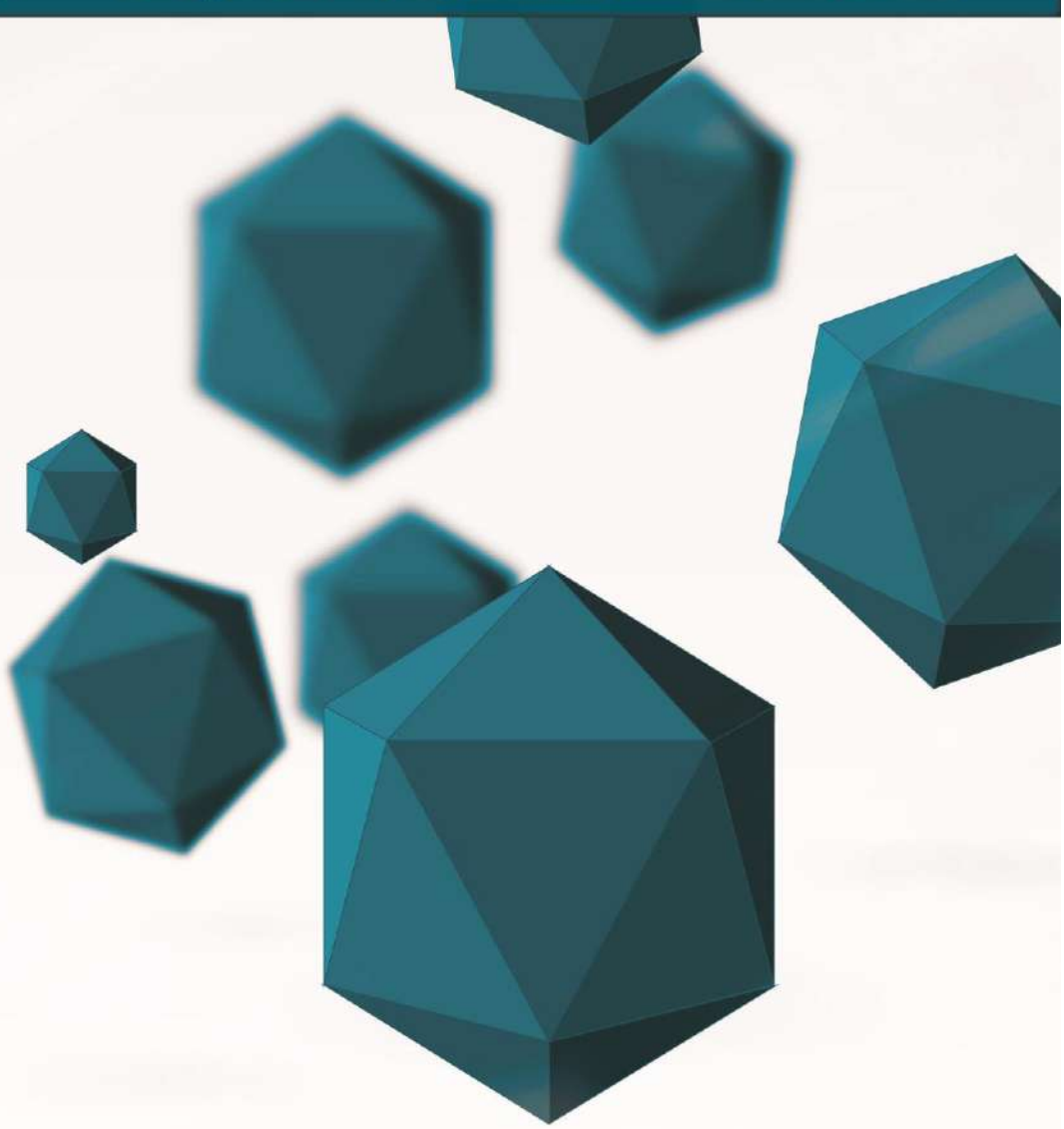

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FOREWORD

I am pleased to put into the hands of readers Volume-6; Issue-7: 2019 (July, 2019) of **"International Journal of Advanced Engineering Research and Science (IJAERS) (ISSN: 2349-6495(P) | 2456-1908(O)" ,** an international journal which publishes peer reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers. Now journal has also been indexed in **Qualis (Interdisciplinary Area) (Brazilian system for the evaluation of periodicals, maintained by CAPES).**

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

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

With warm regards.

Dr. Swapnesh Taterh
Editor-in-Chief
Date: Aug, 2019

International Editorial/ Reviewer Board

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Development of a Low-Cost System for Monitoring Water Quality applied to Fish Culture

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Abstract*— *In fish farming, automation is an outlet to minimize and / or optimize some key points for business success, such as real-time monitoring of water quality and its intervention when they are changed, as well as their interface with other productive management practices. The monitoring of water quality is done through the verification of some chemical and physical parameters, requiring qualified personnel to measure and interpret these parameters in order to provide a good water quality necessary for the good productive performance of the species to be cultivated. In this context, the objective of this project is to analyze the feasibility of implementing a low-cost computer system to monitor the physical and chemical properties of water in aquatic organisms. Taking into account the existence of a wide variety of technologies available on the market that can be used together, this work aims to study the paradigm of automation and its use in the field of fish farming, making use of existing technologies with Arduino, Raspberry pi and sensors. Finally, we intend to analyze the financial feasibility of developing a computer system to monitor the physical and chemical parameters of water in aquatic organisms.
***Keywords*— Automation, Computing, Fish farming, Internet of Things.**

I. INTRODUCTION

Automation can be defined as a set of techniques that, applied to a process, aim to make it more efficient, thus maximizing its production, reducing energy consumption and time, reducing waste emission and improving the safety conditions that are inherent to the process [1]. It is worth mentioning that the automation process takes place in two basic chains, using automatic software to perform a certain task, or only hardware, without using software, purely mechanical, e.g.: ram pump, we also have electromechanical. Example: vibratory pump and the combination of the two modes, hardware and software, with this, implementing an intelligent system, able to reprogram, readapt or even evolve depending on the manufacturing paradigm used.

The evolution of computing has led us to the miniaturization of the hardware and consequently its low cost, with this making its acquisition and its combination possible for the development of control and automation of the processes, providing to its users in the agricultural environment an autonomy, in routine , previously unimagined, that can be used adaptively in several production processes of fish farming, with minimal changes and with little impact on cost and a great impact on the benefit. The screen-based research aims at exploring the viability of the production cost of an automatic and scalable system for water monitoring, initially the study is about its applicability in excavated nurseries, using modulation techniques, making it expandable and adaptive the needs of the fish farmer. In addition, it becomes a set of solutions for everyday situations by promoting benefits directly linked to the production and greater performance of the activities of the producers.

Automation should be advanced by agriculture and livestock as a way to ensure increased production and productivity in Brazil and still maintain and stimulate the growth of agricultural machinery and equipment industries. It is emphasized that the interest of multinational companies in the growing opportunities of Brazilian agribusiness is increasing the investment in automation. Thus, to remain competitive, it will be increasingly important that the Brazilian machinery and equipment industries generate innovations that can improve the performance of the activity and broaden the range of activities served. A good strategy to achieve this

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goal is the expansion of partnerships between industries and public and private research institutions that foster research.

II. STUDIES DEVELOPED IN BRAZIL

Embrapa (Brazilian Agricultural Research Company) has been acting and consolidating itself as a user and developer of automated methods and equipment. An example of this is the work agenda of Embrapa instrumentation (São Carlos, SP), created in 1984, which inaugurated on September 20, the National Reference Laboratory for Precision Agriculture (Lanapre), prepared to create new and strategic partnerships with public and private companies. In fact, Lanapre was already inaugurated as a joint research unit in partnership with the University of São Paulo (USP) and the Federal University of São Carlos (UFSCar). In addition to research networks in progress, related to the theme, Embrapa is also implementing a PD & I (Research, Development and Innovation) Portfolio in Agricultural, Livestock and Forestry Automation [2].

With the objective of developing a quality product using technology applied to agriculture, the present work aims to study the feasibility of creating a computer system capable of collecting information on the chemical and physical parameters of water in excavated nurseries and, and then send it to a database, allowing real time monitoring of water quality, allowing the analysis to be obtained over time, generating a history of physical and chemical changes of the analyzed environment.

III. THEORETICAL REFERENCE

Several areas have pointed out the benefits that technology has brought, in its generality, to society, great benefits in terms of automation, information and knowledge. In relation to companies, technologies mean higher productivity and gain in competitiveness. Technological advancement, especially in the field of computer science and information, is supported by a body of intelligent software development. Technological innovation has become an extremely important indicator for the substantial growth of agriculture, working in an interdisciplinary way and using technology as a tool for resolving real problems, we can have a better efficiency and productivity of the researched object.

DEVELOPMENT PLATFORM

We chose the Arduino UNO platform as a micro controller, firstly to work with free software and to be relatively cheap and scalable, greatly reducing project costs, and can group several sensors for automatic monitoring, McRoberts, (2011), defines the Arduino as: [...] a small computer that you can program to process inputs and outputs between the device and the external components attached to it (Figure 1). Arduino is what we call a physical or embedded computing platform, that is, a system that can interact with your environment through hardware and software. [3, p. 23].

It is important to emphasize that with the wide diffusion of this technology and consequently its low cost, several areas of research such as engineering, medicine, industry in general and especially in the agricultural field can be perfectly employed, thus increasing productivity and reducing errors in the collection and later analysis of the data, when compared to the usual environment, manual collection *in loco*.

COMPUTER SYSTEMS

The screen search is supported by computer networked systems, which can provide the farmer with a range of information in real time and anywhere, allowing to use free or commercial platforms. By computer system, Reisswitz, (2012), defines as a set of electronic devices (hardware) capable of processing information according to a program (software). The most important software is the operating system, it provides the bases for the execution of the applications, to which the user wishes to execute, the choice of set, hardware and software is that determines the cost, our work is based on the use of free software , based on linux, thus reducing project costs, so the author defines hardware as: The hardware corresponds to the electronic and mechanical parts, which allow the existence of the software, the storage of information and the interaction with the user. The CPU, the primary and secondary memories, the peripherals, the computer network components, are examples of hardware elements. [4, p. 51].

Thus, an automated system can allow the existence of several systems and a system can request several computers or tasks to be processed, generating a range of data that can be refined, grouped and analyzed with data mining techniques, subject for future work, the software is defined by the author as: The software is the abstract part of the computational system that works on hardware from instructions encoded in a programming language. These instructions allow the processing and storage of information in the form of encrypted data and can be controlled by the user. This control, as well as the exchange of information between the user and the system is done through the user interface, made up of hardware and software [4, p. 51].

https://dx.doi.org/10.22161/ijaers.671 *ISSN: 2349-6495(P) | 2456-1908(O)*

Being the software the logical part, abstract of a computational system and combined with sensors, can be applied in the same computer system, to collect information in real time, such as water temperature anywhere in the nursery, pH levels, Nitrite, Alkalinity among others, thus, the system becomes scalable according to the need of the fish farmer, that is, one or several sensors can be used in the same computational system as they are necessary for monitoring the environment.

IV. MATERIALS AND METHODS

The methodology is based on an exploratory research, as it seeks a detailed technical and financial feasibility of the prototype to be used. [5], defines this research as: These researches aim to provide greater familiarity with the problem, in order to make it more explicit or to constitute hypotheses. One can say that these researches have as main objective the improvement of ideas or the discovery of intuitions. Its planning is, therefore, very flexible, so that it allows the consideration of the most varied aspects related to the fact studied. [5, p. 51].

In this sense, exploratory research is used when there is little knowledge about the subject to be approached. Since the area of fish farming is the delimitation of the research, and through this study, we seek to know the subject in depth. In the words of [6] one of the characteristics of the exploratory research is the deepening of the preliminary concepts about a certain subject not satisfactorily contemplated previously.

Clarified the method used in the research and after a better understanding of the need to solve the proposed problem. Initially we did a theoretical revision of the concepts involved, both those related to automation and control and fish farming in their physical chemical aspects, to better understand the technology team involved. After that, we held meetings with the professors of the agricultural sciences, in order to collect information necessary to model an automated system for fish farming. In this way, we surveyed the hardware and software needed to create the prototype, thus defining which minimum equipment is required to mount an automated and inexpensive system.

After the process of recognition of the object being searched, we conducted a price survey on websites and catalogs of computer companies to verify which one has the most economically feasible value for the proposed purpose, and finally we end with the final report of the activities.

We used as initial parameters, the work of [7] that brings in its core, the monitoring of the ideal levels of water quality to reduce losses where, it is sought to develop an automatic water analysis system for aquaculture using the platform Arduino Mega with sensors of temperature, pH, ammonia, among others.

Thus, in consonance with the work of Huet (1978), *apud* [8, p. 2], which is determinant in an aquaculture model and the best cropping system to be implanted is the quantity and quality of the water and in the end, after studies and field visits, we can better understand the process and the real needs of automation, finalizing with the descriptive survey of the hardware and software and to be used in the assembly of the prototype.

Finally, as the proposal is of an interdisciplinary nature, the results collected and parameters for measuring water quality for fish culture will be monitored by a specialist in the area.

MATERIAL TO BE USED IN THE INITIAL PROTOTYPE.

The methodology applied in this research is an exploratory one based on a rigid bibliographical revision, relevant to the proposed theme and with a view to the future implementation of a prototype for tests. The purpose of the study is to demonstrate that it is possible to have a more efficient and low-cost control with automation, that is, reports can be obtained at any time of the physical-chemical state of the water according to parameters agreed for the production. Below is shown some equipment needed for assembly of the prototype for tests in real nursery.

Fig.1: Arduino UNO

Arduino Uno, Figure 1, is an electronic prototyping platform that operates under free software. Its interface allows us to operate a variety of sensors, both digital and analog.

https://dx.doi.org/10.22161/ijaers.671 ISSN: 2349-6495(P) | 2456-1908(O)

Fig.2: Module ethernet shield W510

The Ethernet Shield module, Figure 2, allows the Arduino board to connect to the Internet, provides access to the Internet Protocol (IP), Transmission Control Protocol (TCP), and User Datagram Protocol (UDP) protocols.

Fig.3: Temperature sensor

In Figure 4, we have the temperature sensor, which will be submerged collecting in real time the water temperature, with precision of: +/- 0.5 ºC between -10 ºC and +85 ºC, it is sought to monitor the physical appearance of the Water.

Fig.4: pH Sensor Module

In Figure 5, we have the pH-sensor module of liquids, thus ensuring real-time monitoring of the environment, and can be implemented for alert or even automatic correction procedures.

Fig.5: Turbidity Sensor

We have in figure 6, the turbidity sensor, electronic monitoring module to work with the micro controllers Arduino and others. Capable of detecting particles that are suspended in water, measuring the transmittance of light and the dispersion rate, which changes according to the amount of total suspended solids.

V. CONCLUSION

The exploratory research developed showed favorable conditions for the creation of an innovative, scalable and low-cost computer system. Autonomy is the main point of creation of the system, allowing the researchers the best understanding of the object to be searched. Fish farming requires a constant dedication, using techniques that require a shift to collect information, today, the small or large fish farmers can have the same information in real time and anywhere, facilitating their daily work for better management and decision making.

As future works, it is intended to develop an automated computer system for data collection in fish nurseries, with the purpose of optimizing the process of collecting physical chemical information of the environment, it is also worth noting that the present work, through its methodology , provided a greater understanding and consequently a greater learning in relation to the proposed theme, besides envisaging a potential solution at a low cost for fish producers in excavated nurseries.be modularized according to the need and the precision of the monitoring.

The average amount budgeted for the purchase of devices to be used in the project amounted to $ 140.00 Dollars, value found in the market in February 2019, in online stores

We can conclude that the cost is relatively low, when compared to ready-made systems sold in the market. As a pilot project, for the on-screen study, only the basic sensors cited above, according to a meeting with professionals of the area, were budgeted as basic sensors for the monitoring of fish breeding systems. I stress again that the proposal is to have an expandable system, and

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can be coupled and programming more sensors to the module when you need it. As for software, there is no budget expenditure, since we will use free software.

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National School Feeding Program (PNAE): An economic perspective for the family farmers of the municipality of Rio do Sul / SC

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Abstract— *Formal education in Brazil is benefited by the National School Feeding Program (PNAE), which is destined to the agreed farmers for the production and supplies of part of the food consumed by the students of the public education networks. This study sought to analyze the impacts of PNAE on the evaluation of farmers and managers considering the needs for improvements. It is a qualitative research, the instruments of data collection were questionnaires and interviews with the social actors involved in the program. The results indicate that the farmers evaluated positively PNDE, as it encouraged the production of food, there was an increase in productivity and improvement in family income due to the guaranteed sale of the products; the investments in family agriculture were expanded with the acquisition of machinery and agricultural products generating quality of family life. The factors to be improved were related to the possible increase of the supply and improvement of the price of the products by virtue of the costs of the production, but recognized that it is in the average of the market and with guaranteed return of income. The other managers extol the importance of the program and the incentives to family agriculture; the nutritional factors and food quality of the students were qualified by a nutritionist.*

Keywords— National School Feeding Program; Family farming; Federal Institute of Santa Catarina; Prefeitura de Rio do Sul; Rio do Sul, Brazil.

I. INTRODUCTION

Law No. 11,947, of June 16, 2009, known as the "School Lunch Law", defines that public institutions must use at least 30% of the financial resources received through the National Education Development Fund (FNDE) to complement the purchase of foodstuffs for the school lunch of the states and municipalities (BRASIL, 2009). In addition, it establishes that these foods should be produced exclusively by family agriculture and / or its organizations, giving priority to agrarian reform settlements, traditional indigenous communities and quilombola communities (BRAZIL, 2009).

The National School Feeding Program (PNAE) is the Brazilian government's program in the area of school feeding and Food and Nutrition Security (SAN) and is considered one of the largest and most comprehensive in the world involving the guarantee of the human right to adequate and healthy food in school. It is a public policy, managed by FNDE, an authority of the Ministry of Education (MEC), complements all students enrolled in basic education in public, federal, philanthropic, community and denominational schools in the country, according to the principles of Human Right Adequate Food (DHAA) and SAN. (FNDE, 2015).

The family farmer has an essential participation in the PNAE, since he is responsible for the production of part of the food consumed by the students of the basic level public education system. The proposal for this article is based on one of the guidelines of the PNAE, which consists in encouraging the acquisition of foodstuffs produced, preferably, by local family agriculture. Based on this principle, the research reveals how the family farmers evaluate the PNAE in the city of Rio do Sul, which occurs through agreements with the City Hall and the Federal Institute of Santa Catarina (IFC), based in this city.

The general objective of this research is to: Analyze the impacts of the PNAE on the evaluation of

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farmers and managers considering the needs for improvements. The work developed in this study is fundamental for the country, since it evaluates an important Public Policy for family farmers in food production and contribution to students in their nutritional and health conditions. It may also become a qualitative reference for other countries in the organization and production of school meals. The research approach was qualitative and as a research technique, the questionnaire was used for the interviews. For the collection of data, the family farmers and the representatives of the City of Rio do Sul and the Federal Institute of Santa Catarina.

II. THEORICAL FRAMEWORK

2.1 NATIONAL SCHOOL FEEDING PROGRAM (PNAE)

The political and organizational structure that gave rise to what is the PNAE these days began in the beginning of the 1950s through the National Food and Nutrition Plan. The PNAE throughout its history underwent several transformations and adaptations, according to the new demands and new fields of action. The national food plan only continued because of the support received at the time by the International Fund for Childhood Relief (FISI), now known as UNESCO (PNAE / FNDE). The PNAE is a school feeding program with a national scope, since it is a social policy in the process of attending to the students, and especially in the social and economic development of family agriculture (LOPES, 2017).

It can be said that the initial framework of the PNAE was instituted on March 31, 1955, through Decree No. 37,106, which implemented the School Merenda Campaign, subordinated to the MEC (BRASIL, 1955; MEC, 2008; PEIXINHO, 2011).

With the enactment of the Federal Constitution of 1988, the PNAE ceased to be a welfare policy, recognizing in its text the State's obligation to provide school meals for all elementary school students (PEIXINHO, 2011). Since then, the Union has included in its annual budget forecast financial resources destined to the execution of the PNAE (MEC, 2008).

According to Maluf (2009), Peixinho (2011) and Saraiva (2013), an important measure taken at the head of the PNAE occurred in 1994. It was the policy of decentralization of financial resources destined to implement the program, according to Law no. 8,913 of 1994, in which states and municipalities would have autonomy to manage the financial resource received through FNDE for school feeding.

The PNAE, from its inception until 1993 - due to its bureaucracy and internal politics - was implemented centrally by the managing body. This coordinated the actions of management of the program in all its phases, from the purchase of the foodstuffs for the school lunch until the creation and formulation of the menus and distribution of foodstuffs for the whole Brazilian territory (MALUF 2009; SARAIVA, 2013).

According to Maluf (2009), the decentralization of financial resources to implement the program avoided logistical problems and the validity of certain products. And he began to value culture and the local food tradition, Maluf (2009) considers that:

> In a good part of this trajectory, the centralization of the massive purchases of food in the federal sphere favored the predominance of large companies capable, for example, of sending biscuits or sausages from the south-east to the Amazon (MALUF, 2009, p.2).

Law No. 11,947 of June 16, 2009 brought new advances to the PNAE. It enabled the public entities of basic education linked to the MEC to invest at least 30% of the amount passed on by the FNDE in the purchase of foodstuffs produced by local family agriculture, to serve all students in the public basic education network as a supplementary program to educational policy. Through the Federal Constitution of 1988, it is the duty of the public manager to guarantee access and right to school feeding to all students of basic education in the public school system (BRAZIL, 2009).

One of the prerogatives of Law No. 11,947 of 2009 is to encourage state and local governments to create mechanisms that provide for the purchase of foodstuffs from local family agriculture through Public Call (BRASIL, 2009).

> The participation of family farmers in the PNAE can not be considered only in the context of income generation, since the acquisition of products is not only related to the market. In this sense, the social recognition of them as food producers, the appropriation of the right won and the changes in the structures of opportunities are also important elements. "[...] changes are taking place in the sociopolitical and productive organization of the actors. It is concluded that the implementation of the prerogatives of the PNAE, as of Law 11,947 / 2009, increased the social opportunities of family farmers, fostering and fostering new commercial possibilities, new ways

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> of doing agriculture, of social organization and the conquest of a new form of citizenship (WAGNER et al.,2016, p. 121).

Grisa and Schneider (2015) note that the program is a public policy that came with the proposal to include family farmers in the public purchasing market. One of the proposals of Law No. 11,947 of 2009 is to strengthen the local and social dynamics of family agriculture, valuing local and regional production in the market. According to Lopes (2017), the purchase of foodstuffs through PNAE has been well accepted and has brought good results for family farmers, and participation in the program has enabled gains in quality of life and income for families.

> The program has an expressive acceptance on the part of the familiar farmers, who declare the contribution of this one in the development of the familiar agriculture, of the cooperativism and associativism. According to the study, it can be seen that farmers are improving living standards, increasing the diversification of production and improving the distribution of income throughout the year (FERKO et al., 2016, p. 683).

One of the PNAE guidelines is to purchase food products produced by local family agriculture.

> In short marketing channels, the rural and personal (and not industrial and "impersonal") origin of the food is valued, the productive and food culture is rescued, valuing the identity and work of those who produce and transform the food, causing and in the nearby countryside. It is the rurality of family agriculture that "takes body" and cheer up. (GRISA; PORTO, 2015, p. 165).

The FNDE finances and manages the PNAE at the national level. The additional financial resource that the executing entity is entitled to receive is carried out by FNDE. Due to the FNDE's decentralization policy, the financial resources to execute the PNAE are automatically credited to a specific current account, opened by the FNDE itself, to the educational institutions and bodies of the public elementary level public school system (FNDE, 2015; ROCHA, et al., 2017).

It is considered an executing entity of the PNAE every public institution or institution that has students enrolled in the basic level public education system. Thus, institutions have the right to receive the resources allocated to the PNAE, provided that the number of students enrolled is informed in the previous year's School Census (FNDE/PNAE, 2017; ROCHA, et al., 2017).

AR = NA x Nd x VM

AR = Amount receivable;
Na= Number of Students;
Nd = Number of school days;
Vm = Value of teaching modality

The calculation for the receipt of the financial resource of the PNAE is made based on the School Census of the year prior to the receipt of the financial release by the FNDE, taking into account the number of school days of the month and the modality of education. The installments to be paid are deposited in a specific current account of each executing entity, in ten installments throughout the school year. The Federal Institutes have a difference in relation to the other beneficiaries, since they receive the value of the FNDE in a single quota. Table 11 below shows the teaching modality and unit value that the institution receives via FNDE, to be transferred to the educational entity benefited through the PNAE (FNDE / PNAE, 2017; ROCHA, et al., 2017). It is possible to verify that the daily value per student higher R$ is for the schools of the Program of promotion to the schools full-time with 2.00, followed by the Day-care and Comprehensive Education with 1.00.

Table 11: Value of financial pass through by FNDE according to the modality of education of the educational institution

Teaching Modality	Daily value per student (R$)
• Nursery	1,07
• Pre school	0,53
• Indigenous and quilombola schools	0,64
• Elementary and high school	0,36
• Youth and Adult Education	0,32
• Integral education	1,07
• Full-time School Promotion Program	2,00
• Students attending the Educational Service Specialized in the countershift	0,53

SOURCE: FNDE / PNAE 2018. Table prepared by the author.

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The FNDE is an autarchy linked to the MEC that manages the financial resources for the attendance of school feeding in the public level education level. It operates in the municipalities, states, Federal District, Armed Forces, community entities, philanthropic and non-profit organizations that are considered members of the public education network and that meet the criteria established in Resolution nº 26 of the FNDE of 2013 (FNDE, 2013).

FNDE, in addition to administering the PNAE, is also responsible for calculating the amount that the executing agency of the policy will be entitled to receive. O FNDE "(...) *sets standards, monitors and supervises the execution of resources received, as well as evaluating the efficiency and effectiveness of the Program*" (ROCHA, et al., 2017, p. 58).

Table 12 shows the last survey carried out by the FNDE in the year 2015 informs that 3,759 billion reais were invested in the purchase of foodstuffs for school meals. With this amount, 41.5 million students were attended. Of this amount, R $ 858 million was invested in the purchase of food from family agriculture for snacks. This corresponds to 22.8% of the total (FNDE, 2015; SEAD, 2018).

Table 12: FNDE investments for the purchase of school meals in the year 2015

	Brazil	Santa Catarina	Rio do Sul
Total purchase value	3,759 billion	119 millions	1.114 millions
Amount purchased from AF	858 millions	43 million	467 thousand
Percentage of purchases AF	22,8	36,13	41,19

Fout: SEAD, FNDE. Table prepared by the author.

For Peixinho (2011), the PNAE aims to guarantee students access to healthy and adequate food corresponding to their age group. It aims to contribute to intellectual growth and development by providing meals that meet nutritional needs, promoting satisfactory school performance and healthy eating habits.

According to FNDE (2015), in the PNAE, responsibility is constitutional and involves, in large part, a large number of social actors such as public managers, teachers, school principals, students' parents, organized civil society, nutritionists, food handlers, family farmers, school feeding counselors and others. Its objective is to contribute to the healthy habits of students and to enable biopsychosocial growth and development in learning, as well as to increase school achievement by meeting nutritional needs by staying in school and contributing to health.

III. METHODOLOGY

It is a qualitative research that evaluates the implementation of the PNAE and also its development with the family farmers who participate in the Cooperative Agricultural Family Serra Taboão, and seeks to understand individual peculiarities and experiences.

For the construction of the field research, visits and interviews with the beneficiaries of the PNAE were carried out. With the social actors that manage the PNAE in the City of Rio do Sul and IFC in Rio do Sul, questionnaires were applied. The interviews with the beneficiaries of the PNAE are of the semi-open type, so that the researcher follows an established and standardized questionnaire. In the accomplishment of the questionnaires the distinction was made according to the group and participation in the PNAE.

The interviews were conducted with the PNAE beneficiaries (group # 01). The application of questionnaires was directed to groups 02 and 03, according to their relationship and participation in the PNAE, in the City of Rio do Sul and IFC in Rio do Sul and Epagri in Rio do Sul, totaling 20 people.

- **Group 01:** interview with 7 families (husband and wife) of Farmers belonging to the Cooperative Agricultural Family Serra Taboão of the municipality of Rio do Sul;
- **Group 02:** application of a questionnaire to the Agronomist of the Department of Agriculture, Secretary of Education and to the Secretary of Finance of the Municipality of Rio do Sul;
- **Group 03:** application of a questionnaire with the Director General, the Director of Administration and Nutritionist of IFC of Rio do Sul and the Agronomist of Epagri of the city of Rio do Sul.

The research aimed to evaluate whether the participation in Public Policy is economically viable for farmers who participate in the cooperative. In addition, the view of the institutions served was also revealed in order to identify the feasibility, quality and cost / benefit to the buyers.

IV. RESULTS AND DISCUSSIONS

Interviews were conducted with seven families of family farmers who answered 21 questions. However, as a matter of space, more central questions and answers were chosen because the data reveal the impact of the NAP in the lives of the farmers involved and in what aspects the Program

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could be improved. The following are the issues that significantly illustrate the intent of this research.

The first question to the farmers directed to the objectives of the research, seeking to perceive the socioeconomic contribution of the PNAE to the families. About the question ***"The sale of foodstuffs to the PNAE brought positive results for the family"****?* The following answers stand out. Identification of farmers is in parentheses. Being the letter A - Farmer, the number refers to the family interview and the letter M or E - indicates whether the respondent was the Husband or Wife.

> *"I brought it, the PNAE was good. Good great. Better price too, right? Because even in the market you can, there is a time when you can get a good price, not even in the PNAE, but it is not always, right."? (A6-M)*
>
> *"For sure. That was it. It was an incentive for agriculture. This PNAE. Thanks to that the majority of farmers so still in agriculture today because of the sale of PNAE". (A5-M)*
>
> *"Yes, we started agroindustry, made the garage, now made the kitchen, bought machine. Even a restaurant we got the sale now". (A3-M)*
>
> *"And to complement, I want to point out ... that when we started we started in a small area, in the garage, buying a bundle of wheat. Because we could not afford to buy that bundle of wheat. So, from a bundle of wheat, today we do not have any supermarket chains, right, but we've evolved a lot. So I want to say never lose faith. Never give up starting with little. Because our family started with a bundle of wheat. And today is the truck that delivers the wheat at the door of our family agribusiness". (A3-E)*

The improvement in the family financial budget and the quality of life is evident through the above statements. It is perceived that the program provided the maintenance of families in the field, bringing the farmers the right opportunity to sell their products. In the speeches, farmers point out that the guarantee of sale brings security, since the product cultivated counts even with a price previously established, which does not occur in sales to supermarkets or fairs.

Through positive, lively speech, it is perceived that farmers consider participation in NSPP important and interesting to their families. After all, as is evident from previous analysis, the program provided for the reformulation of the crop, changing the cultures with which farmers worked previously (as is the case of tobacco).

The second asked the farmers: ***"With the amount received through the PNAE was it possible to invest in the property? What were the investments"?*** This question sought to investigate the financial return that the program provides. This aspect has value in the sense of identifying if this Public Policy only supplies costs or if it also provides the possibility of investments in the property of the family.

The question was elaborated on the basis of Wanderley (2017). For the author, the lack of agricultural subsidies provokes the rural exodus. Public policies that focus on the development and stimulation of family farming provide financial stability and working conditions for farmers, contributing to the maintenance of the family in the countryside (Wanderer, 2017). Therefore, Question 03 investigates the possibility of investments in the property, considering the resources obtained through the PNAE. For this question, the following answers stand out::

> *"[...] The PNAE also helps pay for PRONAF funding, you do not have to wait just for the crops, right? We're putting this money together a little at a time.". (A2-M)*
>
> *"Look ... [...] since the PNAE came the baking house was made, right. An investment. It was well [...] that the aid for [...] the sale of the PNAE was encouraged. With that we invested to make the House of Biscuit, which today is Sweet Delight, right. That is selling well, and that is the lever of the family".*
>
> *(A5-M)*
>
> *"Look, I've invested a lot. I'm paying for my car, I'm improving the property [...] that's zero, I'm still paying! (laughs). We bought a Yamaha, too, a Yamaha Scooter. We were able to buy everything from it. Tracked tap. First year I bought Yamaha, then second year [...] also financed [...] but paying with the money that came in from the PNAE".* *(A6-M)*

All the interviewees highlighted the possibility of improving the rural property using resources obtained through sales to the PNAE. Through the answers obtained, it is perceived that the PNAE provides a financial return to farmers. The degrees of investment vary. Each interviewee highlighted improvements in the

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properties that were possible with the resources of the program. In addition, they revealed that with the PNAE's profit it is possible to pay personal accounts and financing through Pronaf (National Program for Strengthening Family Farming), and with that they acquired agricultural equipment aimed at increasing production, agility in agricultural work. They also acquired means of transportation for their productions and for personal use. The program has provided the farmer with improvements in his property. Through these investments your income improves and provides more quality of life to your family.

It was possible to identify expressions that were very focused on the positive points of the PNAE, from the point of view of the family farmers. There are evident impacts and results that the public policy reaches in practice having its pros and cons pointed by the participating agents. Carvalho (2003) considers that it is through the observed changes in the behavior of the final beneficiaries that the impact of a public policy can be evaluated. And for this, it is important to consider the evaluation of family farmers, who had their activities redirected after joining the PNAE.

Based on this understanding and the search for possible weak points, which require evaluation, the following question was elaborated: **"*Does PNAE need to be improved? In what aspects*"?** The questioning presented to the family farmers sought to evaluate the social effectiveness of the PNAE, allowing the direct beneficiaries of the program to express their point of view (CARVALHO, 2003). This issue will contribute to a significant evaluation of the program, realizing its efficiency and effectiveness.

Accordingly, the answers below express the views of the beneficiaries of the program:

> *"[...] if the value was a little higher it would be better, right. Because nowadays we have all the expense, fuel [...] that we will not take, delivery, right. So the fuel is now rising almost weekly, almost daily [...] but on the other hand we are finding this price good because it is fixed, right. If the price of the commodity goes down in the market these four, five months we have of the public call is the same price. Only if it doubles in the market we will only receive that price of the public call, right. So we will depend a lot on the market price. If the price there is good, we will earn good price for four, five months. And if the price is [...] if he dips, we get good price. So, after all, it would be better a little. I think it's fair value. If the law is done this search in three larger market to do the average then they so doing. So we can say that it's good, right?".* ***(A2-M)***
>
> *"The amount could be bigger, it's, much bigger. That helped more and we produce, we can produce".* ***(A6-M)***
>
> *"Just ... I think it would be the quota of... increasing the quota of each producer".* ***(A5-M)***
>
> *"Yeah, maybe more items, right? Today, as we see it is market value, right. I think the prices if we were to look them up so good. (...) Of course if they paid more would be better, but only take the demand, right?".* ***(A7-M)***

The above opinions allow for different analyzes. First, it is observed that the value received by the products supplied through the PNAE is satisfactory to the farmers. On this, the farmer A2-M showed in his speech that with the average estimate of market prices, if there is a fall in the purchase value of some food, the price contracted through the public call remains. The respondents were satisfied with the prices proposed through the public calls for supply of food items through the PNAE, but because of the costs, they think that it could be higher.

All farmers stressed that they would be able to provide more or even provide various items. However, they understand that items are bought based on demand, that is, what each school needs or what the IFC needs for meals of its student numbers.

Based on the interviewees' speeches, the following aspects stand out:

- PNAE guarantees farmers the accurate supply of food items, with previously established quantities;
- The price at which farmers sell food is considered fair, since it is established on the basis of the market average, but because of the costs they think it could be higher;
- When there is a fall in the price of a product on the market, the farmer does not suffer the impact, since he will receive the amount previously established through the Public Call Notice;
- Even if the price of the product rises in the market, there is no loss, since the

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average value is established, it is already known by the producer;

- There is a good level of knowledge on the part of family farmers about the rules and functioning of the program;
- PNAE participants express an interest in providing greater diversity of items, or even larger quantities through the program.

Based on the notes constructed through the reports, the effectiveness of this public policy can be verified. Farmers' assessment of the program is positive because the only aspect considered negative is the fact that "they would like to provide larger quantities or more items for school meals through PNAE".

Regarding the data collected with Group 02, the following social actors answered the questionnaire:

- Municipal Secretary of Administration and Finance;
- Agronomist of the Department of Agriculture of the Municipality of Rio do Sul.

The answers will be analyzed below, according to the order of the questionnaire elaborated. As a matter of space, we selected the most relevant questions for the research.

The first question, together with the analysis of the: **"*What obstacles have been encountered for family farmers in Rio do Sul to be able to market their production with local trade"?***

This question was elaborated in order to understand how social actors see the difficulties encountered by family farmers in the marketing of their products. In her reply, the Agronomist expressed the following:

> *"I believe that individually, farmers can not get enough of them to meet the demands of the markets. You must have quantity and constancy for delivery [...]"*

The aspect reported by the engineer turns precisely to the fact that we are talking about the family farmer, the small producer. It finds a limiting factor of area for production. Rural farms have an average of 22 hectares, which is consistent with the reality of the state of Santa Catarina. The interviewee continues her answer referring to the climatic variations of the region, with long periods of intense rains and periods of drought. It also reports the occurrence of hail, which seriously damages plantations.

In answering the same question, the Municipal Secretary of Administration and Finance answers that yes, that the obstacles exist. However, in its response it presents the actions taken by the public power to deal with this problem:

> *"[...] There are incentives, such as: technical monitoring and training through the Executive Board of Agriculture and partner entities, municipal legislation that advocates the purchase of products from municipal family agriculture, the purchase process in products, in which the price is established according to paid in the markets, increasing the profit margin".*

Based on the answer given by the Secretary, it is possible to identify coherence with the statements of the farmers and their levels of satisfaction in the program and to return to the understanding of Secchi (2016) that the decision of the public manager is based on information that requires analysis. Based on a clear analysis, it is up to the public manager to base his decisions and to carry out solid actions focused on the collective good for the benefit of the population.

The incentives which the Secretary speaks in practice express what Secchi (2016) understands as action to be carried out by the public manager. On the basis of the answers to the first question, it is clear that family farmers find obstacles to market their products. However, government actions seek to solve the problems encountered, giving farmers a better.

The second question was thus elaborated: **"*In your opinion, what difficulties does the family farmer find in order to be able to market his production with public agencies"?***

Here, the questioning approaches the action of the public power, in the sense of making the respondents perceive the difficulties faced by the family farmer. The engineer's response is punctual:

> *"The bureaucracy. Overall, farmers do not like to deal with paperwork. In addition, it is necessary to fit into some standards to be considered a rural producer. Our farmers mostly practice pluri activity, and one of the requirements to participate in sales is to have the DAP (Aptitude Statement) for various public policies and this implies documentation delivery and proof of income".*

The Engineer's response presents a different point of view than the one presented by the Secretary: *"We do*

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not have difficulties, since the delivery is even carried out directly in the educational entities, guaranteeing the delivery of fresh products".

By means of the answers to the second question, it is noticed that the engineer observed a difficulty that could be experienced by the farmers, since the preparation of documents for participation in calls for public calls certainly demands specific understandings. The Secretary ends by expressing the point of view of the public power, reporting the inexistence of difficulties.

About Grupo 03, the Director of Administration and the Nutritionist, both from the IFC of Rio do Sul, answered questions. For lack of space, we reproduce only two questions:

To the Director of Administration of IFC of Rio do Sul, we made the following inquiries:

"*What benefits and advantages did the PNAE bring to IFC"?*

The manager's response to this questioning brings important information, as transcribed below:

> *"We can cite as a greater benefit the receipt of fresher products and with little interference from pesticides, allowing the students to consume healthy foods. Besides this factor we can mention the fact that we are a school with an agricultural vocation where students can verify that it is possible to practice family farming obtaining income for the permanence of families in the field. It ends up being, in a way, a showcase of family agriculture, predominant in our region".*

The view expressed by the manager interviewed here consists of a positive evaluation and reinforced by important characteristics of the PNAE. Carneiro (2013) considers that evaluating performances in the public sector leads to an efficient control of public policies adopted and conducted by the State.

Here is another question to the manager: **"*The IFC is applying a percentage higher than 30% in the purchase of foodstuffs produced by local family agriculture, according to the recommendation of the PNAE"?***

The manager's response to this question is accurate, and he demonstrates the percentages applied annually. In 2016 it was 79%. In 2017, 43%, and already in 2018 rises again to 77%. The numbers presented by the Director of Administration demonstrate compliance with the determinants of the PNAE guidelines, and the institution has been applying a percentage always higher than 30% in the purchase of foodstuffs through the PNAE.

The nutritionist of the IFC in Rio do Sul elaborated the following question:

"*What is the benefit to school feeding of foodstuffs produced in family farming"?* To this questioning, the nutritionist highlights a striking aspect and is also emphasized by the farmers, who are directly committed to the quality of the product:

> *"The main benefit is the "freshness" of food. We know that they are harvested close to the delivery date and with this it is believed that the nutrients and properties of food will be preserved".*

The response of the nutritionist is related to what Gomes (2006) recommends that the nutritional standard and the quality of food are important aspects of food safety. For the FNDE (2015), the purposes of the PNDE comply with Law No. 11,947, of June 16, 2009, establishes as directives of school feeding in its goal of healthy and adequate food, directing that varied and safe foods should be used, also respecting the culture and the traditions, with eating habits healthy. They are contributions for the growth and the development and improvement of the scholastic performance of the students, according to age and its state of health.

They are purposes and practices that indicate the valuation of natural and fresh food to the students of the schools. This is a program that has resized the offer of snacks, presenting a food closer to the desired and necessary to the health and nutritional conditions of the students.

Food is a right proclaimed in the Universal Declaration of Human Rights, since 1948, linked to standards of living assured to health and well-being. Actions that promote rights and quality of life are fundamental to the governmental responsibility of each country, especially food that basic need to live and ease suffering.

V. CONCLUSIONS

The quality of school feeding in Brazil permeates Public Policies with programs involving the family farmer, the National School Feeding Program (PNAE). An alimentary proposal that involves the nutritional quality of the foods with products originating from the agricultural crop, avoiding the industrialized foods.

A proposal that has the effective participation of farmers who contribute to the proper nutrition of students in schools and pervades social and humanitarian

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responsibility. Students have benefited from natural and fresh foods that contribute to nutritional needs. Farmers have also benefited from agricultural production of food, among the main advances are the improvement of family income and the possibility of investments in agriculture in appropriate care with land and its inputs; in improving agricultural equipment for production; in increasing productivity and guaranteeing the sale of the products supplied.

Farmers' statements indicate a positive evaluation of the PNDE with the expansion of the family financial budget and the quality of life was very evident in the statements of the farmers. The program provided the maintenance of families in the field and more professional and financial stability with the proper valuation of products. There was an incentive for food production, productivity and guaranteed product sales.

Few of the factors to be improved were cited, namely those related to the increase in supply and the price of products because of production costs. There was recognition that the amounts paid are in the market average.

This is a program that can become a worldwide example of food supply to schools and quality assurance in school meals, mainly by encouraging the planting of natural foods and their consumption, favoring food and health of students. The nutritionist highlighted the "freshness" of food, so the nutritional factors and food quality of the students were qualified by the nutritionist.

All management respondents confirm the quality of the program and the benefits to those involved in agriculture and to students in schools with a guaranteed quality of food.

This is a Program that has fulfilled with its constitutional responsibility and social, human and citizen purpose and has greatly contributed to the stimulus to the exercise of social control; the dynamization and valorization of the local economy, and family agriculture involving employment and income, also valuing more natural eating habits. It is a proposal that could contribute with other countries in the demands of school feeding and valorization of local agricultural production.

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Applicability of Homologous Fibrin Sealant in Bone Repair: An integrative Review

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Abstract *— The repairing of bone defects is still a challenge for researchers and clinicians. No netheless there are many procedures that use different biomaterials such as scaffolds for bone regeneration however the results are often still unsatisfactory. As a result, the fibrin sealant derived from the interaction between proteins participating in the final blood coagulation cascade, is one of the most promising biopolymers in the tissue engineering field due to its unique characteristics. The present study aimed to perform a systematic review on homologous fibrin sealants highlighting its applicability as a three-dimensional framework in the process of bone regeneration. The database used for search strategy was the PubMed (Medline) and followed the guidelines provided in the PRISMA statement. From an initial 313 articles, only 12 articles between 2009 to 2019 were selected for this review after checking all inclusion and exclusion criterias. Due to this background, it is notable that fibrin sealant is one of the promising biopolymers used for tissue engineering and bone regeneration applications.*

Keywords *— **Fibrin Sealant, Bone Repair, Tissue engineering, Biopolymer, Scaffold.***

I. INTRODUCTION

Bone is a highly dynamic tissue that undergoes a continuous renovation process to maintain its architectural bone structure, mechanical properties and metabolic capacities and when injured is able to reestablish the lost tissue morphofunctional characteristics without compromising the function (SEAL; OTERO; PANITCH, 2001; LOI et al., 2017).

However, this mechanism may or may not occur in large defects, such as tumor resections, unconsolidated fractures, congenital malformations, and the loss or surgical removal of bone fragments (HONMA et al., 2008; SPICER et al., 2012; HETTIARATCHI et al., 2017), in addition, it may require reconstructive operative procedures whose bone grafting is the main treatment technique (POUNTOS; GIANNOUDIS, 2016; BAI et al., 2018).

Among the available bone grafts, the autogen is still considered the gold standard in the bone regeneration techniques because it has osteogenic, osteoinductive and osteoconductive properties combined. Although its use is associated with limited supply, possible complications in the donor site and the unpredictability of bone resorption, which may negatively influence postoperative outcomes (POLLOCK et al., 2008; PILIPCHUK et al., 2015).

Because of these limitations, research is being conducted in order to a new treatment approach for bone regeneration, aiming at the development of biologically active natural materials (GHIASI et al., 2017).

As a result, the fibrin sealant derived from the interaction between proteins participating in the final blood coagulation cascade, is one of the most promising biopolymers in the tissue engineering field due to its unique characteristics (NOORI et al., 2017).

For instance, its excellent biocompatibility, controllable biodegradability, and multi-functional three-dimensional structure that provides support, cell proliferation and differentiation, anchoring surrounded molecules and growth factors and therapeutic agents transport, makes fibrin sealants have remarkable advantages over other biomaterials, besides a candidate

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with potential to assist in engineering of bone tissue (SHIU et al., 2014; SPOTNITZ, 2014; BORIE et al., 2015).

Although, all fibrin sealants contain fibrinogen and thrombin, qualitatively and quantitatively the exact composition varies, such as the velocity of rate of hemostasis, clot biochemistry, viscosity, adhesive strength, durability, fibrin polymerization rate and the three-dimensional structure of the clot, and can directly influence its use (WOZNIAK, 2003; DIETRICH et al., 2013; CUNHA et al., 2015). For this purpose, the present study aimed to perform a systematic review on homologous fibrin sealants highlighting its applicability as a three-dimensional framework in the bone regeneration process.

II. MATERIALS AND METHODS

This review followed the guidelines provided in the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Medical subject heading (MeSH) terms were used in this study. The database used for search strategy was the PubMed (Medline). The search string used was following these terms "**fibrin sealant AND bone repair**".

It has been included all articles in English at periods between 2009 and 2019, with access to the full text, either openly or by signatures available at the University of São Paulo (Brazil).

The titles and abstracts of the articles were evaluated and those that did not meet each inclusion criteria were removed from the review. After second analysis, only articles that used fibrin sealant as a three-dimensional scaffold for the lodging of biologically active cells and molecules in the bone regeneration process were selected for detailed review.

Inclusion Criteria:

- Periods between 2009 – 2019;
- Articles types: full articles available;
- English language;
- In vivo research model;
- Fibrin sealant used as a scaffold for tissue engineering applications.

Exclusion Criteria:

- Any article that did not meet the inclusion criteria listed earlier.

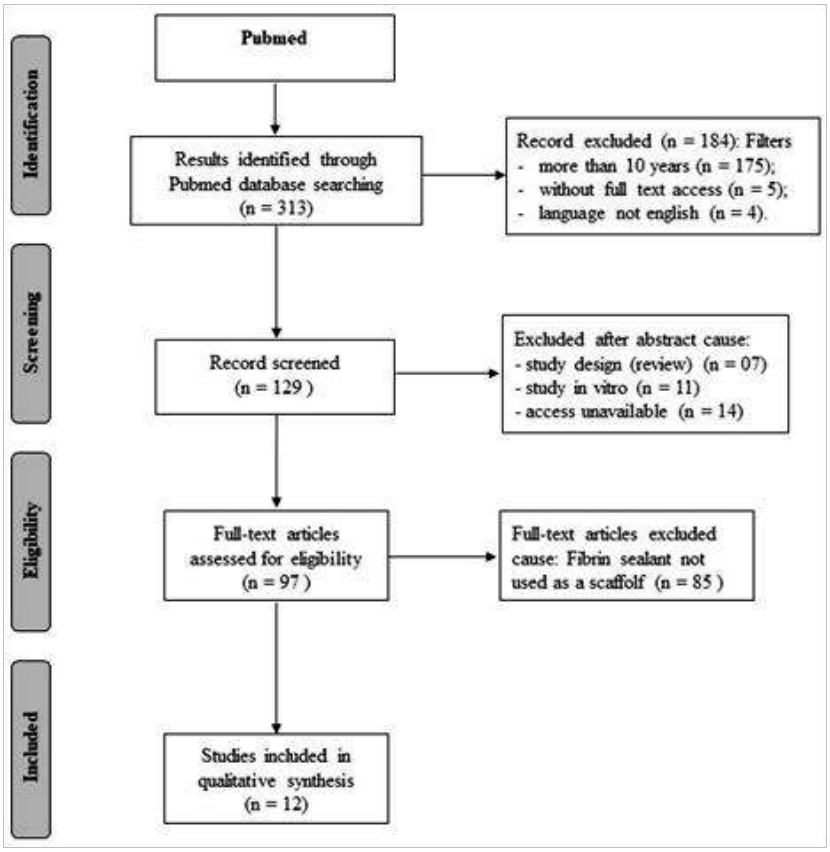

Fig.1: PubMed (Medline) Keywords combination

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III. RESULTS

In total, from an initial 313 articles, only 12 articles were selected for this review (see Table 1) after checking all criterias listed earlier such as periods between 2009 to 2019, full articles available, English language, fibrin sealant used as a scaffold for tissue engineering and in vivo research model. For full search process see Fig. 1.

Table 1 Summarizes of the selected articles about tissue engineering applications of fibrin scaffolds.

Author (Date)	Objective	Component origin and/or Trade name	Implantation Site	Mixture with biomaterials or cells	Conclusion
McDuffee et al. (2012)	To compare the efficacy of osteoprogenitors in fibrin glue to fibrin glue alone in bone healing of surgically induced ostectomies of the fourth metacarpal bones in an equine model.	Homologous (non-commercial)	Metacarpal bone in horses	Osteoprogenitor cells or fibrin sealant alone	Injection of periosteal-derived osteoprogenitors in a fibrin glue carrier into surgically created ostectomies of MC4 does not accelerate bone healing.
Reppenhagen et al. (2012)	To assess the safety and efficiency of a bone substitute as an alternative for autologous bone in the treatment of benign bone tumours and tumour-like lesions.	Homologous Tissucol™ Duo S	Distal tíbia; calcaneal; glenoid in human	Biphasic calcium phosphate granules	The biomaterial represents an easy-to-handle alternative to autologous cancellous bone grafts for the treatment of benign bone tumours and tumour-like lesions.
Zhang et al. (2012)	To clarify whether it could be efficient to reconstruct the alveolar bone by the combination of bone marrow stem cells (BMSCs) without pre-osteoinduction in vitro with fibrin glue (FG).	Homologous (non-commercial)	Rat alveolar bone	Bone marrow stem cells	The results suggest that the strategy of combing BMSCs with FG is effective in the repair of alveolar bone defects. Its clinical application is promising.
Streckbein et al. (2013)	To evaluate the efficacy of bioactive implants (ADSC in fibrin glue) for repair of critical-size mandibular defects in athymic rats.	Homologous Beriplast™ P	Mandibular defects in rats	Adipose-derived stem cells	Fibrin sealant is a suitable biological scaffold for cell transplantation.
Xuan et al. (2014)	To compare the potentials of PRF-mixed Bio-Oss® and Tisseel®-mixed Bio-Oss® to enhance bone regeneration in	Tisseel™	Canine sinus model.	Demineralized bovine bone	The findings from this study suggest that when platelet-rich fibrin is used as an adjunct to Bio-Oss® particles for bone augmentation

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Author (Date)	Objective	Component origin and/or Trade name	Implantation Site	Mixture with biomaterials or cells	Conclusion
	a canine sinus model.				in the maxillary sinus, bone formation in the graft sites is significantly greater than when Tisseel® is used.
Lappalainen et al. (2015)	To evaluate ossification of cranial bone defects comparing the healing of a single piece of autogenous calvarialbone representing a bone flap as in cranioplasty compared to particulated bone slurry with and without fibrin glue to represent bone collected during cranioplasty.	Tisseel™	Rabbit calvarial	Autologous particulate bone	Autogenous bone grafts in various forms such as solid bone flaps or particulated bone treated with fibrin glue were associated with bone healing which was superior to the empty control defects.
Santos et al. (2015)	To compare the potential of bone repair of collagen sponge with fibrin glue in a rat calvarial defect model.	Tissucol™	Rat calvaria	Fibrin sealant alone	Results have shown the benefits of using collagen sponge and fibrin glue to promote new bone formation in rat calvarial bone defects, the latter being discreetly more advantageous.
Zazgyva et al. (2015)	To establish an experimental model and assesses the effect of glass granules fixed with fibrin compared to fibrin alone as fillers of the osteochondral defects created in the weight-bearing and partial weight-bearing regions of the distal femur in six adult rabbits.	Tisseel™ Lyo	Rabbit distal femur	Bioactive glasses	A commercially available fibrin sealant can be successfully used to retain bioactive glass granules in the defects, offering a fast intra-operative and a subsequently stable fixation.
Hao et al. (2016)	To evaluate the efficacy of local injection of bone mesenchymal stem cells (BMSCs) and fibrin glue in the	Homologous (non-commercial)	Rat distal femur	Allogeneic bone mesenchymal stem cells	The analyzes demonstrated that local injection of BMSCs-seeded fibrin glue promoted

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Author (Date)	Objective	Component origin and/or Trade name	Implantation Site	Mixture with biomaterials or cells	Conclusion
	treatment of atrophic nonunion in an animal model.				atrophic nonunion repair.
Mehrabani et al. (2018)	To investigate the healing and regenerative effects of fibrin glue associated with adipose-derived stem cells (ADSCs) and fibrin glue scaffold alone with autologous bone grafts in experimental mandibular defects of the rabbit.	Autologous	Rabbit mandible	Adipose-derived stem cells	The healing process had a significant increase in the thickness of new cortical bone when fibrin glue scaffold associated with Adipose-derived stem cells was used.
Pomini et al. (2019)	To evaluate the support system formed by a xenograft fibrin sealant associated with photobiomodulation therapy of critical defects in rat calvaria.	Tisseel™ Lyo	Rat calvaria	Demineralized bovine bone	The support system formed by the xenograft fibrin sealant associated with the photobiomodulation therapy protocol had a positive effect on the bone repair process.
Rezaei et al. (2019)	To evaluate the effects of PRP and canine BM-MSCs (marrow-derived mesenchymal stem cells - cBM-MSCs) in combination with a suitable carrier (fibrin glue) on periodontal regeneration.	Autologous	Dog class II furcation defects	PRP, cBM-MSCs and alone	More studies should be done in order to recommend an effective therapeutic approach that induces endogenous regenerative processes, such as cell homing.

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IV. DISCUSSION

The aim of the present study was to perform a systematic review of the homologous fibrin sealants unique properties as a support material for cell adhesion, migration, proliferation and differentiation, and to enhance the physical and biological osteoconductive biomaterials properties.

The advances achieved in reconstructive surgical techniques combined with the development and natural biopolymers improvement by tissue engineering have attracted the attention of several research groups because it is a promising alternative to existing treatments (CHEN; LIU, 2016).

Among the available sealants, fibrin sealants are the most promising in this field due to the combination of excellent biocompatibility, biodegradability and intrinsic bioactivity. Additionally, over the last few decades emphasis has been placed on the importance of fibrin sealant properties in the repair of bone defects in different anatomical regions (NOORI et al., 2017).

As a consequence, it has been searched for alternative methods to obtain blood components, for this reason, a group of researchers from Center for the Study of Venoms and Venomous Animals (CEVAP-Unesp-Botucatu-SP-Brazil) has developed a fibrin adhesive derived from the snake *Crotalus durissus terrificus* venom and the buffalo blood. In its composition, the cryoprecipitate containing fibrinogen and coagulation factors are derived from the buffalo blood (*Bubalus bubalis*), and the functional thrombin by gyroxin, a thrombin-like protein derived from the snake (FERREIRA, 2014; BISCOLA et al., 2017; FERREIRA et al., 2017; MOZAFARI et al., 2018).

Likewise, fibrin biopolymer is a clinically useful tool due to flexibility and applications diversity such as nerve injury repair, chronic ulcer treatment, and bone repair (BUCHAIM et al., 2015, 2016, 2017; DE OLIVEIRA GONÇALVES et al., 2016; ROSSO et al., 2017).

Hence several studies have been reported the use of fibrin sealants as a support for mesenchymal stromal cells (MSCs) and stem cells derived from adipose tissue to facilitate cell attachment, growth and differentiation, allowing enhancement of expansion and survival in the area implanted (RYU et al., 2005; KALBERMATTEN et al., 2008; VADALÀ et al., 2008).

In the same time, the insertion of these cells into the three-dimensional fibrin network has presented promising results in the process of bone repair in several models (ZHANG et al., 2012; STRECKBEIN et al., 2013; HAO et al., 2016; MEHRABANI et al., 2018; REZAEI et al., 2019). In addition, these researchers suggested that fibrin sealant is able to lead a stem cells microenvironment, without deforming its structure, increasing cell survival time and therefore being effective in repairing bone defects.

However, previous results from McDuffee et al. (2012) contradict the previously mentioned results, since they affirm that osteoprogenitor cells inserted in the three-dimensional network formed by fibrin sealant is not able to accelerate the process of bone consolidation.

Despite, the fibrin sealants have beneficial characteristics in the bone regeneration, it is still not possible to have precise control over the microarchitecture of these materials and good tensile strength (GUÉHENNEC; LAYROLLE; DACULSI, 2004). Consequently, is necessary to associate with materials that have great scaffolding potential in many tissue engineering applications in order to minimize or eliminate these limitations. In this way, it allows the manufacture of multifunctional scaffolds with greater resistance mechanics, the graft greater stability in the surgical site, and longer time of cellular support throughout the process of bone repair (AHMED; DARE; HINCKE, 2008).

Several experimental and clinical trials have demonstrated the synergistic characteristics of fibrin sealant associated with materials that have great scaffolding potential led to satisfactory results (REPPENHAGEN et al., 2012; XUAN et al., 2014; LAPPALAINEN et al., 2015; ZAZGYVA et al., 2015; POMINI et al., 2019).

V. CONCLUSION

Due to this background, it is notable that fibrin sealant is one of the promising biopolymers used for tissue engineering and bone regeneration applications. Indeed, the combination with different types of bone grafts, biomolecules and stem cells make this scaffold unique and attractive feature for futures studies.

Nevertheless, there is a necessity for additional studies, for evaluation the concentrations of the components, as a fibrinogen and thrombin, which directly interfere in the density of the network, allowing or not the cellular migration and consequently the bone consolidation.

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The Concept of Precariousness: What Definition?

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Abstract*— *Through this article, we try to give a definition of the concept of precariousness by adopting a historical approach. Indeed, at the beginning the term "precariousness" was adopted in a way that confused poverty or exclusion without distinguishing the meaning of each of these terms. Then, this concept "precariousness" covered two social realities. The first is related to poverty and vulnerability and the second is associated with the different statuses of jobs. In the end, this notion has been developed by producing another a broader concept that is the precariat. This last word comes from the contraction of "precariousness" and "proletariat" to designate a new social class undermined by economic insecurity and the daily anxiety of precariousness.
Keywords*— *Exclusion, Insecurity, Poverty, precariat, Precariousness, Vulnerability.

I. INTRODUCTION

The concept of "precariousness" has undergone a historical evolution. Our problem is to project light on this term while seeking to answer the following question: what definition can we assign to precariousness?

Referring to the literature and following the historical evolution of this term "precariousness", we try, in the first section of this article, to advance a definition by history, in its second section, of treating the relation between work and precariousness and in its third section, distinguishing the concept of precariat from precariousness.

II. PRECARIOUSNESS: A TEST OF DEFINITION BY HISTORY

Since the end of the seventies, the term "precariousness" has become commonplace in political discourse in France. The use of the term appeared in the social and medico-social sector in a context characterized by the economic crisis of the early eighties and which generated a massive increase in unemployment in the context of the "new poverty.

Historically, it was in the years following the economic crisis of 1973 that the notion of precariousness appeared.

Theoretically, the term "precariousness" can be adopted in a way that confuses poverty or exclusion without making any distinction as to the meaning of each of these terms. According to Lochen Valérie, poverty can be considered relatively or absolutely. Relative, it is treated in terms of inequalities within a society. Absolutely, poverty means not having some basic opportunities for material well-being and immaterial resources, including knowledge and culture[1].

However, the exclusion is related to the non-realization, or the inadequate realization, of certain rights by individuals, human rights for the Council of Europe, but more generally social rights for the European Union. . Similarly, Join Lambert (1995) proposes to define exclusion based on the non-respect of civil, social and political rights that are declared open to everyone in a given geographical entity.[2]

The term "precariousness" since it appeared, and that was imposed, in the 1990s, in the heart of the scientific, politico-administrative and media fields to make understandable a multi-faceted insecurity and mark an area of social fragility and economy marked by an uncertain relationship in the future[3]

In France, in 1985, J. Wresinski drew up a report on poverty entitled "Great poverty and economic and social precariousness" in which the author defined precariousness as: The absence of one or more securities, notably that of employment, enabling individuals and families to fulfil their professional, family and social obligations and to enjoy fundamental rights. The resulting insecurity may be more or less extensive and have more or less serious and definitive consequences. It leads to extreme poverty when it affects many areas of life, when it becomes persistent, when it compromises the chances of assuming one's

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[2]**Jérôme BALLET(2001).** «exclusion: definitions and mechanisms »..Edit. l'Harmattan. p.19
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responsibilities again and regaining one's rights by oneself "[4]

Moreover, Patrick Cingolani explains that: "precariousness, translated into insufficient and random income, is the antechamber of poverty, the beginning of socialization, the impossibility of projects, the beginning of a path where it is possible to pass of nothing, because illness or separation adds to their lot of problems that of monetary difficulties of existence[5].

From the sociological point of view, MaryseBresson has distinguished four interpretations of the term "precariousness"[6].

- It can cover all the diversity of social situations in a general framework that makes no distinction with poverty and exclusion. In this sense, René Lenoir in his book "The excluded" which speaks of "populations in social difficulties"
- Precariousness can be distinguished from poverty and exclusion. In fact, precariousness applies to populations that are poorly equipped in terms of income, access to employment and education. However, poverty is an additional degree of denouement and exclusion refers to extreme poverty, including lack of housing.
- It can also designate a life trajectory marked by a movement of impoverishment that is to say populations or individuals who have become or are becoming poorer relative to their environment of origin or their standard of living prior.
- Precariousness is ultimately the uncertainty, the instability of a situation in an ever-changing society.

However, it remains to clarify that the term precariousness was often associated with employment and work. In this context, Serge Paugam, "conceives precariousness as a degradation of employment for life. It analyses the consequences of transforming employment contracts into fixed-term contracts»[7]

In the same vein, Henri Eckert, 2010, sees precariousness as "the perception that disseminates a proletarianization of a fraction of the wage-earning, that which has lost some guarantees-related to full employment-or protections-against unemployment, in particular- from which she had benefited until then and the obsession with dependencies in which their new situation plunges them "[8]

III. WORK OR PRECARIOUS JOB?

In the early 1980s, the term precariousness covers two social realities. The first is related to poverty and vulnerability and the second is associated with the different statuses of jobs. Social precariousness or precariousness related to living conditions is questioned in the context of the social situation of households in terms of purchasing power and the financial constraints vis-à-vis compulsory expenditure.

However, precarious employment is linked to new forms of employment called "precarious jobs" related to the instability and uncertainty characterizing employment situations.

According to INSEE, precarious jobs in France include all employment statuses that are not permanent contracts (CDI), such as: temporary employment, fixed-term contracts (CDD), temporary employment learning and contracts aided.

Jean Claude Barbier has remarkably deconstructed the path of the various variations of the term "precariousness", especially when precariousness was closely linked, starting from the 1980s, to the problem of work, with regard to the break-up of the wage-earning system, to the corollary rise of the instability of employment and the multiplication of atypical forms of it.[9]

S.Paugam, 2000, conceives precariousness as a degradation of employment for life. It analyses the consequences of transforming employment contracts into fixed-term contracts[10]. In the same way, Paugam distinguished, within the framework of the extension of the notion, between precariousness of the job and precariousness of work. For him, the precariousness of the job corresponds to the incapacity of the employee to anticipate his professional future and to ensure his social protection in a sustainable way, because the new contractual forms of employment are considered according to him as precarious jobs. Whereas job insecurity mainly refers to states or situations where work is made useless, uninteresting and poorly recognized by the employer.[11]

In the same sense, H.Eckert, 2010, considers precariousness as "the perception generated of a proletarianisation of a fraction of the wage-earning, that which has lost certain guarantees generally linked to full employment or against unemployment, which it had

[4]***Wresinski J.(1987).*** *« High poverty and economic and social precariousness » report submitted on behalf of the Economic and Social Council. Official Journal 1987..*
[5]***Cingolani Patrick, Coll. (2005).*** *« Que Sais-Je ? »(What do I know?), éd. PUF.*
[6]***Maryse Bresson (2015).*** *« Sociology of precariousness », éditionArmond Colin, p.9*
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benefited until then and the obsession with dependencies in which their new situation plunges them[12].

From the legal point of view, Article L1243-8 of the French Labor Code, mentioned for the first time the term "precariousness" by stating that:

"When, after a fixed-term employment contract, the contractual relations are not pursued by an employment contract of indefinite duration.The employee is entitled, as a supplement to salary, to compensation to compensate for the precariousness of his situation". This is a premium of precariousness that corresponds to an allowance of a minimum of 10% of the total gross remuneration that must be paid to the employee at the end of a fixed-term contract or an interim contract by the employer.

The precariousness of employment generally produces a situation of instability and insecurity for the workers since it periodically generates periods of unemployment. It leads to the disruption of the social and economic life of the employee both physically and materially. However, the precariousness of jobs represents for employers a great advantage in terms of demands and wages.

This situation will lead according to V.HELARDOT, 2005, from the precarisation of employment to the precarious living conditions of workers from the reappearance of new forms of financial vulnerability and poverty, including among people with stable jobs.

The author has stressed the difficulties that can directly influence the conditions and lifestyles (food, housing, clothing,) and disrupt the organization of life in the short and medium term by forcing to live "the day the day "without possibility of projection in the future.[13]

IV. THE NOTION OF PRECARIAT: A CONTRACTION OF "PRECARIOUSNESS" AND "PROLETARIAT"

Over the past three decades, the world of work has undergone a "great transformation" because of the dominance of financial capital in an open and globalized economy characterized by the principle of liberalizing the international market and the constant search for competitiveness at the national level.

On the other hand, and in parallel with this transformation, about two billion additional people added to the global labor market quadrupled a global labor supply. This new situation has put downward pressure on wages in most Western countries, particularly from the implementation of the so-called "labor market flexibility" policies that led to the birth of insecurity of employment and wages among employees.

In the same direction, we must also add the consequences of the "revolution of technologies and information", they led, without doubt, to profound changes in the labor market and especially through the mechanisms of offshoring. Economy (production and employment) as part of the search for benefits mainly related to prospective costs and profits, this of course results in a further increase in the downward pressure on wages.

It is in this context that Guy Standing (2017), explained that the precariat "is a world reality, the word comes from the contraction of" precariousness "and" proletariat "to designate a new social class undermined by economic insecurity and the daily anxiety of precariousness "[14].

For Robert Castel (2009), the precariat "is a new social phenomenon which, according to him, constitutes the index that edifies the deregulation of work. The institution of precarious labor relations today concerns thousands of people and gives rise to a new social category that of the working poor, that is to say, workers deprived of employment status "[15]. The author explained that this deregulation manifests itself in the marginal increase in the status of employment, in work activities that are not. Alternatively, insufficiently, protected by the law. It originates in the fear of unemployment that individuals accept to work under any conditions[16].

V. CONCLUSION

Few literatures have dealt with the concept of precariousness, and many authors are unable to distinguish this concept from other similar concepts such as poverty, vulnerability, exclusion, etc. through this work we have tried to enrich the debate on this concept that is developing day by day by touching several domains and various disciplines.

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Regression Tributary, Arrecadative Efficiency and Fiscal Crisis in Brazil

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Abstract— *The fiscal problem that plagues Brazil today is a feature visible in the various economic cycles faced more or less accentuated in several historical periods, with a tendency to prolong and deepen depending on the structural causes that potentiated the critical effect. In this article, the aim is to explore the actual situation of the tributary system in Brazil and analyze it by the perspective of the Federal Constitution of 1988. Considering the regressive tax burden in the Brazilian case, the distributive disproportionality points to the selective character in the execution of a fiscal policy that induces structural inequalities in the taxation of consumption, production, patrimony and income, affecting in an uneven and concentrated way in the classes with lower income and ability to pay. A paradox that contradicts the precepts of the 1988 Constitution, which aim to establish equality and social justice.*

Keywords— ***Fiscal Crisis, Taxes, Tributary Structure***

I. INTRODUCTION

The fiscal problem that plagues Brazil today is a feature visible in the various economic cycles faced more or less accentuated in several historical periods, with a tendency to prolong and deepen depending on the structural causes that potentiated the critical effect. The debate about who finances the State, its size and the distribution of the tax burden is broad, with primordial origin in the economy, whether in classical economics, neoclassical or Keynesian thought.

The 1988 Constitution defined tax competencies, conferring in Title VI an improved System Tributary National, with general principles that go from taxation and budget, that when completing 30 years of the current one Constitutional System Tributary Brazilian law, indicates the need to rethink this taxation model, the forms of tributary taxation, the contributory nature, its unique character in consonance with Constitutional Law.

Taxes are considered not only an obligation of the citizen, but a price to be paid to guarantee the activities of the State, which requires sources of financing to provide services to the population, satisfying the collective needs that cannot be left to the private sector. In this way, the public revenue, is composed mainly by taxes, being fundamental for the economic, social and cultural development of the country.

The System Tributary National is a set of hierarchically organized norms that deals with tributary matters, composed of taxes instituted in Brazil, by principles and norms that are registered in the Federal Constitution of 1988, regulated in articles 145 to 162. Such constitution of the System Tributary depends on the conception of the State of Democratic and Social Law, designed to ensure social rights and justice as values that were defined in the Constitution of 1988.

Thus, from the perspective of a growing fiscal crisis, the neoliberal economic reforms adopted in Brazil include the necessary action of the judiciary to order social relations between public and private entities and individuals in an attempt to solve distributive conflicts.

II. ECONOMIC BASES OF STATE REGULATION AND TAXATION

On the decade in 1930, Keynes pointed to the need for state regulation in the economy, mainly in the production of public goods / services to guarantee the process of capitalist accumulation, as well as a determinant in fiscal and monetary policy aimed at guaranteeing full

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employment, which strengthen the State of social welfare, with the aim of stabilizing policies and reducing inequality [1].

In the neoclassical conception, a tax system cannot break the market equilibrium, taxation will obey the principles of "neutrality" and "equity". In the first case, taxes can not affect the decisions of economic agents in the allocation of resources, which would affect efficiency in the universe of economic rationality. On the other hand, taxes should be distributed evenly among members of society, not altering the distributive structure of income, since market automatism produces an optimal allocation, and the tax system cannot break such equilibrium [2].

From the 1920, especially in the face of the crisis of 1929 and the great Depression of 1930 in the USA, the State added to the functions of justice and security, to be a supplier of public goods of electricity, sanitation, infrastructure, among other goods and services. The new economic functions of the state expanded from the Keynesian matrix, in practically all capitalist countries, with a significant increase in public spending, a growing participation of the state in national production, and a wide range of laws regulating economic activity [3].

Such a need for economic performance of the public sector, since the market cannot provide public goods, the presence of the State would fulfill the allocative function – by definition the allocative function of the State is characterized by the supply of goods and services not adequately offered by the market system – as a rule, because the price system does not lead to a fair distribution of income, hence the distributive function of the public sector, elements that are financed by the fiscal policy that will be adopted to meet the needs of a government. Finally, state intervention changes the behavior of prices and employment, highlighting that there is no market automatism, leading to a stabilizing function.

One can consider State, as a set of organs, among them, legislative, courts and others that make possible the action of the government, being this action, a set of projects and programs in which part of the society proposes them through a government that performs the function of State in a determined period [4].

In the many definitions of "public policy," the idea that policymakers are embedded in a technical-political process that aims to define and reconcile objectives and means among social actor's subject to restrictions. It is argued that policies are intentional actions by governments that contain some or some articulated objectives, which are justified and formulated [5].

The most well-known definition in public policy studies is Thomas Dye, who succinctly describes public policy as "everything a government decides to do or fails to do," describing a treatment of public policy as any and all governmental behavior, making decisions sustained by sanctions against those who transgress them, which refers to initiatives sanctioned by governments [5].

Economic and public policy theories tend to give an organicity of the chained actions of the economic policies that guide the governmental actions of a certain State. Thus, economic policy in capitalism deals with processes through which the state intervenes in the market, correcting it, guiding it to certain formulated plans, projects and programs.

Concerning the congruence between law and economics, in the significant variants of modern capitalism, there is surpassing one over another, depending on the stimuli considered in these systems, generating a continuous process of interrelationship or structural coupling, so that the right is produced by the economic structure, but also, interacts with it, producing changes, in a reciprocal condition [6].

In the case of federalism, especially the Brazilian, the federation can be defined, above all, as a pact between territorial units and different policies, by building agreements and negotiating different policies. In this sense, the Federal Constitution of 1988, establishing the federative form of State as the fundamental principle that governs the Brazilian nation, also established the obligatory federative decentralization, municipalizing numerous public activities [7].

There is a complex institutional design in Brazilian federalism, composed of several arenas of negotiation, coordination and production of public policies and services, stimulated by diverse interests, ranging from competition to cooperation. Budgetary and financial constraints and increasing social demand for public goods and services require broader federal articulations that address the diversification of citizens' preferences and constant technological development. This dynamic pressures for the adoption of public institutions that provide the new social relations established by the federative pact [8].

In the same direction of federalism, he emphasizes that the central government must provide public goods and services for the entire population of the country. Decentralized levels provide goods and services in a

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limited way to the extent of their respective territories. By tailoring the outputs of such goods and services to the particular preferences and circumstances of citizens, decentralized delivery increases economic welfare above the results of the more uniform levels of these services at the national level.

The Federation means alliance, pact, union between States, with the purpose of forming a single sovereign unit, through the Constitution Federative Republic of Brazil of 1988 (CRFB / 88). The main idea that falls on federalism is the decentralization of power, through the distribution of parcels of political administration among the federated entities. Such entities are treated in an isonomic manner and there is no disparity between them (Member States). Thus, the member states do not have sovereignty, so they do not have the freedom to separate from the federation, and must subordinate themselves to the central power, even if motivated by non-unanimous decisions. Moreover, they confer full sovereignty on a central entity, maintaining only autonomy. In this way, the member states of the federation are autonomous, but are not sovereign [9].

The principle enshrined in CRFB / 88 is that of the contributory capacity, which is essential for the social justice criterion, which is associated with the principles of progressiveness and selectivity, tending to determine the sustainability of public finances, which advocates taxes, pointing to which pays the bill and finances the State, in the various federative entities, in the context of the fiscal crisis of the recent period.

III. FISCAL CRISIS AND TAX BURDEN IN THE BRAZILIAN CONTEXT

In the recent decade, fiscal problems in Brazilian public accounts have sharply increased due to the high level of public indebtedness, an increasing budget deficit resulting from imbalances between revenues and expenditures of the Federal Government, States and Municipalities. The public sector deficit represents a structural node because of the difficulties it creates for public administration, as a result of the accumulation of imbalances over the years, largely financed by the increase in public indebtedness. To a certain extent, the decision to increase revenue or reduce expenditure is a technical-political decision, taking as imminent solution to the fiscal crisis of the State, increasing the tax burden [10].

The Federal Constitution is the guarantor of fiscal federalism, ensuring the financial autonomy of the federation entities: Union, States and Municipalities. Although the Tax System in the Constitution is a controversial issue, security for citizens is a positive fact, given that the federative system creates difficulties in promoting changes or fiscal restructuring, feasible only through constitutional amendments [11].

Fiscal policy plays a central role in the evaluation of recent economic policy, the adjustments considered necessary are the basis for a resumption of growth, the debate focused on fiscal policy is complex with several shades, varying in time, occupies importance in the Brazilian economic policy regime [12].

In a recent study, the evolution of general government gross debt (GGGD) [13], is the main indicator of public indebtedness, whose rapid growth in recent years - from 2013 to 2016, has jumped from 51.3% to 72.5% of gross domestic product (GDP). If the recent trend is maintained, the result according to the monetary authority, would be an explosive trajectory, compromising the capacity of the Federal Government and its federative entities. The Constitutional Amendment (EC) no. 95 [14], approved in 2016, aims to prevent this trajectory from materializing, establishing a limit for the growth of public spending in the long-term horizon, reversing the upward trajectory of public debt, essential to regain confidence in the economy by market agents, and a reduction in the cost of capital and a reversal of the downward trend in investments [15].

In fact, the problems of the public deficit are derived from the fiscal crisis of the Brazilian State and its federated entities (Union, States and Municipalities), being considered by the scholars in the area of economics and law, as fundamental cause, in the domestic plane, a good part of the current problems that afflict the country. The strong budget imbalance resulted from the need to finance expenditures higher than public revenues. When the state increases its expenditures (or reduces taxes), there is an increase in aggregate expenditure, causing an imbalance in the general price level, an increase in the demand for money, causing a rise in the interest rate, which will result in a fall in investment and increase of the need to finance the increase in State expenditures, in view of the percentage increase in the commitment of public debt services – such an effect is known in economists' lexicon, such as crowding out.

When the government is in a deficit situation, traditional fiscal policy measures - tax increases and cuts in spending, denote a central political problem, how such a deficit should be financed by the government. As a general rule, financing may be carried out by extra-fiscal resources, whose main source is: a) issue of currency, with a loan made by the National Treasury with the

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Central Bank; b) sale of public debt securities to the domestic and foreign private sector [16].

Fiscal reforms, due to an urgent need due to the crisis in public finances, have been trailing since the 1980s, gaining a symbolic character in the Real Plan in 1994, when the economy stabilized, admitting a new regime fiscal, marked by the renegotiation of state debts, pension reform and privatizations. The process of changing economic policy sought to regain confidence, the result of a currency collapse in the late 1990s [16].

In this way, the strictness of the fiscal policy was a mechanism adopted to demonstrate a control of the public accounts, with clear demonstration of the sustainability of the public debt. However, there was a discontinuity resulting from the macroeconomic conditions of the Brazilian economy in the late 1990s, and, at the beginning of the 21st century, indicating a reversal in stabilizing patterns, providing greater budgetary rigidity, making necessary, norms to meet the goals of primary surplus, which made it compulsory in Law Budget Guidelines [15].

In the commitment to control public debt in budget execution, with public expenditure contingent on the amount required for the primary surplus target to be reached, the surplus became compulsory expenditure and discretionary expenses, residual paper, always conditioned to the fiscal target adjustments. In 2001, the Brazilian government approved the Fiscal Responsibility Law (LRF) [17], reinforcing the control of the accounts of states and municipalities, defining the legal limits of consolidated debt and specific expenses, norms for contracting credit operations and criteria for eliminating excess indebtedness, this was the new conception of the fiscal regime in defense of stability and minimization of risks, with the use of fiscal instruments to ensure the intertemporal adjustment of public accounts [15].

Such an agenda that was based on a rigid fiscal policy had to reconcile another conflicting agenda, the increase of the tax burden and the problems derived from the federative pact, managing the increasing public debt, adopting development policies and the relationship between the governmental spheres. According to the Brazilian Federal Revenue Studies (SRFB), the distribution of the tax burden among the three levels of the Federation indicates a trend of concentration of resources collected in the Union (68%), with state participation (25%), finally the municipalities (7%), maintaining a trend of increasing the tax burden in the order of 32.66% of GDP - Gross Domestic Product [18].

In the recent context, the central issues of fiscal policy are linked to the tax burden, which since the promulgation of the Fiscal Responsibility Law in 2000, has significantly advanced as a solid driver of the credibility of fiscal accounts, which was questioned by international organizations, avoiding that the surplus positive impact on public debt, since, for the first time in 2014, the Federal Government presented a primary deficit. Such changes in legal definitions and unusual accounting measures ensured poor performance in budgetary standards and rules, with measures considered incompatible with FRL and CRFB / 1988, as well as by the Court of Audit of the Union (TCU).

The current Brazilian fiscal crisis with growing public deficit translates into negative risks that unfold in the non-implementation of reforms by the international multilateral organizations (IMF - World Bank), and, if they were substantiated by the growing loss of market confidence , in view of the political divisions between the Executive and Legislative branches, with additional declines in the contraction of the gross domestic product, essentially after the re-election of President Dilma Rousseff in 2014. The negative impacts unfolded due to the successive corruption scandals, involving Petrobrás, with the cancellation of investments, investigations that caused more bankruptcies in upstream activities, including the construction sector, in fact provoking a deep recession in the years 2015 and 2016, with a contraction of the GDP in the order of 3, 8% and 3.6%, respectively [19].

With the difficulties faced for the balance of public accounts, as a result of the fall in economic activity in almost all sectors, with an increase in unemployment and in the collection of the three federative spheres, and a rise in current expenses, a deterioration of the Brazilian fiscal situation occurred.

To get out of this situation and create fiscal space for investments, Federal, State, District and Municipal Public Administrations will have to adopt measures to increase revenue, reduce expenses and improve the quality and efficiency of public spending, increase or create taxes and contributions or cut public programs of great social impact through the linking of public revenues and expenditures in the establishment of "constitutional minimums", as a result of the increase in the State of its compulsory expenses [20].

The issues of fiscal policy refer to the problem of the Brazilian tax structure, the degree of regressivity and progressivity, to meet the dynamics of national economic

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policies, with effects of strong interpretation between the social phenomena of law and economics.

IV. REGRESSIVENESS AND PROGRESSIVITY IN THE BRAZIL TRIBUTARY STRUCTURE

In the first half of the twentieth century, from the Keynesian premises, social economic phenomena went through a strong interdependence between market and state, in different economies of the capitalist world, the inevitable action of the State to meet the needs of reconstruction of the European economies in post 2 Which expanded to the peripheral countries of the system. Such intervention favored the national development, in the process of import substitution, financing strategies for industrial infrastructure, in the regulation of the relations between capital and labor, and, in the coordination of economic policies, essentially the exchange, fiscal and monetary policies [21].

Public spending was no longer understood as a simple means of serving essential public services, but as a preponderant factor for the promotion and targeting of economic growth and as a tool for redistribution. Thus, the greater the volume of goods and services offered by the State, the greater will be the need for expenses to cover the costs of direct investments, subsidy expenses and the maintenance of state-owned and public enterprises.

The expansion of public spending ends up generating imbalances and difficulties that can be financed by: a) indebtedness - growth of the expenses of loans with the financial market; b) inflation - growth of monetary expansion expenses, which by increasing demand generates a process of raising the general level of prices; c) increase of the tax burden - when the growth of expenses entails the creation of new taxes or increase of the rates, and, respectively, bases of incidence of the respective taxes.

The latest changes, especially at the state and municipal levels, have increased expenses with active staff and costs for restructuring. They were discharged and had an economic slowdown, mainly from 2011, affecting a tax collection, including a set of measures to contain the scenario of fiscal deterioration of Brazilian public finances.

V. TAX POLICY AND TAX BURDEN IN BRAZIL

Fiscal policy reflects the set of measures by which the government collects revenues by spending to meet the three basic functions: macroeconomic stabilization, income redistribution, and resource allocation. In this way, public finances follow the principles and processes through which the federal, state and municipal governments carry out their functions, that through the public budget, governments pursue goals to satisfy social needs, inducing the efficient use of resources, correcting the income distribution of a society [22].

The stabilizing function refers to the allocation of resources from the state activity to promote sustained economic growth, with low unemployment and price stability. The redistributive function aims to ensure an improvement in the distribution of income using, for this, all the legal instruments that it has. This means using direct and indirect taxes, subsidies, incentives and exemptions. Finally, the allocative function consists of the efficient supply of public goods and services, compensating for market failures. The results of fiscal policy can be evaluated from different angles, which can focus on measuring the quality of public expenditure as well as identifying the impacts of such a policy on the well-being of citizens [23].

In the Brazilian case, fiscal policy seeks a high degree of responsibility, with a balanced use of public resources, aiming at gradually reducing net debt as a percentage of GDP, contributing to stability, growth and economic development in the country. Specifically, fiscal policy seeks to create jobs, increase public investment, and expand the social security network, with a focus on poverty reduction and inequality.

The tax burden in Brazil corresponds to the ratio of total taxes collected in Brazil by the three spheres of government (Union, States and Municipalities), as entities of the S system (SESI, SENAI, SEBRAE, SENAC, etc.) and by the Fund (FGTS), and the Gross Domestic Product (GDP). Fig. 1 shows the tax burden updated by the new methodology, according to the international standard required in the Manual of Statistics of Public Finances of the National Monetary Fund (IMF).

R$ billion

Components	**2014**	**2015**
Product Internal Gross	R$ 5.687,31	R$ 5.904,33
Tax revenues Gross	R$ 1.843,86	R$ 1.928,18
Gross Tax Charge	**32,42%**	**32,66%**

Fig. 1: Gross Tributary Burden - 2014 and 2015

https://dx.doi.org/10.22161/ijaers.675 *ISSN: 2349-6495(P) | 2456-1908(O)*

The taxation studies show an evolution of the Brazilian tax burden in the last decades, but the series presented in Fig. 1 shows that growth is maintained, however, it is not the highest tax burden in the world, as many publications tend to affirm. As a matter of fact, starting in 2013, there is a downward trend in tax revenue, reversing a series that has been increasing since 2010 (Brazilian Federal Revenue Service SRFB). In the States, the reality is no different. In spite of the slowdown in economic activity and the lack of control of public accounts, in every country observed in recent years, they are not alone responsible for the current fiscal crisis of the Brazilian State - although they have contributed significantly to this picture.

Fig. 2: Tax Burden by Federative Entity 2002 to 2015

According to Technical Standard no. 7, of the National Treasury Secretariat, the detailed updating of the tax revenues of all states and municipalities, using estimation techniques, allowed for a breakdown that demonstrates the Brazilian federalism crisis, given the concentration of revenues in the Union, but this fact will not be the guiding focus of this study [24].

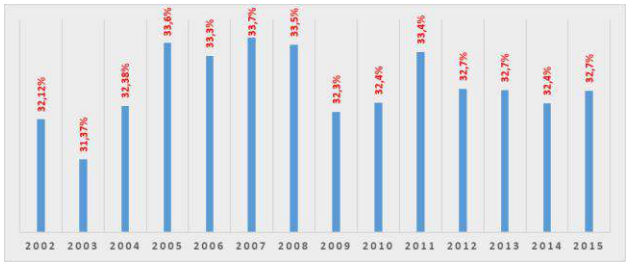

Fig. 3: Total treasury charge 2002-2015

In this context, the Total Tax Burden can be observed in Fig. 3, according to the variations in total tax revenue, considering the variations in GDP growth - Gross Domestic Product in the period 2002-2015, demystifying the current aspects on the weight of taxes in the Brazilian economic and social order in the recent period.

VI. REGRESSIVENESS AND PROGRESSIVITY IN BRAZILIAN TAX POLICY

The components of fiscal policy are geared towards collecting revenues and executing expenditures, determining how the government makes significant market interventions, promoting impacts in the various sectors of the economy. Therefore, fiscal policy may be expansive - when measures expand aggregate demand by increasing public expenditures; reduction of the tax burden; stimulus to consumption and investment; stimulating exports, inhibiting imports through the imposition of tariffs and barriers, in order to favor domestic production and employment. At another pole, fiscal policy is restrictive, when measures are adopted to reduce public spending, increase the tax burden, reduce production and employment levels.

Considering that the economic base of the society suffers a compulsory imposition, with the taxpayer's State being required, given the legitimacy of the taxation oriented to the good of a determined community, taxation is added a sense, which must be fair among the citizens, the principle of fiscal justice is based on two different approaches: the tax benefit and the ability to contribute [25].

It is understood that each individual must bear the tax burden equivalent to the benefits he would enjoy with the government, and his ability to pay can be measured by the income (flow of wealth) that he obtains in a given period, by the wealth he holds (stock) , and finally, by the individual sacrifice quota that will bear the tax burden.

Under the criterion of an individual's ability to contribute, the distribution of the tax burden should be carried out equally among all citizens, recognizing that certain individuals have a greater capacity to pay taxes than others. If the claim is for tax justice, whenever possible, the value of taxes should be calibrated progressively, that is, those who have higher income should contribute the greater part of the taxes. On the other hand, a tax burden will be regressive when individuals with lower incomes suffer a greater burden on the paid portion of taxes [25].

Whereas, the National Tax Code - CTN, established by Law no. 5,172, dated October 25, 1966, defined as tribute as entered:

> Art. 3 Tributo is any compulsory monetary payment, in money, or whose value can be expressed in it, which does not constitute sanction of an unlawful act, instituted by law and charged through a fully bound administrative activity [26].

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Considered from the point of view of the legal reserve, only the law can institute tribute. The collection, besides being compulsory, cannot be due to the sanction of an unlawful act, otherwise it would be a fine, and, not tribute.

When considering the economic basis on which they occur, taxes can be classified into three broad categories: those that affect wealth, taxation of income and the burden of consumption. As collected, taxes are classified as rights and indirect. In direct taxation, it is commonly said in the economic corollary that there is fiscal progressivity, given that the taxpayer pays or is burdened, according to the taxpayer's capacity and proportionally to his income or equity. In indirect taxation, the value of the tax is usually embedded in the prices of goods and services purchased by consumers, and there is no parameter for proportionality and maintenance of the principle of proportional contribution to income, that is, indirect taxation is from the economic- fiscal, more unjust [27].

In the Brazilian tax structure, what is observed in the recent context, is an extremely regressive tax base, considering that, the greater part of taxes collected has its tax base that relies mostly on circulation and consumption, indicating a regressive burden on individuals and / or consumers.

VII. RETIRING EFFICIENCY, EVICTION, EVASION AND FISCAL ELISION

Considering that tax jurisdiction is a private ability constitutionally attributed to the political entity so that, based on the law, the tax exoneration is instituted, in other words, it is the ability to create taxes, distributed among the various political entities, with competence to impose tax benefits, as set forth by the Constitution, producing legal norms on taxes and forms of taxation, according to the ability to contribute, graduating taxes according to income of each taxpayer, the State will seek to maintain the efficiency base, normalized in the legal framework [28].

This attribution of jurisdiction lies with the National Tax Code (TNC), which defines taxes as "(...) any pecuniary benefit, in money or whose value can be expressed in it", which is a compulsory, monetary benefit that does not constitute a sanction of not establishing a punishment for the practice of infractions, is established by law and charged through administrative activity linked. Although there are doctrinal divergences about the division of taxes, for the purpose of our theme, the classification is adopted quinquipartite offered by the Federal Constitution of 1988, where taxes are divided into five categories: tax, rate, improvement contribution, compulsory loans and special contributions [29].

In the Brazilian context, the size of the tax burden and its comparison with the adequacy of the national socioeconomic profile, especially in relation to the productive structure, is a recurring subject, since the tax complexity, positive and negative effects, are pressing issues of the economic viewpoint, since the distortions generate choices by the economic agents that results in losses of efficiency. The Brazilian tax system, post-1988 Constitution, favored increasing the amount of revenue to the detriment of distributive issues and efficiency. In this process, the increase in state assistance and transfers of resources to the states and municipalities generated pressure on expenses, reducing the Union's revenues. The government option was to opt for a system of higher collection with lower cost [30].

The problems of tax efficiency, therefore, collected in the Brazilian reality, are conditioned by the exits of the federated entities for increasing the terms of revenue generation. The Union sought as an exit, the increasing use of social contributions, highly productive in the generation of revenue, and legally not shared with states and municipalities.

On the other hand, if the low cost of collecting such contributions allows a safeguard for non-allocation, it generates distortions in cumulative taxes. The tax and federative problem resulting from the decentralization provided by CRFB / 88, demanded from the states and municipalities an increasing need to increase revenues, such as raising taxes on specific items such as: energy, fuel, telecommunications and transportation.

The distribution of the tax burden, as well as its evolution presented previously in Tables 1 and 2, show that on the basis of incidence, mainly in indirect taxes on circulation / consumption, regressive character and low tax legislation are evident, contributing to a "fiscal war" resulting from the need for a constant increase in tax revenues, and, consequently, a concentration of taxes in the Union, since the form of distribution perpetuates the increase of the tax burden, conspiring against the allocative efficiency of the economy, as described in Fig. 4 [30].

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Federal Entity	2014			2015		
	R$ millions	% of PIB	% of tax reven.	R$ millions	% of PIB	% of tax reven.
Union	1.260.983,20	22,17%	68,39%	1.316.190,50	22,29%	68,26%
States	468.319,34	8,23%	25,40%	489.103,22	8,28%	25,37%
Counties	114.557,95	2,01%	6,21%	122.889,13	2,08%	6,37%
Total Tax Revenue:	1.843.860,49	32,42%	100,00%	1.928.182,85	32,66%	100,00%
Source: STN - Secretariat of the National Treasury, 2017						

Fig. 4: Tax Burden by Federal Entity

The Brazilian Institute of Planning and Taxation (IBPT) pointed out that the fall in economic activity and the increase in unemployment led to an increase in the stock of Brazilian taxpayers' debt, which surpassed the revenues of the Union, States and Municipalities.

The various studies show that, although the tax burden has increased in the last 36 years, in the order of 70% in the historical series, the current tax burden in relation to GDP in 2014, shows that Brazil does not present the highest taxation compared to others according to Fig. 5.

Fig. 5: Total Tax Charge 2014

The recessionary picture that began in the second quarter of 2014, which is present in recent GDP data, shows that fiscal stimuli - tax relief and increased spending - were not effective in reversing the downward trend in economic activity, but the high cost of public debt, the imbalances between revenues and expenditures, raising the perception of inefficiency in collecting the Brazilian State. This situation was aggravated by the lack of transparency of the government's accounting results, and the true size of the fiscal problem (public deficit) [31].

In fact, there is an ambiguous relationship between increase of taxes and increases in revenue, considering the central idea that a tax rate equal to zero, will provide a zero collection, and if the rate is 100%, there will also be zero collection because no one would work if the government were to earn all income, hence the idea of seeking an optimal rate, where the government will raise as much as possible without distorting incentives for economic agents, whether they are producers or consumers.

The increase in the tax burden and evasion are reciprocally fed, since the multiplicity of taxes and contributions, the increase in tax rates and tax bases generate a defensive reaction of the economic agents, who, in moments of crisis or economic retraction, seek means to escape from taxation. In every move to raise the legal burden, taxpayers are redoubling efforts to avoid tax evasion, noting that in addition to the tax burden and the myriad of existing taxes, the central problem in pursuing fiscal policy is the lack of enforcement [32].

In Brazil, conduct that leads to tax evasion is not framed as common crimes, with special laws, implemented from the mid-sixties. In broad sense, tax evasion is the procedure or the atypical or abnormal legal form, when the taxpayer seeks means and ways to avoid, delay or reduce the occurrence of a taxable event resulting from an original tax liability, failing to pay the tax, or paying less than due, and further, postponing such obligation [33].

In tax crimes, the norms that are effectively prejudiced are those established in the National Tax Code, where the offending behavior that describes the transgressions of a tax fund, such as tax evasion, cannot be applied without the support of the Tax Law, since fiscal crimes depend on the fraudulent and fraudulent violation of the material and formal obligations described in the tax legislation, classified according to the infractions of a purely administrative nature, labeled in the Criminal Tax Law.

Finally, it should be pointed out that the incentive to fiscal control of all spheres of public administration, demanded a greater rationalization of tax collection procedures, in search of tax efficiency and enforcement effectiveness, always putting in question the issue of tax evasion, which refers to the economic dictates. This

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practice is widely disseminated, where both the efficiency of tax collection and the mechanisms of taxation are precarious, being one of the obvious structural problems to improve Brazilian tax capacity.

VIII. FINAL CONSIDERATIONS

The analysis in the constitutional framework from the point of view of the Brazilian tax legislation, describes and considers the sanctioning powers in the Brazilian legal-tax field in the face of noncompliance with the tax obligations towards the Brazilian State, in the various federal entities, be it the Union, the States or the Municipalities. Thus, by constitutional force and administrative responsibility, as an active subject, the State uses all coercive means to comply with the economic order, the premises of a tax and fiscal policy. It is the duty of the State to establish mechanisms for collection and distribution of taxes, following the provisions of the National Tax Code and corresponding legislations.

The current Brazilian fiscal problem, characterized by cyclical dilemmas, linked to the structural nature that deepens the fiscal policy weaknesses under the juridical-institutional arrangement, in summary demonstrates that the tax burden is extremely regressive and disproportionate to individuals / families / companies according to the economic.

The transformations in the Brazilian economy, brought new challenges in relation to the State's performance. Tax practices tend to prioritize the adjustments suggested by international institutions, seeking taxation that causes the least possible distortion in the economic sectors. Considering that the Brazilian tax system has a federative character, the excessive complexity of this model, combined with legislation in the state and municipal context, and the tax question related to regressively and progressivity aspects of the system, are remarkable in studies related to the capacity tax collection and tax evasion.

The aspects of the country's legislation, where tax laws were obtained, the connection with the principles of tax incidence, tax evasion, evasion, tax avoidance and tax evasion, which reach economic repercussions for economic agents and individuals, with the current criminalization of tax infractions, with current hermeneutical absurdity, observing that the Brazilian Tax Law is conforming the economic order, while the government does not fulfill its elementary prerogatives.

In particular, the various articles of the National Tax Code (CTN), dealing with the question of the destination of taxes, forms of tax incidence, and especially the perspective of execution of the sanctioning and judicial activity, through Administrative Law, provided for by law, the techniques adopted by the legislator that confer some discretion when applying the sanction, leading to a lack of legal certainty when taken into account the principle of reasonableness and observing the constitutional principle contained in art. 5 of the Federal Constitution of 1988.

Considering the Brazilian tax structure, regressive and unfair, the aspects adopted in the tax legislation are treated disproportionally in legal terms, considering that the sanctioning power applied in the Tax Law, does not meet the inclusion criteria of the productive sectors (entrepreneurs and workers) in order to reduce the negative impacts of taxation, inducing the economic agents to informality and illegality given the current complex structure in Brazil. As observed in the Tax Law and subsidiary legislation, there is a growing public deficit arising from the fiscal crisis of the Brazilian State, with a tendency to increase the tax burden due to the taxable capacity of legal entities or individuals.

It should be noted that, in the various cycles and fluctuations of the Brazilian economy, the repeated disproportionality in the distribution of the tax burden increases the levels of evasion, evasion, tax avoidance and tax avoidance, as a result of the inefficiency and inefficiency of the Brazilian State in informalization of the economy. In another aspect, the complex structure of tax legislation denotes mechanisms that require managers to impose sanctions or legal tools that indicate fiscal foreclosures by means of the police power of the State, correlating the aspects of eviction to criminal offenses.

The incorporation of an abusive sanctioning attitude that part of the legal-institutional apparatus, based on the worsening of the fiscal crisis, although, complying with the constitutional precepts, denote for the possibility of the tax debtors not to self-incriminate before the illegal or illegal. The procedural delays, with the various postponement mechanisms for fiscal execution, focused on the sanctioning powers, demonstrate that effectiveness is limited, reducing the collecting efficiency of the Brazilian State, in the different federative entities.

In the context of consecration of the three decades of the Brazilian Tax Constitutional System, considering the Tax Law and subsidiary legislation, legislators and managers find limits in the legal application, creating obstacles to make public administration feasible, implying in practices that do not contribute to the determination of tax irregularities.

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Considering the regressive tax burden in the Brazilian case, the distributive disproportionality points to the selective character in the execution of a fiscal policy that induces structural inequalities in the taxation of consumption, production, patrimony and income, affecting in an uneven and concentrated way in the classes with lower income and ability to pay. A paradox that contradicts the precepts of the 1988 Constitution, which aim to establish equality and social justice.

Consequently, in addition to the difficulties of applying an adequate fiscal policy, as a result of the macroeconomic policy that concentrates its efforts on the collection of indirect taxes, on circulation / consumption, the tax legislation included in the National Tax Code, as well as the tax structure, contributions and fees must follow the path of the Tax Reform, to relieve and simplify the taxation process, seeking the efficiency and effectiveness of economic logic with fairer and more equitable legal mechanisms.

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Collaborative Learning in the Military Police of Tocantins: perspective without frontier

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Abstract *— This study presents collaborative learning and the main digital tools used in technology-mediated teaching. This work aims to demonstrate that collaborative learning can strengthen and develop skills as a requirement for the development and sharing of knowledge as a strategic learning tool resulting from the interactions of the participants. For this, a bibliographical review, participatory research, qualitative-quantitative research was carried out. By demonstrating that technology-based collaborative learning develops a transdisciplinary view, enabling the identification of new methodologies that can be implemented in the qualification of the Tocantins Military Police.*

Keywords *— **Collaborative Learning; Social interaction; Digital Tools.***

I. INTRODUCTION

Technology-mediated learning has become a topic that has been occupying space in the discussions. These approaches usually present communication technologies as tools that innovate educational practices, as they allow more flexibility in training methods. Digital technologies have occupied the educational environments in recent years, as the Internet became popular, either as part of a pedagogical approach or teaching and learning methodology [1].

In this sense, researchers defend the importance of interactions in online learning environments. Technological innovations and their use for scientific, technological, cultural, social and educational purposes were instrumental in bringing the benefits of technology closer to the needs of education [2].

In this sense, the Internet and its popularization to society through digital technologies guided the emergence of new structures, methodologies and approaches in teaching at all levels of education. According to [3] the internet provides interaction with a universally accessible, democratic and interactive communications center and fast, low-cost features that connect people. And this information technology has created new opportunities for education. Therefore, technological evolution plays a fundamental role in educational development, providing mechanisms for the evolution of the teaching and learning process in order to meet social demands.

In this way, the Public Security professionals, especially the Military Police, experience a constant modernization of society, caused mainly by the technological advance. In this context, technology-mediated education appears as an instrument to subsidize educational practices and professional qualification in a collaborative way.

The qualification courses with a collaborative approach would be based on values, where it is not assumed that the oldest is the one who knows everything, plus the one who has the qualification to disseminate knowledge. This structure would provide students with the necessary example for reproduction in the fulfillment of their functions and their relations with different segments of society [4].

Therefore, this modality can be used by military institutions, both in the formation and in the dissemination of knowledge. Allowing that the knowledge taught reaches a larger number of people who can benefit from public services without the current limitations imposed by time and space [5].

Thus, the use of technological tools tends to potentiate new forms of learning, which can generate new reflections and teaching methodologies with active participation of students in the sharing of ideas through collaborative learning.

Collaboration is an essential component in the development of intellectual capacities that creates an effective learning environment, providing opportunities for discussion, argumentation and reflection on existing conceptions and knowledges. However, it is not a question of changing the concept of what is important, but of finding the right combination of traditional teaching and learning tools [6], [7].

Technology-mediated teaching is a more democratic model of how to acquire knowledge, since it uses

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information and communication technologies to overcome obstacles and innovate traditional forms of teaching [8].

It is emphasized that social interaction motivates the participants to understand the processes of collaboration and communication through the exchange of knowledge. In this way, a deep understanding of the projects implemented in a collaborative way.

It should be noted that technologies develop new ways of teaching and learning outcomes in procedural learning changes that tend to evolve towards a collaborative approach to e-learning.

In this way, the use of these learning tools is of great relevance, since, it makes possible a more dynamic and efficient learning process. In view of the requirement that students with training in areas of knowledge other than the courses be integrated in the search and resolution of innovative solutions.

Collaborative learning can guide institutions in strengthening the quality of care, improving services through participatory education that can develop new skills and work in groups.

The scope of the issues and problems affecting Public Security warns of the need for security debate and for the incorporation of new actors, scenarios and public policies in the area of training and qualification of professionals.

In addition, the dimension of interdisciplinarity can further strengthen and develop the Military Police with collaborative learning, so it is not only the availability of content in the teaching environment, but the involvement of these in the search for problem solving.

The military police officer "needs to have the flexibility to receive new knowledge, develop new skills and have behaviors that demonstrate their professionalism" [8]

In this way, Public Security agents, especially Military Police Officers who directly serve the public need to have a load of knowledge because it is a multidisciplinary profession, acquiring new skills and competencies for their daily performance.

Technology-mediated teaching has proved to be the most appropriate tool, capable of reconciling the quality aspect with the impossibility of absenting the Military Police Officers of the final activity [9]. What are the improvement, habilitation, adaptation, reducing costs and displacements of distant OPM personnel, minimizing the distance of the Military Police of its OPM, having as main beneficiaries the professional himself and the population that will not be without quality services [5].

For [10] changes that may occur in methodologies and procedures in training, qualification and improvement of police officers will only succeed if there are recommendations and norms.

Experience in any profession is a difficult process that requires the combination of many factors and usually includes advanced knowledge, skills and abilities developed through years of experience. In this sense, the police profession requires individuals who possess innate skills and abilities complemented with knowledge gained through formal training, and experiences in the course of their professional years [11].

The modernization needs of the Military Police must be related to construction in a democratic perspective, by means of flexibility in the new educational proposals. Given that police officers work under conditions that are unpredictable and range from highly stressful to uninterrupted and routine [11], [12]

The systems enable self-learning, through the mediation of systematically organized didactic resources, presented in different information media used alone or in combination, and transmitted on the world wide web. [5].

Influenced by such precepts, some military institutions have adapted and shaped themselves so that part of their activities, in what concerns the formation, qualification or qualification of their professionals occurred at a distance [9].

Therefore, the Military Police Officer can not be excluded from technology-mediated teaching because it allows time and space to be easily overcome, making education much more effective and adequate to the student's rhythm of life, maintaining the same pattern of face-to-face classes [5].

The pedagogy of Collaborative Learning is centered on the group and not on individuals, in isolation. The individual learns from the group and contributes individually to the learning of others, with an interdependence between collaborative learning and individual learning [13]

In this sense, the general objective of this article is to demonstrate that the Military Police of Tocantins can use collaborative learning to qualify its professionals, aiming at the economics of public resources and a quality service with the impossibility of the absence of the Police in their activities.

II. RESULTS AND DISCUSSIONS

For [15] the contemporary literature describes that online and distance education depends on the interactions of the students. And that these relationships between different types of interactions and learning outcomes.

We can state that the main objective of collaborative learning is the active participation of members. This is possible because the interdisciplinarity of the students can

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foster new discoveries from the feedbacks and supports. This dynamic improves learning practices.

Learning tools should be included in strategic ways by promoting a new critical thinking to evaluate adoption, deployment and effective use for collaboration [16].

The development of these technologies facilitates the sharing of spaces for collaboration and production, distribution and aggregation of information in online learning environments [17].

the digital tools and technologies allow students to assume the autonomy of their learning, establishing the context that inspires them in the search for new ways of learning [18].

"The interdisciplinarity present in the advanced pedagogical approaches makes it possible to expand the human capacity to understand the reality and the problems that are presented in it [19].

collaborative learning refers to processes of social interaction in which students actively work together with shared learning objectives and participate in a teaching-learning process [20].

Collaborative learning refers to tasks that require intellectual efforts among groups actively in conjunction with shared learning goals. So a personal philosophy, not just a classroom technique. Being that just knowing and dealing with the ideas of others is not enough for the coupling of goals. It is an educational approach that emphasizes the active and collective efforts of participation and interaction by those involved. [21], [22]. [23], [24], [20].

According to [25], [26], society increasingly uses social media to complement teaching that is no longer tied to context, but to collaborate, create, and modify content at any time and with any device unifying the real world and the digital world, facilitating the process of innovation of knowledge to improve the learning experience in a collaborative way.

Society every day uses social media in teaching using mobile devices to enhance the learning experience in a collaborative way [25], [26].

Therefore, collaborative learning associated with social networks can favor positive results, since virtual social networks, besides promoting interactivity between individuals, allow each member to expose their ideas, share knowledge and even emotions.

defines ubiquitous education as open learning processes, spontaneous, unsystematic and with continuous access to information and at any time. In this way, ubiquitous learning is based on interactive learning through digital technologies that enable students to access information and mediation through the use of any device that accesses virtual networks [27], [27].

It is unquestionable that the use of mobile devices tends to potentiate new forms of learning, generating reflections in teaching through the sharing of ideas through collaborative learning. This information is available on devices that fit in the palm of the hand like smartphones and tablets, among others present everywhere.

The collaborative tools available are easy to use and are socialized, tested, and validated, allowing users to collaborate, learn, share and disseminate information, thus a mix of tools and technologies that reflect in practice, allowing students to take control on learning, setting the context that inspires them to manage new learning situations[18].

Therefore, technology tools facilitate the distribution of content, experiences between teacher and students in a virtual environment anytime, anywhere. [29], [30].

Technology-mediated teaching has become an alternative for training and professional qualification in various segments of society, where the evolution of web 2.0 can be used for the benefit of teaching. Having in mind that the virtual learning environment (AVA) is intended to facilitate the way of teaching and learning in any environment used, in Public Safety is no different.

Public safety, education and technology are bases that need to coexist in partnership, thus facilitating a distance education that is characterized by bringing together people who are in different geographic locations, seeking a union in the sharing of knowledge necessary for a Public Security of efficient and effective quality, thereby reducing distances, facilitating access to information [31].

The training of the police officer is highly questioned when failures occur in their attendance, giving them unprepared and poor-quality training [4]. Therefore, the qualification of the Military Police to act in such a way as to meet the aspirations of society, ie, social demands will only occur with quality training, through a program of continuous improvement of these agents.

The qualification of the Military Police to act in the service with quality in the performance of its function is done by a program of continuous improvement. This process is a strategy of Public Security policy, within the institution, which has as a rule the stimulus to constant learning, so that, as such, it becomes the active military police, within its constitutional duties.

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learning, so that, as such, it becomes the active military police, within its constitutional duties.

The training of professionals must be a constant goal on the part of the managers, therefore, it is an actor of great importance in the present days. In this way, encouraging the military to continuously seek qualification is converted into a better service rendering society, since, that the qualified police force is synonymous with effectiveness in the public service.

Dessa forma, o ensino mediado pela tecnologia supera o espaço e o tempo, estimulando as constantes discussões dos alunos sobre assuntos que transcendem seu conhecimento, devido às suas formações em diversas áreas do conhecimento, fortalecendo suas contribuições em ambientes de aprendizagem.

Given the above, the fact is that the Military Police need a solid formation, having the need to develop their skills and attitudes through qualification, contributing to the preservation of public order.

The Military Police of Tocantins are in a dynamic and complex social scenario that requires new strategies and technologies to promote quality Public Safety along with continuous training.

Technology-mediated learning provides a shared training, which improves the skills of professionals, building knowledge in the interaction between subjects, and therefore, students must produce knowledge, guiding their practices in everyday life.

In this way, it is emphasized that technology-mediated teaching can guide institutions in strengthening teaching, since it can improve and improve professionals through peer-to-peer education. It should be emphasized that EAD teaching has been distinguished in the world scenario, since it innovates teaching and strengthens institutions.

A. *The Technology-Mediated Teaching in the Military Police of Brazil*

The use of technology-mediated learning platforms enables new paradigms for teaching-learning production, due to the constant evolution of applications and digital tools. Thus, for efficient and effective collaborative learning, one must first develop attitudes and paradigm shifts for teachers. In this sense, the expectation is that the collaboration between students can transform and transform the way to do quality education.

Therefore, digital learning tools must combine theory and practice, defining strategies as essential factors for a more autonomous and dynamic learning, favoring multiple teaching paths.

Given the subject matter, social interaction through learning becomes an innovative instrument that can adapt teaching to the qualification needs of the Military Police of Tocantins, in addition to reducing expenses with displacements, transfers among other expenses.

Therefore, knowledge in Public Security must meet the National Curriculum Matrix, which is an instrument of "educational and pedagogical" management, with suggestions in the area "strategic-political and didactic-educational" to the development of training actions in the area of public safety [32].

In addition, the digital tools are formalized and offer more possibilities of learning, in view of their dissemination through the virtual learning environments.

Currently in Brazil, several military police institutions are using technology mediated by technologies for training, habilitation, improvement and continuing education according to table 1 and 2, 75% of states have a virtual learning portal. Since 01 State does not have a portal and does not use technology-mediated modality in its training or improvement. The states that have a partnership with the National Secretariat of Public Security (SENASP) represent 14%. Of this total, we had no return if it would have or not courses this modality.

Table I: Military Policemen using VLE

Data	Estados	%
It has VLE	21	77,8
does not have VLE	01	3,7
No information	01	3,7
Senasp Module	04	14,8
Total Military Police	**27**	**100**

De acordo com as necessidades de cada Estado, através de seus secretários e policiais militares podem criar classes fechadas, no “Module Academy " para a melhoria profissional, atendendo demandas específicas para os profissionais da polícia civil e militar, fogo militar Brigade, guarda municipal, habilidades e polícia técnica, do mesmo modo para finalidades do avanço da carreira.

Para a polícia militar, as disciplinas são: ação policial contra grupos vulneráveis; Filosofia dos direitos humanos aplicados à ação policial; Gestão de crises; Preservação da localização do crime e aspectos jurídicos da ação policial, totalizando 300 horas de aula [33].

B. *The Technology-Mediated Teaching in the Military Police of Brazil*

Institutions are modifying the methodologies and formats of qualifications, aiming at overcoming the traditional models, which determines the need for a new model of professional education focused on the development of skills.

According to the [35] (ABED, 2018, page 120), technology-mediated teaching has increased significantly in corporate institutions around 30.43% of these offer free

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courses. They observed, although 15.28% of them increased their investments in this type of qualification.

For the Military Police of Tocantins, the implementation of courses mediated by technologies, is surpassing the traditional models of training, habilitation and improvement. Therefore, a professional with knowledge and skills to perform his function, predisposing himself to "learn, learn to learn and contribute to his improvement"[34].

the Military Police of Tocantins, it has a set of rules and conduct related to the training, qualification and professional improvement that are described in the Standards for Planning and Conduct of Teaching - (NPCE), which has its references in Laws no. 125 and Law No. 1,161. (NPCE, 2008) and standardize teaching in the State Military Police, establishing a unit of thought in the planning, execution and evaluation phases, tactical and operational levels of the Corporation. In order to establish criteria to subsidize quality education.

teaching activities related to training, habilitation, improvement, extension, specialization and updating. Applying new methodologies, implementing professional technical learning process.

In this way, establishing criteria for teaching-learning, innovating with new methodologies for training, habilitation and improvement of the military police, unifying the teaching doctrine of the institution and training qualified teachers to train new Public Security agents.

In 2016, the Military Police of the State of Tocantins and the University of Tocantins Foundation (Unitins), signed a partnership agreement where Unitins will install on the PMTO server the AVA platform *Chamilo* 1.9.4 2016 - educa.unitins.br, as well as the training and guidance of PMTO's teachers, tutors and technicians. This partnership aims at the training of military police in the distance modality. The Military Police of Tocantins, after signing the partnership agreement with Unitins, made available on its website the technology-mediated teaching platform currently available on the main page of the Tocantins Military Police website.

Therefore, it is noticed that the Military Police of Tocantins possesses the means to promote the education mediated by the technologies. Therefore, the command seeks to use various methodologies to measure the knowledge and skills acquired of the students in the courses.

III. DEVELOPMENT

The methodology adopted in this research is presented below: The research objectives were formulated, the formulation of the question and the definition of the problem. Aiming to generate new knowledge, skills and information sharing through collaborative learning for practical application of the activities of the Military Police, directing to solve problems by improving the provision of services to local communities using applied research.

A quantitative-qualitative approach was used, and the results obtained with the use of these alternative "quantitative-qualitative" methodologies point to a greater reliability and validation of the research. Regarding the objectives, exploratory research, involving bibliographical survey and data analysis.

IV. CONSIDERATIONS

The evolution of technologies is the diffusion of knowledge is becoming increasingly incisive in the way users share information. So, people connected to the web can access millions of information just by clicking a button. As a result, digital technologies and the Internet have innovated the way of transmitting and collecting new knowledge.

Its importance lies in the interaction needs that increasingly provide society with facilities for learning, which can be applied as a tool for the work, consultation and publication of important information.

In addition, digital technologies are formalized and offer more and more opportunities for learning. We need to appropriate uncertainties and transform education into processes of ongoing formation, since no current training gives guarantees that will have any value in a decade.

In this sense, these methods involve social interaction, which motivates the participants to understand the processes of collaboration and communication through the exchange of knowledge using various technological resources. Given this, the technological changes are affecting the learning environments and enabling a better adaptation of the institutions by new demands.

The Military Police of the State of Tocantins and the University of Tocantins signed a partnership agreement to use the AVA Chamilo 1.9.4 2016 platform to qualify military officers in the distance mode. In this way, Chamilo is an internet system that organizes teaching and learning procedures through instructional content and collaborative interactions (CHAMILO, 2010).

Interacting with multiple interfaces in its learning environment, it is designed to run on the "LAMP platform: Linux, Apache, MySQL, PHP" (CHAMILO, 2010).

Chamilo, which is free software, is designed to run on free platforms. Therefore, a content management system, which seeks to improve the educational level of learning through the interactivity of users. This work discussed the

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implementation of digital tools, which can be used in collaborative learning, in this sense Chamilo allows the use of social networks and creation of groups, through blogs and wiki.

Chamilo is an AVA that contains several EaD tools, which allows customization according to each educational institution, is considered safe and facilitates student / teacher interaction. In addition, it is a free system, easy to use and that comes more and more, conquering the community that opted for distance education [37].

It supports teaching and learning processes that take place in virtual environments. It uses synchronous and asynchronous communication channels and provides facilities for the insertion and administration of content. Therefore, the courses can be prepared for students to the training area as well as those related to the exercise of the profession.

The main functions, provided by Chamilo for collaborative learning are: The wiki, Blog, Forums, and Social networks (Facebook, Twitte, LinkedIn, Google +, Hi5). among others, that can be implemented in the qualification of the military police of Tocantins.

We understand that the results presented in this study can contribute to the improvement of Public Policies for qualification and technical improvement of the Military Police officers through technology-mediated teaching, aiming at quality service for the Tocantinense Society.

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The Role of Geospatial Information for Accelerating the Delineation of Village Boundaries in Indonesia using Cartometric Method

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Abstract— *The number of villages in Indonesia currently is 83,436 villages, which will continue to increase each year. For instance, 49 years ago in 1969/1970, the number of villages was 44,478. The administrative boundaries of a village are very important to affirm and to stipulate legal aspects in the management of resources. Considering the large number of villages, it is necessary to accelerate the affirmation of village boundaries [Riyadi, 2018].*

The study was conducted using a qualitative descriptive approach, by analyzing the contribution of geospatial information in supporting the delineation acceleration of village boundaries carried out by Geospatial Information Agency (BIG) during the period from 2013 to 2019 throughout Indonesia. High resolution orthorectified satellite imagery was used by implementing the cartometric method as mandated in the Minister of Home Affairs Regulation (Permendagri) No. 45 of 2016 concerning Determination and Affirmation of Village Boundaries. This method has been proven to accelerate the processes of establishing village boundaries. It is estimated that the number of villages in the period 2013-2019 will reach 76,196 villages or approximately 91,26 % of a total 83,436 villages. Settlement of village boundaries is part of the work plan of One Map policy contained in Presidential Regulation No. 9 of 2016 which is a catalyst for speeding up administrative boundaries including village boundaries.

Keywords— ***Cartometric method, Delineation and Village Boundaries.***

I. INTRODUCTION

The era of political decentralization in Indonesia, which began in 1999 is often referred to as the beginning of the era of regional autonomy, Law Number 22 of 1999, which was later revised with Law Number 23 of 2014 concerning Regional Government providing opportunities for regions to regulate their own domestic affairs. Regional expansion has been carried out by the government to strengthen the principle of decentralization [Sumaryo, 2014]. This principle allows provincial, regency/city and village governments to regulate their own regions based on the principles of regional autonomy and co-administration tasks. The implementation of regional autonomy has been running for 20 years. During this time many emerging New Autonomous Regions or designated *Daerah Otonomi Baru* (DOB) were established. Until now there are 34 provinces, 416 regencies, 98 cities and 83,436 villages [Permendagri, 2017]. The establishment of the DOB is stated in the law on the formation of regions which contain chapters on regional delimitation. In Law No. 23 of 2014 it is clearly stated that regional boundaries become one of the territorial basic requirements that must be delineated by coordinate points on the base map. The map becomes an inseparable attachment to the law. Administrative boundaries are included in the basic geospatial dataset of national topographic maps (*Peta Rupabumi Indonesia*), and is one of the important data to support development planning in Indonesia. This kind of geospatial information has an impact on the management of internal affairs such as natural resource management, spatial planning, taxes, land administration, expansion of new autonomous regions, census of statistical data, and others.

With the existence of the Law number 6 of 2014 concerning Villages, the position of the village government became stronger as the executor of regional autonomy. This law has implications for the importance of determining boundaries between regions and even between villages, and the need for village maps on a large scale map that will support many matters that are mandated by this Law. Village maps are increasingly needed to

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implement the Indonesian government's policy to assist village development by providing village allocation funds. One of the parameter indicators for allocating the amount of village funds is the size of the village. To obtain the village area and size, a clear and firm village boundary map is needed thus enabling the area of the village to be calculated more accurately. In terms of spatial aspects, there are still 83,436 villages that do not yet have village maps in accordance with the rules of mapping, and thus has an impact on not-yet-defined areas. For the villages which already have maps, most of them did not obey the cartographic rule, for instance the delineation of the village boundary is given only in sketch form, not a map. The obstacle faced in making a map of the main village is the unavailability of large-scale national basemaps [Ambarwulan, 2014].

Determinations of village boundaries must be done considering the villages in Indonesia continue to grow over time and the number increases along with regional autonomy implemented by the central government. The expansion of the villages always increases every year, in 1969/1970, the number of villages was 44,478, and in 1978/79 the villages increased by around 15,000 in total to 60,645. In 1983/84, when there was a new village arrangement based on Law No. 5 in 1979, the number of villages increased to 66,437. And now based on Permendagri Number 137 of 2017 concerning the Administrative Region Code and Data, the number of villages has reached 83,436 [Riyadi,2018]. The formation of new villages resulted in changes in the boundaries of the village administration so that it needed the determination and affirmation of village boundaries.

However, the rate of expansion which has increased from year to year is almost entirely not preceded nor followed by the affirmation of the village which has resulted in unclear division of village assets, resulting in conflicts between villages and even between regencies/cities if village boundaries, as well as regional boundaries, are not yet stipulated and affirmed. Considering the large number of villages, it is necessary to accelerate the affirmation of village boundaries. In such regulation, it is mentioned that the determination and affirmation of village boundaries aims to create good governance, providing clarity and legal certainty of the village that meets the technical and juridical aspect.

The authority for definite determination of regional (province and city/regency) boundaries is made by the Ministry of Home Affairs, and the Regional Government for sub-district/village boundaries. The administrative boundary on topographical maps is an indicative boundary. In order to change the indicative boundary into a definitive, a determination and affirmation process is needed. For delimitation/delineation, it can be done in a cartometric manner on topographic maps or images. The stipulation of the cartometric method as one method in tracking regional boundaries was followed by the addition of realization of affirmation of regional boundaries.

Acceleration of boundary affirmation between adjacent areas is very necessary as an important effort to accelerate the implementation of One Map Policy as stated in Presidential Regulation No. 9/2016 on One Map Policy, which is targeted to be completed by the end of 2019. It shows the positive action in reducing the spatial conflict problems. The target of that policy was to reintegrate all map themes in Indonesia into one map (single reference, single standard, single databasae and single Geoportal). Administrative boundary dataset was one of 85 thematic maps. The One Map Policy is a catalyst for speeding up administrative boundaries including province, regency/city and village boundaries [Patmasari,2017].

As reported by the Ministry of Home Affairs based on data from 2016 - 2017, the number of definitive segments increased significantly by 45.45%, out of a total of 977 inter-regional segment boundaries 453 segments were completed [Riyadi, 2018]. The cartometric method can be said to accelerate the realization of boundary affirmation. In addition, indirectly, the One Map Policy is also indicated to be one that contributes in accelerating the realization of boundary affirmation. Even the Ministry of Home Affairs has targeted that at the end 2019 the problem of regional boundaries in all regions can be resolved, and the acceleration of the settlement of this boundary is also to reduce conflicts between adjacent areas. The eastern region of Indonesia is the main focus of completion of the boundary segment, particularly the boundary segments between the provinces of Papua and West Papua. For both regions since the formation of several autonomous regions in 1998, there is no segment that has been resolved by the adjacent regency or city (Permendagri, 2018)

According to the Law No. 4 of 2011 on Geospatial Information, the Geospatial Information Agency or *Badan Informasi Geospasial* (BIG) is an institution authorized to carry out geospatial information in Indonesia, especially Basic Geospatial Information. Officially, the Indonesian base map called *Rupa Bumi Indonesia* (RBI) is one manifestation of basic geospatial information that contains the following elements: coastline, hypsography, waters area, geographical names, boundary lines, transportation and utilities, building and public facilities, and also land cover. The village boundary

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which is the subject of this study is part of the boundary element that is included in the Indonesian Basemap.

BIG as the National Mapping Agency is responsible for providing the basemap in various scales, i.e.: 1:1,000,000, 1:500,000, 1:250,000, 1:100,000, 1:50,000, 1:25,000, including large scale basemaps 1:10,000, 1:5,000, 1:2,500 and 1:1,000. However until the end of 2018, the availability of large-scale RBI maps was still very limited. For the scale 1: 10,000 only 1.17% were available of the territory of Indonesia (BIG, 2018). To overcome the problem of the availability of village boundary in producing the RBI map with a scale of 1:25.000 or larger, BIG has introduced the cartometric method using high resolution orthorectified satellite imagery with a spatial resolution of approximately 0,50 m, which can be used for identifying the village boundary line instead of investing in time consuming and expensive field surveys. For this purpose some satellite imageries as Pleiade, Geo-eye, and WorldView that have spatial resolution equivalent to the level of accuracy of the base map scale 1:5.000 can be used to prepare village boundaries with sufficient accuracy.

In order to accelerate the affirmation of village boundaries in the territory of Indonesia, during the period 2013 to 2019, BIG has carried out delineation of village boundaries using a cartometric method. Starting in 2013 a trial of cartometric delineation was carried out for 47 villages. Each year the acceleration of delineation is increased in line with the government One Map policy which is stated in the President Regulation No, 9 of 2016. Using the available data of high-resolution satellite images, up until 2018 a total of 43,486 villages have been delineated (BIG, 2018). And in 2019 the village delineation activities are still being carried out to complete the delineation of village boundaries in the remaining areas, approximately around 32.840 villages.

The aim of the study is to obtain a comprehensive understanding of the role of geospatial information for accelerating the determination and affirmation of village boundaries in Indonesia and an inventory of challenges and solutions.

II. MATERIAL AND METHOD

The territory of Indonesia consists of provinces, regencies/city, district and villages. Geographically, Indonesia is located at 6ºN - 11ºS to 85ºE -141º E, with a map of the location of study shown in Figure 1. The Indonesian territory consists of 34 provinces, 416 regencies, 98 cities, and 83,486 villages with the distribution of the number of villages in each region and a varied village area shown in Figure 2. In general, the problems in determining boundaries in areas other than in Java, are that the area of the villages are very wide, difficult to reach, limited human resources and the lack of data availability with sufficient accuracy. Therefore, to solve this problem it requires the best method for time efficiency and funding saving. The cartometric method is relevant to this need because of the fact that the village boundaries are virtual lines that only exist on the map.

Taking into account the importance of village boundary maps and the limited number of village boundaries agreed upon, in this study, it will be described how the geospatial aspects play an important role in acceleration of village boundary delineation in Indonesia. The cartometric method is the search of boundary lines on the work map and the measurement of the position of points, lines, distances and area coverage by using basic maps and other additional geospatial data and information (article 1, number 11). According to Malling (2013), the cartometric method is a method of measuring and calculating the numerical value of a map. This method is applied for delineation of village boundaries following certain procedures to measure and determine a set of points, line and area (polygon) on work maps that are supported by adequate geospatial information.

This research used three general steps. First, was the analysis of various policies and legislation which emphasize the government's commitment in implementing village boundaries. Secondly, an evaluation of the delineation mechanism including the type of image used and result of delineation was carried out by BIG during period 2013-2019 throughout Indonesia. Thirdly, conclusions were made on the basis of the results of the discussion and various problems and constraints discovered that will be resolved.

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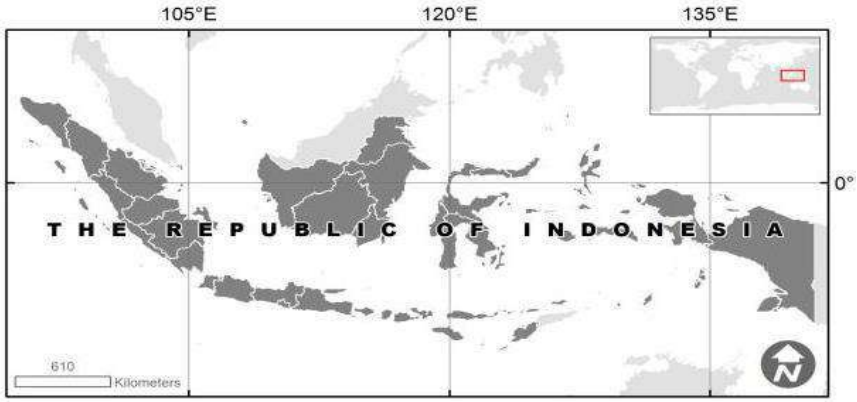

Fig.1: Map of study location

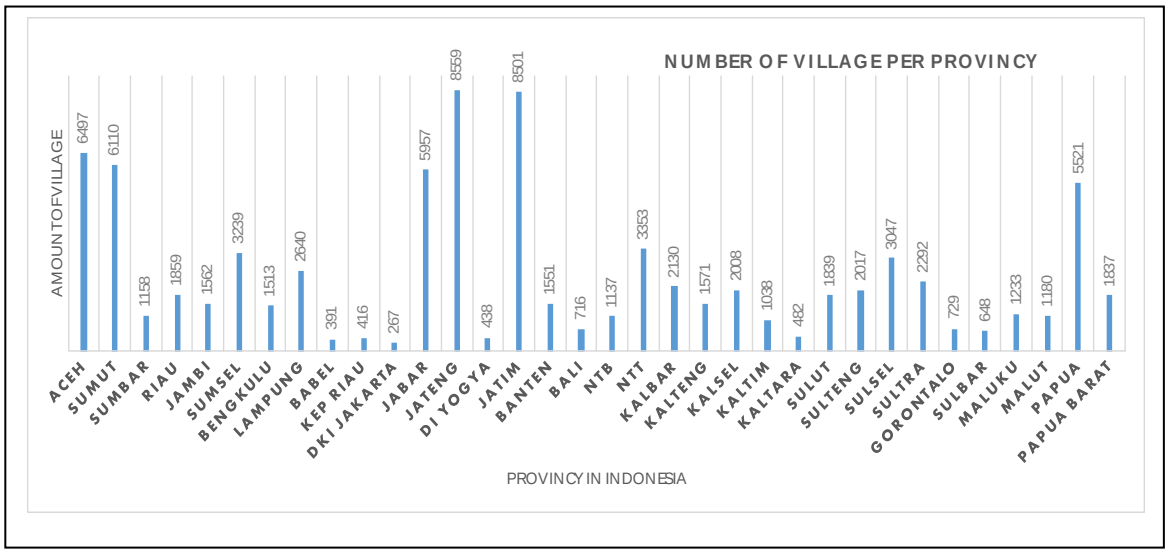

Fig.2: Distribution of number of village in each province (Pemendagri,2017)

III. LITERATURE REVIEW

Administrative boundary mapping has legal and technical aspects that should be considered by decision makers during work using maps to delineate boundaries. Both related aspects have been correctly prepared and implemented to produce the good legal boundary. These technical aspects consist of determination, measurement, and mapping. The legal aspect is related to the prevailing laws and regulations. The dynamics of legal regulations strongly affect the governance of administrative boundary mapping.

1.Village boundary and village map

According to Law No. 6 of 2014 concerning the village, a village is defined as the unity of the legal community that has boundaries and the authority to regulate and manage government affairs, the interests of local communities based on Community initiatives, the right of origin, and recognizes and respects traditional rights in the government system of Republic of Indonesia. In the case of village formations, it is required to attach a map of the village boundary area approved by the relevant technical institution.

Village boundary map is one type of thematic maps that is made referring to the National basemap with a scale of 1:5,000 or larger. In the event that the needed basemap is not available, then high resolution orthorectified satellite imagery can be used instead. Village boundaries are the boundaries of the administrative area of inter-village governance with administrative areas that are the authority of other village governments.

The village boundaries indicate the existence of the village which, according to prevailing laws and regulations, must have an area boundary map. Village boundary delineation is done by cartometry on an agreed basemap or an agreed substitution basemap. In Permendagri No. 45 of 2016 the village boundary is a boundary between the administrative areas of villages that are a series of coordinate points located on the surface of the earth which can be natural signs such as a watershed, median of rivers and/or elements of artificial objects (for instance roads, railroads,

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irrigation channels, and boundary pillars) in the field which are outlined in map form.

2. **Legal and Policy Basis in the village boundaries**.

a. Law No. 23 of 2014 concerning Regional Government in Transitional Provisions article 401 paragraph 2 states "Confirmation of boundaries including area coverage and broad determination as referred to is carried out based on technical calculations made by institutions in charge of Geospatial Information". The institution authorized to handle geospatial information is the Geospatial Information Agency, based on Law No.4 of 2011 concerning Geospatial Information.

b.Law No. 6 of 2014 concerning Villages

Law No.6 of 2014 concerning Villages, states in Article 8 paragraph 3f that the boundaries of the Village Area which are stated in the form of Village Maps are regulated in Regulations of the Regent / Mayor. It is further related to article 17 paragraph 2 which states that regional regulation including the formation, deletion, merger, change of status, and determination of the village, are enclosed with maps of village boundaries. It was stated that the village formation meant here was the establishment of a new village. Determination is made through the relevant Regent/City Regulations. One of the conditions that must be fulfilled is that there are village boundaries in the form of village maps. Therefore a village that will be expanded must first have clear and firm boundaries, and village maps must be available.

c. Presidential Regulation No. 9 of 2016 concerning Acceleration of the Implementation of the One Map Policy (OMP) at the Level of accuracy of Maps Scale 1:50.000. The target of the policy is to reintegrate all map themes in Indonesia into one map (single reference, single standard, single database, and single geoportal). The One Map Policy Program shows positive actions in reducing the problem of spatial conflict. Administrative boundary maps are one of 85 thematic types to be integrated and synchronized. The target of the One Map Policy must be completed by 2019.

d. Law No. 4 of 2011 concerning Geospatial Information. According to this law, BIG is the institution authorized to manage and realize geospatial information covering whole Indonesia. So far, BIG has completed Mapping at scale 1:25,000 in certain areas (Java, Bali, Nusa Tenggara and Sulawesi). . And scale 1:50.000 has covered Sumatra, Kalimantan, Maluku and Papua. To support the mapping of village areas, large scale maps are needed starting from a scale of 1: 10,000 to scale 1: 1,000. Until the end of 2018, the availability of large-scale RBI maps was still very small. For the scale 1: 10,000, only 1.17% of the territory of Indonesia was available (BIG, 2018). Village boundary map is one type of thematic maps, which must be made in reference to the basemap. A scale of 1: 5,000 or larger or using the best available data such as high resolution satellite imagery that has been orthorectified is needed to fulfill sufficient accuracy. In cases where very high resolution imagery is not yet available then an orthorectified high resolution image with the spatial resolution of 4 meters can be used.

e. Permendagri No. 45 of 2016 concerning Guidelines of Determination and Affirmation of Village Boundaries,

This Permendagri contains regulations on the procedures for village boundary delineation and demarcation, the executing organization, the result validation process and the dispute settlement. The attachments detail the principles and the process for village boundary delineation and demarcation which is very relevant to the Geodesy aspect and requires geospatial information data. The village boundaries indicate the existence of the village which, according to prevailing laws and regulations, must have an area boundary map. Determination and affirmation of village boundaries aims to create orderly government administration, providing clarity and legal certainty towards the boundaries of a village that meets technical and juridical aspects. Determination means determining the boundary on a map, which is referred to as cartometric determination on an agreed base map. The boundary determination only applies to villages that were formed after this regulation took effect. Boundary demarcation includes the installation of boundaries on the ground based on prior delineation results.

f. Regulation of the Head of the Geospatial Information Agency No. 3 of 2014 concerning Specifications for presenting village maps. Making village maps refers to the specifications of village map presentations and with certain layout templates. Matters that follow in developing village maps must refer to the geospatial aspects which are related to the datum and the map projection system, map scale, boundary lines and the map accuracy rules. The status and type of boundary lines are important issues that must be arranged in the village map. The village map will be in the form of a definitive boundary line after it has been stipulated in the regent/mayor's regulation regarding affirmation of village boundaries.

3. The Role of Geospatial Information in Boundary Making

a. The role of map in the delimitation/delineation Stage**.** Theoritically and empirically, two important stages of boundary making are the delimitation/delineation and demarcation of boundaries, which in the process require Geospatial Information as an infrastructure for identifying, selecting and defining the boundaries (Jones, 1945). In the

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delineation stage, a map has an important role as a technical tool for choosing the location and defining boundary lines, as a negotiating tool to reach boundary line agreements, as a media to display the results of agreement in the delimitation that will be attached to the minutes of the agreement or will later be used as a guideline in the demarcation stage, and to describe and present the boundary lines that have been made at the stage of delimitation and demarcation. Therefore the scale and quality of the map become very important. The delineation is an accurate, detailed. legally phrased definition, to avoid any future dispute over its practical interpretation (FIG, 2013).

b.The roles of maps in the demarcation stage

The results of the delimitation/delineation stage, which include narrative in the articles of agreement and boundary maps attached in annex of agreement, will be transferred to the ground through the installation of the demarcation pillars. Demarcation is to determine the position of a point and the true boundary line on the ground which is done bilaterally. Boundary points that have been agreed in the delimitation process are transformed into the field and physically marked by a construction of a monument or boundary pillars, guard post or other facilities (Jones,1945). This demarcation is done to determine the coordinates of boundary points through measurement, survey and mapping activities using appropriate technology, equipment and methods and up to date technologies, including commonly used geodetic equipment such as GPS and common worlwide geodetic reference systems, e.g. WGS 84. In village boundary mapping in Indonesia, the Indonesia Geospatial reference System referred to as *Sistem Referensi Geospasial Indonesia* (SRGI) must be used as the mapping reference. It is possible to define the boundary very precisely by coordinates at the centimeter level. The results of the demarcation activities will be described in the demarcation of the boundary map. This map contains coordinates of the boundary points as a result of the field measurement which will be used in the administration and boundary line management phase. Therefore large-scale maps such as 1:10.000 or greater would be very helpful. The existence of these pillars is very important in some boundary segment conditions. For this reason, the boundary pillars can be prioritized in certain boundary segments, among others, in conflict-prone boundaries, in areas that are difficult to interpret in the field. For areas with access to reach limits that are difficult to reach, for example on hills, in remote areas, etc., it can be done in a cartometric manner.

c.Geodetic aspects in Village boundary making

The determination and affirmation of village boundaries are carried out through the principle of geodesy and processed in a cartometric manner on an agreed basemap. Referring to the attachment of Permendagri 45 of 2016, several technical matters that follow in developing village maps must refer to the geospatial aspects which are related to the datum and map projection systems, map scale, and boundary lines.

The maps used in the formation of the village must use the datum and reference system that applies nationally (SRGI 2013). This was done to facilitate the process of integrating village boundary data. The projection system is used to calculate the area of the village. Different projection systems can result in broad values that are also different. Calculation of village area throughout Indonesia must be carried out using the same projection system (Lailissaum, 2017).

d. Availability of Geospatial Information in Indonesia for village boundary mapping

The basic map used to create the village map is the map RBI scale 1:5,000. As mentioned in Permendagri No. 45 of 2016, in cases where it is not available then it may use an upright high resolution image with the lowest spatial resolution of 4 meters. (Please give actual information) Unfortunately until the end of 2015, the availability of large-scale RBI maps covers only approximately 1,17% of the territory of Indonesia, thus the village boundary delineation activities in Indonesia during period 2013-2019, use high resolution image data. High resolution images can be used to recognize objects in the field and facilitate easy identification of boundary objects that are used as a reference for setting boundaries, such as riverbanks, road edges, and other objects as illustrated in Figure 3. To interpret or examine the objects seen in the image, the image is interpreted. Image interpretation can be defined as the process of intensively interpreting an image carried out thoroughly to identify and conclude the appearance of the elements in the image, which are then used to present the necessary information about the interpreted area (Sumaryo, 2002).

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Fig.3: Boundary segment between Medan - Deli Serdang

To meet the needs of high-resolution image, the Presidential Instruction Number 6 of 2012 assigns BIG and LAPAN to provide, process and disseminate upright high resolution image to be used for development purposes, including village boundary mapping. The following is the coverage of Satellite Imagery that has been provided by BIG and LAPAN consisting of Satellite Imagery: Airbus (Pleiades), Digital Globe (Quickbird, Geoeye, Worldview-2, Worldview-3), with the acquisition year 2013 - 2015, and spatial resolution of 0.5m. Image coverage is 1.043.252 km2 (almost55,2%) of Indonesia as illustrated in Figure 4.

The high resolution image still needs to be perfected with geometric corrections and topographical correction with the orthorectification process, so that the image becomes an upright image with correct orthogonal projection for better mapping accuracy, and include coordinates in the reference system that applies nationally. (BIG, 2012). The implementation of Satellite Image Orthorectification has been carried out by BIG using Pixel factory Software. In general, the first step of the correction procedure is an implementation of geometric correction, with Digital Elevation Model (DEM) and Ground Control Point (GCP) as input data. Unfortunately, these ortho images as mentioned above covered only 50% of Indonesia, while the remaining area was supplied by SPOT 5 and SPOT 7 imagery. The SPOT 7 Ortho satellite imagery are provided by the vendor in the form of data that has been PANSHARP/fusion with a resolution of 1.5 m using systematic orthorectification processes.

Furthermore, in the implementation of delineation of village boundaries, there are complications since satellite images in some areas were covered by clouds in excess of the permissible percentage (due to weather conditions), especially in areas in Kalimantan, Sumatera and Papua known as eternal clouds. For this reason, and also for areas that are not yet available, high resolution satellite imagery was substituted using Bing Map which is georeferenced to primary data and ESRI image basemap.

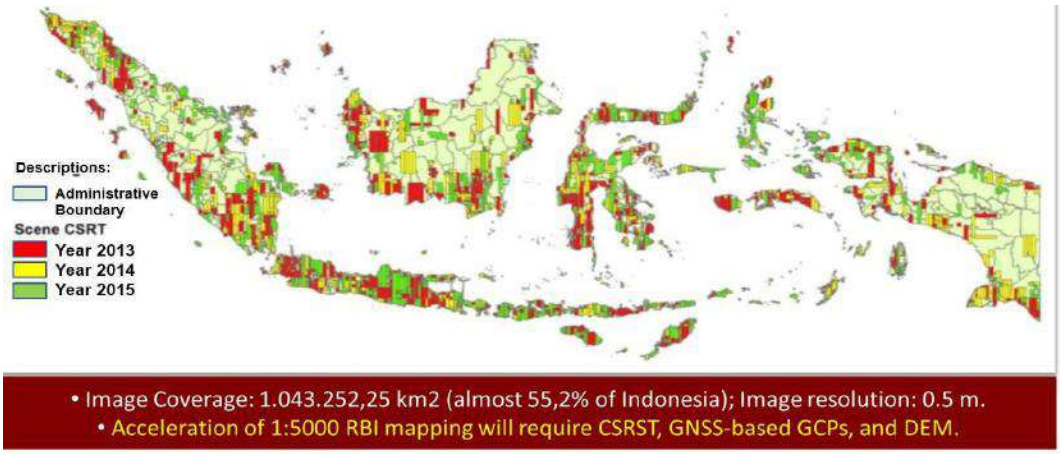

Fig.4: Coverage of High Resolution Satellite Imagery

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e.Village boundary delineation using cartometric method

Village boundary delineation is a part of the village boundary affirmation stage referring to Permendagri no 45 of 2016. Tracing the village boundary lines above the draft work map follows the shape of a river, mountain ridge or any other natural features to delineate village boundary. Other than that, the delineation of village boundary may follow an artificial feature, such as roads, railways, irrigation waterways, etc. With the availability of technology geospatial information along with appropriate images, the delineation can be carried out easily and accurately. Of course, human resources are needed that possess the ability to use GIS software. Delineation process must involve stakeholders in the area, such as village officials and village community leaders who understand the boundaries of their territory. If all segments of the boundary line have been agreed upon, a cartometric boundary line can be drawn on the agreed map/ortho image. With this method, village boundaries are determined on maps, both hardcopy and digital, while activities in the field are only carried out if needed. The resulting data is in the form of village boundary maps and coordinate listings of boundaries points in a cartometric manner (in certain regions). Delineation of village boundaries to meet the basic needs of geospatial information on village administrative boundaries, with the aim of producing indicative administrative boundary data, include results of a village boundary map for each village.

The general stages on delineation village boundaries are carried out in villages that are adjacent to each sub-district. The stages of village boundary delineation are carried out as follows:

- ✓ Tracing the village boundary above the draft work map follows the shape of a river or mountain which is a natural boundary or follows a non-natural boundary
- ✓ Verifying the indicative limits in the draft work map, by carrying out the interpretation above the draft work map with background of high resolution upright images
- ✓ Tracing village boundaries based on data and information from boundary instructions submitted by the two village heads on a cartometric basis on the draft work map (hardcopy) according to the agreement.
- ✓ Updating village boundary data digitally with GIS software displayed on a large screen using a projector, in order to see in more detail the appearance of the various types of elements identified above.
- ✓ The selection of cartometric points on easily recognizable objects. For example, on a river or a straight road points are only made at the ends of segments (intersections or turns of roads or rivers). Cartometric point coordinate extraction is done using GIS software
- ✓ Signing the minutes of the boundary agreement that contains information on the results of the boundary description and the delineation process and lists the coordinates of the village boundary cartometric points.

IV. RESULT AND DISCUSSION

1. Strategy in Accelerating Delineation of Village Boundaries in Indonesia period 2013 – 2019

As clearly stated in the Village Law, that BIG is responsible for the validity of the Village Map. In order to support the government's current vision and mission, as mentioned in Law No. 23 of 2014, Law Number 6 of 2014, Presidential Regulation No. 9 of 2016, the Center for Boundary Mapping of BIG is obliged to provide regional boundary information, including village boundaries. In connection with the number of villages, the implementation of delineation activities conducted by BIG partners in this case private consultant engaged in survey and mapping with supervision by BIG personnel. In the process of delineating village boundaries in the regions, BIG has involved local government officials and village officials. The following is the implementation of delineation of village boundaries in Indonesia carried out by BIG.

a. Starting in 2013, a prototype of cartometric delineation with agreements between adjacent village officials was carried out in 47 villages. The delineation of the village boundary as a pilot project was done in several areas in Java, namely Bantul, Semarang, Bogor and Surabaya. In determining village boundaries, the stages are carried out through document research, determination of work maps and delineation on work maps and village bounadary map making. In these cases, the images used are the best available image data, (such as image from Bing map) with a note that it will be recreated with a high resolution orthorectified satellite image provided by BIG. In 2014, the delineation was continued in Java for 201 villages in several regencies, namely West Bandung, Tasikmalaya and Pekalongan. After successful implementation of the cartometric method, furthermore in 2015, this method was widely applied for 1392 villages bringing the total of completely delineated villages to 1640, apporximately 2% of the

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total number of villages in Indonesia. The result of delineation consists of, among others, village working maps with a scale 1:10.000, verbal description of the boundary delineation, minutes of agreement and disagreement. During the process of making cartometric village boundary maps, disputes or differences of opinion may occur between community members in a village or with adjoining village members. Differences in perceptions, opinions or disagreements regarding village boundaries are a logical consequence of Village Boundary delineation. In the case of disagreement over boundaries, dispute resolution has been regulated in Permendagri 45 of 2016 (article 18, to be resolved through deliberation and facilitated by the Regent/Mayor and stated in the minutes). In fact, the cartometric method is more efficient than delineation with the field survey method that requires a high level of man power, money and time.

b. With respect to government policies and availability of high-resolution orthorectified satellite imagery, in the fiscal year 2016 – 2017 BIG accelerated the village boundary delineation with agreements between adjacent village officials, using high resolution ortho image, namely Pleiades and Worlview 3, provided by BIG with the acquisition year of 2013 - 2015. Using these images with spatial resolution of about 0.5m, the boundary element objects visualized in the satellite image are very clear, hence village officials can easily identify and verify village boundaries. To facilitate the implementation of delineation, the activities to trace the village boundary above the draft work map were carried out following natural and artificial features using digital or hard copy image. Village boundary data was also updated digitally with GIS software displayed on a large screen using a projector in order to see in more detail the appearance of the various types of elements identified above. In cases where the natural and artificial features are not apparent to delineate the boundary, the delineation may follow a line which is agreed upon by the stakeholders. In 2016, **BIG** conducted delineation in 2510 villages spread across 19 regencies/cities. Continued in 2017 BIG has further completed delineation in 8009 villages spread across 38 regencies/cities in various provinces in Java, Bali and the Nusa Tenggara regions. Up to 2017, BIG completed an accumulated amount of 12,159 villages or 14,57 % of the total number of villages in Indonesia (BIG, 2017). During this period, the delineation also produced a set of cartometric points. Thus the results during this delineation process, besides producing a map of delineation work include a descriptive part data of list coordinates of entire boundaries in a common geodetic datum system. Extraction of coordinates of boundary points with a certain distance was conducted only in the agreed boundary segment. The selection of cartometric points was conducted on easily recognizable objects, e.g. on a river or a straight road where the points were only determined at the end of segments (intersections or turns of roads or rivers). Cartometric point coordinate extraction is done using GIS software.

c. Taking into account that the target of One Map Policy must be completed at the end of 2019 and BIG's commitment as the provider of administrative boundary data as part of the national data set, in period 2018 -2019 there will be a change in strategy and policy. With consideration of the reasons mentioned above and the large number of remaining villages, more than 60,000 villages, the strategy for delineation mechanism is carried out without agreements between neighboring villages. With this strategy delineation without agreement/without minutes of agreement. delineation will speed up . In 2018 delineation has been carried out with a volume of 31,147 villages (in 227 districts/cities, 18 provinces) especially in most regions of Sumatra, Kalimantan, Maluku, and Papua regions (BIG,2018). With this volume, and in consideration of the quality of the image data used, namely SPOT-5 and SPOT-7 with spatial resolution $\leq$ 2.5 meters, then delineation of village boundaries is carried out without minutes of agreement. Based on experience using SPOT 5 and SPOT 7, the boundary elements in the image are difficult to identify, so village officials have difficulty interpreting the image to understand the village boundaries. And no point coordinate extraction is carried out. For delineation in the Papua region, taken into account are the difficulties of geography (because the area is very large so it is not possible with limited time to reach each village or gather village officials). Delineation is carried out in the district/city and without agreement. A similar approach was used for the Maluku region. As for delineation in the Kalimantan and Sumatra regions, the implementation of delineation was carried out in the sub district and without agreement. However, the results for all regions are still presented in each village, a work map of resulted delineation. The achievement of village boundary acceleration

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activities during the period 2013-2018 was 43,486 villages or 51.39% of the number of villages in Indonesia, a very significant progress (BIG, 2018). Distribution village delineation ia as illustrated in Figure 5.

Fig.5: Distribution of the location of village delineation carried out during the period 2013-2018 (BIG, 2018)

d. As mentioned previously, one of the One Map Policy targets is to complete the village boundary for the entirety of Indonesia by the end of 2019. Currently in 2019, the cartometrics delineation without agreement is being carried out for approx. 32,840 villages, 194 cities/regencies, 18 provinces, in areas that RBI map scale 1:25.000 are available, especially the whole region of Sulawesi, Sumatra, Java, Nusa tenggara and Papua in areas that not have been delineated yet in previous years [Artanto, 2019]. The images used are SPOT-5 and SPOT-7 with spatial resolution ≤ 2.5 meters. The strategy for delineation mechanism is carried out without agreements between neighboring villages. The stages of delineation of village boundaries carried out in 2019 are the same as in the previous year 2018, and the results for all regions are presented with a delineation work map for each village. Basically, the areas of delineation in 2019 have RBI map scale 1:25,000. Thus the results obtained also are simultaneously updating village boundaries at a resolution of 1: 10,000. At the time of writing this paper the implementation of delineation is still ongoing until November 2019. It is estimated that the number of villages in the period 2013-2019 will reach 76,196 villages or around 91.26%. The realization of Village boundaries delineation period 2013 – 2019 by BIG, is as illustrated in figure 6. All efforts made to describe village boundaries throughout Indonesia will be completed until the end of 2019.

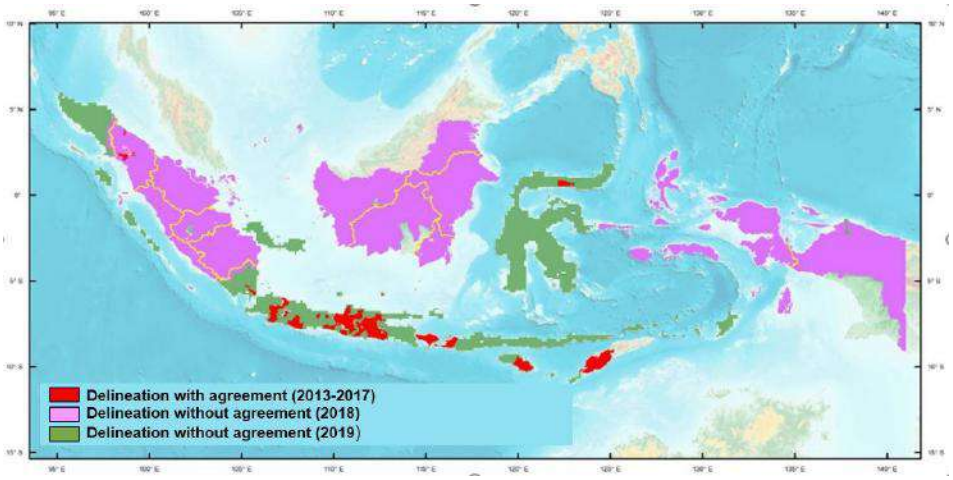

Fig.6: Distribution of Delineation village boundary in Indonesia period 2013-2019 (BIG, 2018)

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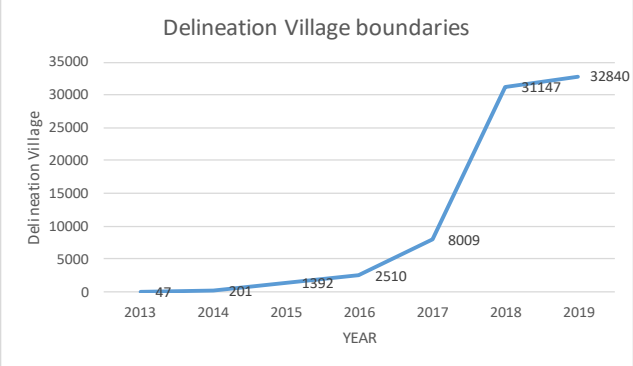

Fig.7: The Acceleration graphics for the realization of Village boundaries delineation Period 2013 – 2019 by BIG

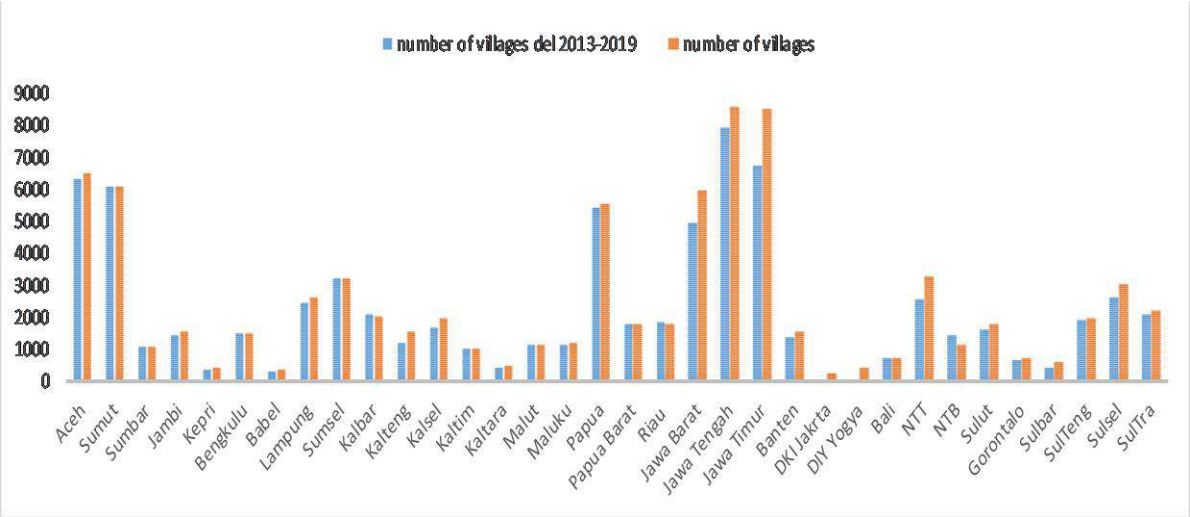

Fig.8: The Acceleration of number of village and number of delineation period 2013 – 2019 in each province

2. Achievements and Challenges

a. It is estimated that the number of villages in the period 2013-2019 will reach 76,196 villages. The results showed that village boundary mapping using high resolution orthorectified satellite imagery had produced accurate village maps according to cartographic and geometric rules. The cartometric method can be concluded successfully accelerating the realization of boundary delineation. In addition, indirectly the One Map Policy is also indicated to be one of the government's policies that encourages accelerating the realization of boundary village delineation as shown in figure 7 and figure 8, which accelerated during the period of 2018-2019 in line with the one map policy target by the end of 2019. Significant increase in realization of boundary delineation was in 2018 towards 2019, from 12,159 villages (year 2017) to 76,196 villages. The trend of realization of boundary delineation in each province during the period 2013-2019 has fluctuated according to Figure 8.

b. It could be noted that the accelerating of boundary delineation without agreement between stakeholders may lead to conflicts or problems in the future. It can be anticipated to use new and more accurate data in the future.

c. By using the cartometric method in carrying out delineation of village boundaries, it provides village boundaries without the need to conduct field surveys in examining village boundaries. Delineatiom and mapping of village boundaries may be executed faster and inexpensively, especially for Indonesia with a large number of villages. Of course, the accuracy of the village boundaries obtained will depend on the quality of the images used. With Pleiades and WorldView 3 images with a resolution of 0.5 meters, it will produce a geometric horizontal accuracy that is much better than using SPOT 5 and SPOT 7. But the boundary images on satellite images are also very dependent on the interpretation of images carried out together with village/district officials. The role of geospatial information fully

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supports the acceleration of village boundaries in the territory of Indonesia.

d. The results of the village boundary delineation by cartometric that has been carried out by BIG during 2013-2019 will be used as a reference for administrative boundary data on the topographic map at resolutions 1:10,000. In addition, it is also recommended to be used for updating village boundary data on Spatial Maps to support the One Map Policy. In addition, it is very easy to integrate all the results of the village boundary data in the Indonesian territory into a boundary for each district/city, province (in the form of seamless) because it is already within one national reference.

e. Delineation produces a number of documents, such as a work map village boundary, list of cartometric coordinate data, minutes of agreement (for certain regions), etc. The importance of certain documentation was recognized as a technical report of the delineation and is important for preventing loss of data, which may be valuable for future demarcation and future surveying and geodetic work. According to our experience, the value of the documents above are very useful to support any technician in reconstructing the boundary line. The positional and geodetic data that fully document the location of the boundary are essential descriptive data, and the type and shape of the pillars is only complimentary.

f. The result of village boundary delineation consists of work maps. The data will be used and followed up for the next stage in the affirmation process. The regional government requires the final product in the form of village maps that have been agreed by village officials, and the ratification of regent/mayor regulations (legalization efforts in legal aspects) with village maps and coordinates of village boundaries as attachments.

g. The development of mapping technology and spatial data requires geospatial data and information in a digital format that can facilitate data analysis, etc. With the rapid development of mapping technology, and in following up on the delineation of village boundaries that are filled with geodesy aspect and the use of geospatial data information, reliable human resources are needed in the field of geospatial information. This special expertise can be obtained through education and training related to the field of geospatial information, such as understanding aspects of village boundary mapping, the use of GNSS for positioning, remote sensing, and the use of GIS software etc. So far there is a lack of human resources in local governments in the geospatial sector or mapping. Training of a combination of conventional methods (face to face) and elearning systems should be considered. By implementing the E-learning system, it is expected to be more optimal.

V. CONCLUSIONS AND SUGGESTIONS

1. The large volume of villages in Indonesia and the urgency of the availability of village maps require a mechanism to accelerate the provision of village maps. Cartometric method has been succesfully applied as an alternative model in accelerating the determination of village boundaries
2. Upright high resolution satellite images (ortho image) such as Pleiades , World View 2 , SPOT 5 and SPOT 7 are very useful to use in mapping village boundaries, especially in areas where topgraphic maps on a scale of 1:5,0000 are not available. Technical studies are needed regarding the assessment of geometric accuracy of coordinates related to horizontal accuracy, mainly when coordinates are extracted by cartometrics from ortho images
3. It is expected that the availability of village boundary spatial data in the form of work maps resulting from delineation of village boundaries produced by BIG in the 2013-2019 period, can be immediately followed up by the regional government in supporting the acceleration of legalization in the legal aspects, especially in areas with agreed boundaries. Simple procedures need to be formulated by BIG as technical guidelines.
4. It is necessary to increase coordination between the level of regional and central government in accelerating the implementation of village boundaries, so that they can be implemented efficiently, transparently and accountably in order to intensify the implementation of Permendagri no. 46 of 2016 concerning Determination and Affirmation of Village Boundaries
5. There is a need to improve the synergy between the Ministry of Home Affairs, BIG, Local Governments, and Universities to improve adequate human resource capacity in the aspects of planning, village boundary mapping through education/training, technical guidance, and border research primarily related to spatial information, both hardware and software.

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6. It is necessary to conduct human resource development in enhancing the competence of the geospatial information specifically for the purpose of establishing and affirming village boundaries
7. It is necessary to accelerate the complete coverage and updating of basic Geospatial information throughout the NKRI region and necessary to procure large-scale maps to support various development programs in Indonesia

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Citrus Fruit Quality Classification using Support Vector Machines

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Abstract *— The large-scale fruit selection process is still manual or semi-automatic, mainly in small industries. This fact can lead to errors during the sorting of good fruits. Thus, this paper proposes an application using computer vision and machine learning to improve this task. The genus studied was the citrus, more specific the orange, one of the most produced fruit in Brazil. However, the methodology used can be applied on any fruit which quality can be measured by vision. The initial step was the construction of the learning space, consisting of image acquisition, pre-processing and features extraction. After the construction, the learning phase begins, consisted of the training of the support vector machine model, and then, statistical methods were used to valida te the model. As the final result, it achieved the accuracy of 97.3% in fruit classify.*

Keywords *—* ***Computer Vision, Fruit Quality, Support Vector Machines, Machine Learning.***

I. INTRODUCTION

Brazil is one of the largest fruit producers in the world, in accordance with FAO, Food and Agriculture Organization of the United Nations, it produced more than 40 million tons of fresh fruits in 2017, which 17 million tons were alone by orange fruit. In Brazil, the sorting process still is manual leading to errors in the quality inspection, due to the intensive, repetitive and tedious work routines, resulting in low-quality fruits that affect commercial acceptance [1].

With the increasing demand for the use of Artificial Intelligence, new areas had diverged like computer vision, machine learning, and the most recent area, Deep Learning (DL). Computer Vision (CV) aims to behave like human perception, using image processing and analysis to achieve this goal. Both Machine Learning (ML) and DL tend to minimize the intra-class variance along with the feature space for the given classes [2], the main difference is on the feature extraction phase. ML models often use feature extraction algorithms to find edges, corners, and descriptor like SIFT [3] and SURF [4], to create the feature vector as input for the training model. DL models use a hierarchical set of layers that produces learning representations from data, some layers can abstract the concept of edges, others contours, colors information, etc. In this approach, the model learns from the data, extracting features from the convolutions and pooling operations through the connected layers [4], [5]. The main idea for the feature extraction is to reduce the dimensionality, using obtained characteristics features from the signals, instead of the signal themselves [6].

The selection process induces the problem of the attribution of quality in the fruits, which, even according to legal standards, has a certain degree of subjectivity. Another aggravating factor is the possibility of a wrong classification by the person since human perception is easily deceived due to knowledge being inappropriate or being misapplied [7].

In this sense, a machine learning model using Support Vector Machine (SVM) in conjunction with a computer vision system to assist in a faster and more reliable sorting process is proposed. A computer vision system uses an optical device such as a sensor or a camera and a processing system. The image capture is followed by an analysis process and, in general, algorithms for segmentation are used to find regions of interest and feature extractors. Thus, to build the learning space and making it possible to classify the image according to previously adopted criteria. Also, it is possible to establish well-defined sample classes, according to the judgment of specialists and the characteristics to be identified.

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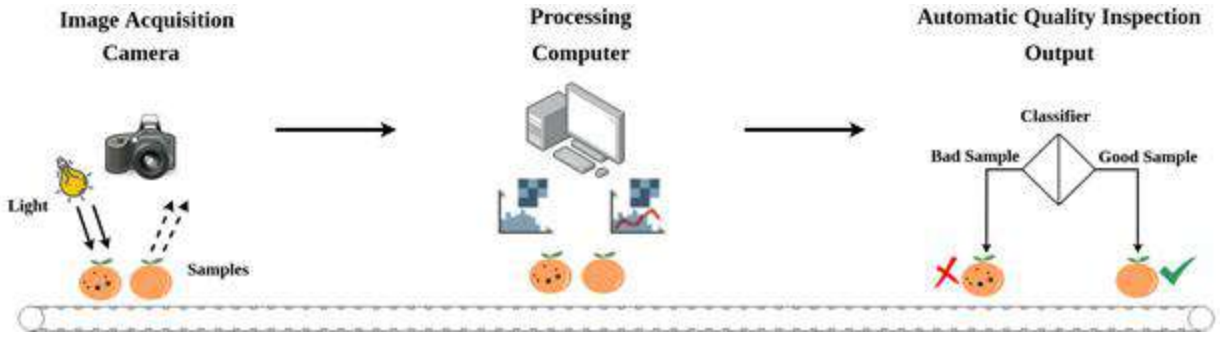

Fig. 1: Computer vision system architecture proposed in this paper.

Fig 1 shows the proposed architecture used to build the computer vision system, on the image acquisition stage the system captures the image. But on this paper, it doesn't discuss how the image acquisition system works or how it was implemented, the focus was the processing and automatic quality inspection stages.

The database was collected from COFILAB[1], which consist of two well-defined classes: citrus with stem, a collection of oranges in good maturity state and quality, and oranges infected with scale. The pre-processing stage is composed of three steps, background reduction, image filtering, and segmentation. After the segmentation, the learning space is built with the knowledge gathered from these steps.

The automatic quality inspection stage is composed by the use of the proposed classification model, which is SVM, a method based on machine learning theory. The feature vector built for the training was inspired by [8], using 64 colors features, 7 texture features, 8 shape features.

II. IMAGE ACQUISITION, PRE-PROCESSING, AND SEGMENTATION

The image acquisition was proposed using two datasets provided by COFILAB, Citrus with stem and Oranges infected with scale. Both datasets were created under the same circumstances [9], composed of a digital camera used to acquire high-quality images. At first, the images contained unnecessary information, like the background, as the research focused on the quality of the fruits, a background reduction was made. As the base is standardized by COFILAB, the reduction was a simple task, it starts with the use of Sobel filters to find contours and then a bounding-box is used to subtract the background.

Fig. 2 shows the steps to achieve the background subtraction, the Sobel filters are applied to find the contours and a routine to find the most significant contours is used, a threshold of 25% of the total area is used to dismiss the small contours leading only to match the fruit in the image. After the find of the most significant contour a mask using the min and max of each axis, width, and height of the image, is used to build the bounding-box to apply into the original image extracting the fruit and reducing the background.

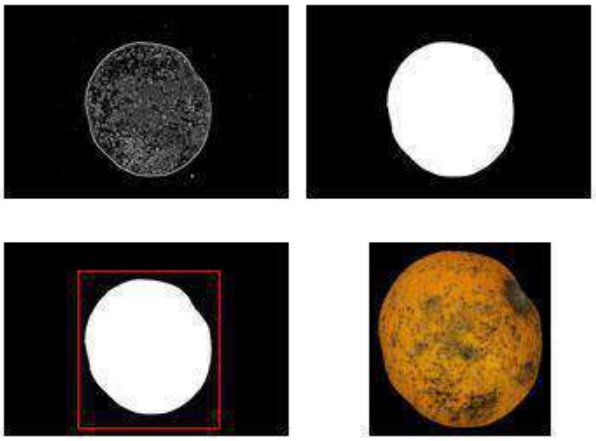

Fig. 2: The steps to achieve the background subtraction, in (a) the Sobel filter is applied, (b) apply mask inside the most significant contour region, (c) bounding box is formed by the min and max of each axis, (d) result image

After the background subtraction, image filtering is used to reduce the noise caused by sensors fault in the digital image acquisition. Vector median based filters or Gaussian filter are often used in this task, however, these classical methods tend to blur image edges and details

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possibly losing crucial information about the image. In order to mitigate the blurriness caused by linear filters, Peer Group Filtering (PGF) is applied [10] without losing information about edges, making the segmentation robust.

The segmentation routine was made using JSEG (JPEG image segmentation), an unsupervised segmentation of color-texture regions in images and videos [11]. The JSEG objective is to segment images and video into homogeneous color-texture regions, but to identify this homogeneity, three pre-set rules are necessary:

- Each image must contain homogeneous color-texture regions;
- Each region can be represented by quantized colors in it;
- Colors between two neighbor regions are distinguishable.

The JSEG segmentation is formed by two steps, a color quantization, which performs a color reduction using a clusterization algorithm replacing the pixel value by its cluster color, generating a class-map, and a spatial segmentation is applied into the texture composition on the class-map.

Initial the color quantization is proposed during the image filtering process using the PGF, resulting pixels receive assigned weights, textured areas weights less than smoothed areas. CIELUV color space is used because its perception is uniform, the human eye senses changes in color better in uniform regions [12], and a General Lloyd Algorithm (GLA) creates the vector quantization of the pixel colors. The cluster's initial position for GLA is estimated by the popular splitting initialization algorithm. The weighted distortion D is given by:

$$D = \sum_i D_i = \sum_i \sum_n v(n) \parallel x(n) - c_i \parallel^2, \quad x(n) \in C_i,$$

And the update rule is derived to be:

$$c_i = \frac{\sum v(n)x(n)}{\sum v(n)}, \quad x(n) \in C_i.$$

where c_i is the centroid of C_i, $x(n)$, and $v(n)$ are the color vector and the perceptual weight for pixel n, and D_i is the total distortion for cluster C_i.

At the completion of GLA, some pixels may have similar color values, causing the pixels to belong to different clusters, so an agglomerative clustering algorithm is used to merge clusters, minimizing the distance between them, parameterized by a threshold.

After color quantization, all necessary information for segmentation is saved into a class-map. The generated class-map, often called J-image, is the value of each pixel in its given class by its position in the image as a bi-dimensional vector (x,y), this value can be represented as J-value. Each point belongs to a class, using these spatial data the JSEG segmentation is proposed:

Let Z be the set of all N data points in a J-image. Let z = (x,y), z ∈ Z, and m be the mean,

$$m = \frac{1}{N} \sum_{z \in Z} z.$$

Suppose Z is classified into C classes, Z_i, i=1,...,C. Let m_i be the mean of the N_i data points of class Z_i,

$$m_i = \frac{1}{N_i} \sum_{z \in Z_i} z.$$

Let

$$S_T = \sum_{z \in Z} \parallel z - m \parallel^2$$

and

$$S_W = \sum_{i=1}^{C} S_i = \sum_{i=1}^{C} \sum_{z \in Z_i} \parallel z - m_i \parallel^2$$

Sw is the total variance of points belonging to the same class. Define the J-value as:

$$J = (S_T - S_W) / S_W.$$

In the case of images containing homogeneous regions, the more separated the classes will be resulting on a high value of J. In opposition if classes are uniformly distributed on the image the value of J tends to be small.

Circular windows of various scales are used to determine possible regions in the image. The value J is calculated for each region obeying the window size and the mean of the values is given by:

$$\bar{J} = \frac{1}{N} \sum_k M_k J_k,$$

where Jk is J calculated in the region k, Mk is the number of points in region k, N is the total number of points in the class-map. Thus, the criteria for segmentation is to

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minimize J over all regions. The window size affects how much an image region can be detected. Small size windows are useful to locate intensity and color edges, while large windows detect texture boundaries. Therefore, a region growing using seeds is necessary, it is followed by a region merging to give the segmented image, this parameter is controlled by the user, named scale factor. It was empirically analyzed that scale factor below value 10 fewer areas were detected and above 10 had no effect in to improve detection. So, with scale factor 10 was able to detect more areas, being healthy or unhealthy.

A threshold T_J is used to establish how the seeds are created over the image, given by:

$$T_J = \mu_J + a\sigma_J.$$

where μ_J is the mean of the values that represent the homogeneity over the image and σ_J is the standard deviation, a is a constant chosen from preset values that result in the number of seeds. Pixels with local J values less than T_J are candidates to be a seed point, the connection used in the JSEG algorithm is the 4-connectivity, (x+1,y), (x-1,y), (x,y+1), (x,y-1), where (x,y) is the position of the pixel.

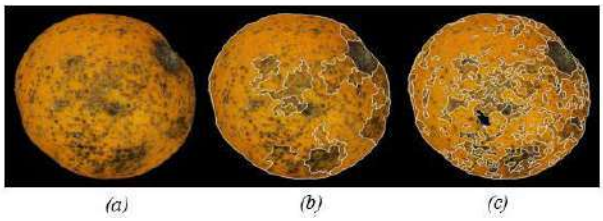

Fig. 3: JSEG step, (a) image filtering is applied generating the class-map, (b) default scale parameters on JSEG, (c) using 10 as the scale parameter

Fig. 3 illustrate the JSEG resulting image with the segmented areas overlayed with a white line, (b) result shows the default configuration for the JSEG, (c) uses 10 as the factor scale, values above 10 results on similar images, but the computational cost and time is increased, the proposed method uses 10 as a factor scale.

As for post-processing, a color reduction is applied to the segmented areas to reduce the color information, the objective in this phase is to improve the color disparity between areas, enhancing possibles rotten areas and preserving healthy areas, the Fig. 4 shows a better visualization of the color reduction.

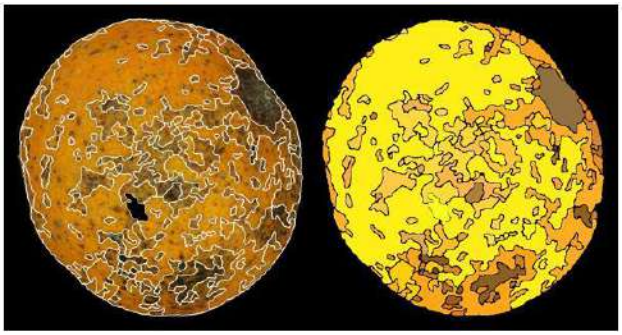

Fig. 4: Color reduction procedure output

III. SUPPORT VECTOR MACHINES

The learning paradigm chosen in this research was supervised learning, in this approach the machine, at the training process, know what class the inputs belongs to. SVM model, proposed by Vapnik in [13], is a representation of examples as points in space, mapped so that the series examples are divided by a clear gap that is as large as possible. New examples are then mapped, shared and defined for a category based on which side of the gap they fall into.

SVM constructs a hyperplane, or a set of hyperplanes, in a space of high or infinite dimension, which can be used for classification or regression. A good separation is achieved by the hyperplane that has the largest distance to the trained know points closest to classes, Fig. 6 exemplify the problem to find the largest distance between the separable classes, this distance is called functional margin. In general, the larger the margin, the smaller the generalization error is obtained.

The margin can be determined by calculating the distance between any two points, one of each translational hyperplane, both located in the normal vector w. Denoted by x_1 and x_2 the points in the vector w belonging to the upper and lower hyperplanes, respectively, the margin is computed simply as the length of the line segment connecting x_1 and x_2, that is, $||x_1 - x_2||_2$.

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The margin can be written much more conveniently, taking the difference evaluated at x_1 and x_2 respectively.

$$\left(b + x_1^t w\right) - \left(b + x_2^t w\right) = (x_1 - x_2)^t w = 2$$

Given that the two vectors $x_1 - x_2$ and w are parallel to each other, we can solve for the margin directly in terms

$$\|x_1 - x_2\|_2 = \frac{2}{\|w\|_2}$$

of w, as:

The margin problem is extensively discussed in the theory of statistical learning. This discussion addressed the use of Kernels Machines where it explains the margin problem. The functions chosen were the most used in the literature, such as:

- Linear Function;
- Polynomial Function;
- Radial Basis Function;
- Sigmoid Function.

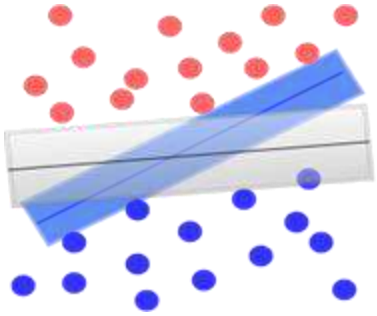

Fig. 5: Different separators trying to fit a larger margin

IV. PROPOSED METHOD

The proposed method uses an image processing routine described in Section II to process the input, and a feature space composed of 64 color features, 7 texture features, and 8 shapes features to create the feature vector. The initial dataset configuration was unbalanced, 125 images from the orange infected with scale, and 210 images from the citrus with stem, so a data augmentation procedure was used to balance the data sets.

The final configuration for the dataset was 300 images for each class. Operations like rotation, random noise, random crop, perspective-skewing, and elastic distortions were applied during the augmentation.

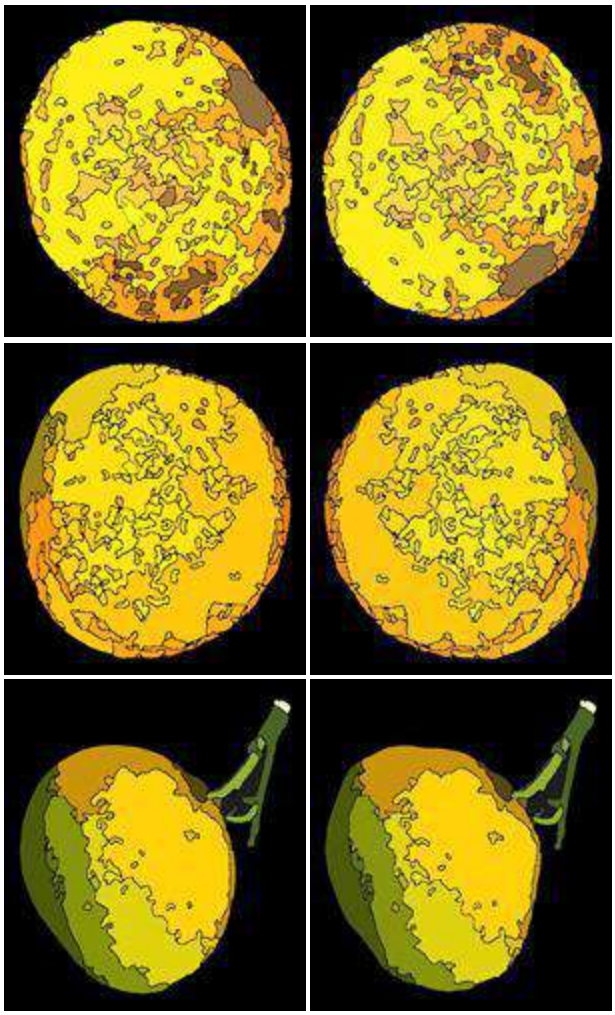

Fig. 6: Left side - Original Images, Right side - Augmented Images.

Fig. 6 exemplifies the operations, the left side is the original images, the right side is the augmented images results, the images might be similar, but the features generated is completely different.

Since the images do not have the same size, to create the 64 color feature, a dynamic filter was created to output the 64 color characteristics, also the color features used the RGB color space and HSV in its construction. As part of the texture features, it uses the mean, the contrast, the homogeneity, the energy, the variance, the correlation, and entropy, based on sum and difference histogram measures proposed by Unser in [14]. The shape features or morphology based measures, the features used as the area, perimeter, Euler number of the object, convex, solidity, minor length, major length, and eccentricity. In total the feature vector is built with 79 dimensions.

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Normalization is applied to the feature vector to preserve the learning abstraction within all the features, the main objective in normalization is to change the dimension values in a uniform common scale.

Within the features vector built, the training process uses 70% of the data set and 30% for tests, both classes uniformly distributed in each process. The metrics chosen to evaluate the model was f1-score, accuracy and confusion matrix one of the most used metrics to evaluate pattern recognition models [1],[2],[8],[15].

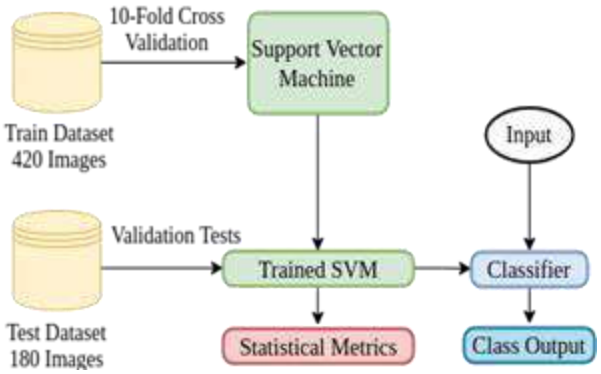

Fig. 7: Flow chart of the proposed method

A cross-fold validation using 10 folds were applied in the training process. Fig. 7 illustrate the proposed method using a flow chart.

V. RESULTS AND DISCUSSION

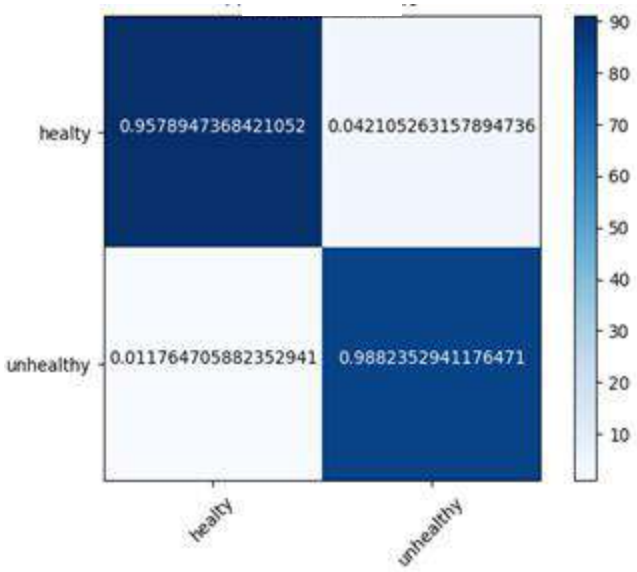

Fig. 8: The best generated classifiers in RGB color space using a Linear Kernel.

Evaluating the model, a cross-validation methodology was applied using 10 folds. Cross-validation results in a less biased model because it ensures that every observation from the dataset has the chance of appearing in the training and test set [15]. It split the data into 10 sets of 60 images, in each iteration it uses 70% for training and 30% for the test, and each class is balanced among the folds. At the completion of each fold iteration, a set of metrics is proposed, using f1-score and accuracy to evaluate each fold, additionally at the end of the iterations a confusion matrix is created. This paper analyzes two color spaces in the creation of the color feature, the additive color space, RGB, and perceptually-uniform color space, HSV.

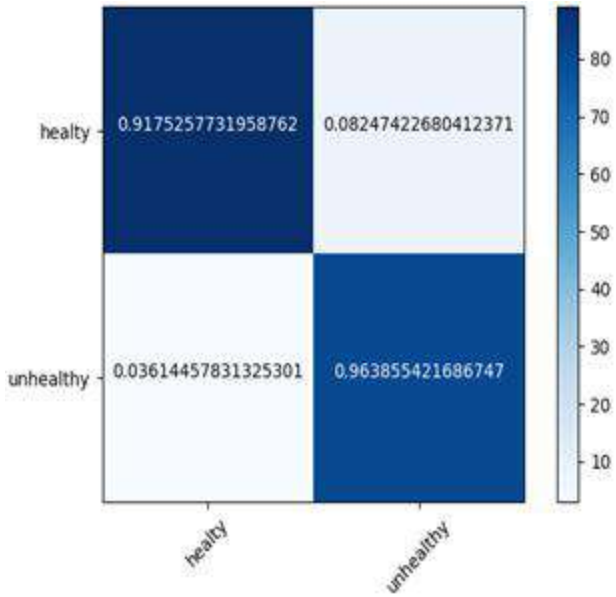

Fig. 9: The best classifier generated among the HSV color space using Radial Basis Function Kernerl.

In each color space, the SVM trains and generate the chosen metrics, in Fig. 8 the best classifier among the RGB color space utilizes a Linear Kernel generating a 97,3% accuracy. In Fig. 9 the classifier generated in the HSV color space uses a Radial Basis Function achieving a 94% accuracy.

Table 1: Classifier Generated at RGB color space

Classifier	***Accuracy***
Linear	***97,3%***
Radial Basis	96,6%
Sigmoid	*97,1%*
Polynomial	*86,2%*

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Table 2: Classifier Generated at HSV color space

Classifier	*Accuracy*
Linear	*90,6%*
Radial Basis	**94%**
Sigmoid	*91,2%*
Polynomial	*84%*

VI. CONCLUSION

This paper proposes an image processing method, composed of image filtering, segmentation, and feature extraction, also presented an analysis of variations of the SVM for citrus fruit quality classification in which a very good result was observed with the color information feature represented in the RGB color space and with its linear kernel, obtaining a rate of 97,3% shown in Table 1, 3,3% higher than HSV color space radial basis classifier, seen in Table 2.

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Methylphenidate Produces Conditioned place preference, and cannabidiol Exposure during Extinction does not Inhibit the Reinstatement of Methylphenidate in the Marmoset Monkeys

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Abstract— *Methylphenidate (MPH) is a central nervous system stimulant used as a pharmacotherapy to treat Attention-Deficit/Hyperactivity Disorder and narcolepsy. Scientists are concerned that MPH use could lead to increase the risk of vulnerability to drug abuse later in life. Little work has been carried out on the addictive potential of MPH in non-human primates (NHP). In the present study we intend to evaluate whether the MPH is able to produce a conditioned response and if the exposure to cannabidiol (CBD) during the extinction trial of the conditioned preference place (CPP) paradigm can inhibit the reinstatement of the response in male marmoset monkeys. Animals received alternating intraperitoneal (i.p.) injections of either MPH (5mg/kg) or saline (SAL) to a daily 15 min conditioning trial during 10 consecutive days in drug- and saline-paired compartments, respectively, of a CPP box. After a place preference test the animals were submitted to daily CBD injection in a 15min extinction trial, until the association between MPH and the MPH-paired compartment was extinguished. Then, 24h after the last extinction trial, animals received a priming dose of MPH (1mg/kg) and were submitted to a 15min retest trial. We found that MPH induced strong and long-lasting reinforcing properties during the conditioning period even after extinction training and reinstatement test. Therefore, MPH induced a CPP response in a NHP model and CBD administration could not inhibit the reinstatement of the MPH-induced CPP response.*

Keywords—***Methylphenidate, Cannabidiol, Extinction, Reinstatement, Conditioned place preference, Non-human primates.***

I. INTRODUCTION

While the etiology of attention deficit/hyperactivity disorder is still actively being explored, there is good evidence to suggest that stimulant medications can reduce some of the most common symptoms (1). MPH is, like amphetamine and cocaine, a central nervous system stimulant drug, mainly used as medicine for the treatment of attention deficit/hyperactivity disorder; high repeated exposure to MPH can cause adverse effects in behavior such as increased risk of substance abuse, tolerance or behavioral sensitization by action on the dopaminergic system to elicit a reward response in to MPH (2,3). Also, there is evidence that long-term effects of MPH exposure on the behavior could lead to long-lasting alterations in brain structure, natural reward systems and induce a CPP in both adolescent male and female rats (4). There is general agreement about the observation that endocannabinoid signaling is involved in reward circuitry and memory mechanisms related to extinction and relapse (5). CB1 receptor blockade is effective in reducing cue-induced reinstatement of drug seeking in

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psychostimulants, opiates, nicotine and alcohol addiction. There are no previous studies directly linked methylphenidate uses to biological changes in the endogenous cannabinoid system. The above considerations could suggest that methylphenidate early exposure may alter endocannabinoid or reward (6).

NHP seem to respond more similarly as humans to the effects of MPH treatment. However, only a few studies have investigated the use of MPH as a psychostimulant drug to induce dopamine (DA) release in the common marmoset (7). A study on juvenile rhesus monkey showed cognitive impairments following chronic MPH administration (8). It was also demonstrated that long-term exposure to oral MPH during peri-adolescence has weak effect on physiological or behavioral/cognitive development in NHP (9) and MPH produced no significant changes upon the locomotor activity of young squirrel monkeys (10). There is also only one study that show methylphenidate-induced striatal dopamine release in the common marmoset could be evaluated by [18F] fallypride (7). It has been found that CBD is the major non-psychoactive chemical found in marijuana has an antipsychotic effect and lacks hedonic properties, may help reduce the risk of drug relapse, blocks the reward-facilitating effect of morphine (11) and attenuates cue-induced reinstatement of heroin seeking (12). The CBD appeared to be effective in reducing reinstatement of substance abuse drug and alcohol relapse in rats (13). Nonetheless, the knowledge about the behavioral effects of MPH in marmoset monkeys is still elusive and, to our knowledge, studies looking strictly at CPP behavior in response to pharmacological manipulations of the MPH or CBD in NHP have not been held. The purpose of this study is to evaluate whether MPH can produce a CPP response in male marmoset monkeys (Callithrixpenicillata), and if CBD can inhibit the reinstatement of this response after extinction sessions (1,2).

II. METHODS

Five male adults black-tufted-ear marmosets (*Callithrixpenicillata*) were used, weighing 352±5 (range: 340-365g) at the beginning of the study. Marmosets were pair-housed at the Primate Center of the University of Brasilia in cages (2m x 1m x 2m each) of the same colony room. Marmosets were exposed to natural light, temperature and humidity conditions. All procedures herein were approved by the Animal Ethics Committee of the University of Brasilia and followed NIH/USA guidelines for care and use of laboratory animals.

Testing was conducted in a two-compartment CPP box, suspended 1m from the floor. Each compartment (60cm x 60cm x 35cm) had three walls and the floor made of aluminum, whereas the fourth wall and the top were made of glass (14). Each compartment had different visual and tactile cues. One had a smooth surface and white color, whereas the other had a rough surface and was painted with black and white diagonal stripes. The aluminum wall dividing the CPP box into two compartments consisted of a horizontally-sliding door. If retracted, it gave access to both sides of the apparatus. Each compartment had an independent entry/exit door located on the aluminum side directly opposite the glass wall. Attached to the apparatus, was an aluminum antechamber that encompassed both access doors. The subjects could only access the compartment's sliding doors and enter the respective compartment via this common antechamber, which had a guillotine-type door as its access point.

The CPP box was set-up in a test-room 50m away from the colony facility and subjects were transported between their home-cages and the test-room via a transport-cage (35cm x 20cm x 23cm). This aluminum box prevented them from seeing their surroundings and was attached directly to the guillotine-type door of the CPP box. The apparatus was monitored via a closed-circuit system using two cameras (model C920, Logitech, Brazil): one mounted 1.5m above the arena and other placed 1.5m in front of its glass wall. Both cameras were connected to a same laptop located in an observation-room adjacent to the test-room.

Pills of Methylphenidate hydrochloride (MPH; 5.0mg/kg; Ritalin®, Novartis, Brazil) were macerated and dissolved in phosphate-buffered saline. Cannabidiol (CBD; 30mg/kg; STI Pharm, UK) was dissolved in a 1:19 solution of Tween 80 (Sigma-Aldrich, Brazil) and phosphate-buffered saline, serially. Doses (MPH, CBD) were based on previous studies in primates (7,15). Treatments were given i.p. in a volume of 1ml/kg, 10 min prior to behavioral testing for MPH and 30min for CBD.

Marmosets were submitted to a CPP protocol similar to that used in previous studies from our group (14). Each marmoset initially underwent was initially submitted to a 15 min habituation trial in the CPP box on two consecutive days and no drug was available in neither compartment and the aluminum sliding-wall was kept partially retracted, providing a 30 cm passage between compartments. The marmosets then were submitted to a daily 15 min conditioning trial in the CPP box during 10 consecutive days. On these trials, the common sliding-wall remained shut. On alternate days, each marmoset

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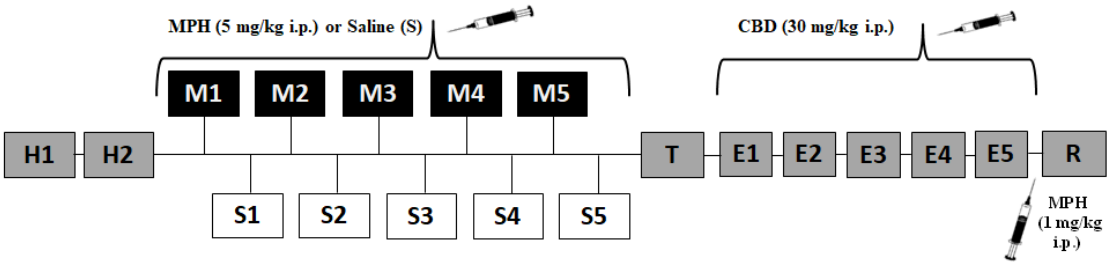
was given access to either the white or striped compartment. Subjects received MPH on odd-numbered trials (i.e., 1, 3, 5, 7 and 9) on the conditioned compartment (CC). On even-numbered trials (i.e., 2, 4, 6, 8 and 10) animals received saline. Animals were arbitrarily conditioned in the white or striped context. Place preference response was determined in a 15 min test trial in the CPP box, 24h after the last conditioning trial. During this trial, each marmoset could access both compartments and no drug was provided, similarly to the habituation trials.

After the test trial, subjects received daily i.p. injections of CBD 30 min prior to entrance into the CPP box for 15 min extinction sessions. These trials were made until the extinction of the place preference response. This extinction was determined when subjects' place preference response was statistically different from the test trial, for two consecutive days. One day after the last extinction trial, one reinstatement trial was made, similarly to the conditions of the test, except that a prime dose (1.0 mg/kg of MPH) was given 10 min before the behavioral test, to evaluate the sensitization and reinstatement (Supplementary Fig. 1).



Supplementary Fig. 1. *Schematic representation including the two initial habituation trials (H1 and H2) that marmosets had free access to the entire CPP box, and then followed by the methylphenidate (MPH, 5 mg/kg; i.p.; M1–M5) and saline-conditioning trials (S1–S5) held on alternative days with access to one of the compartments. Test trial (T) was held after a sequence of ten MPH/saline-conditionings and the extinction period (E1-E5) was held 24 hours after the test phase with a daily injection of cannabidiol (CBD; 30 mg/kg; i.p.) for five consecutive days. During the test and extinction trials, marmosets had free access to both compartments, and no injections were given prior to the habituation and test trials. One day after the last extinction trial, the reinstatement trial (R) was made, and similar to the test trial, animals had free access to all compartments and received a prime dose of MPH (1 mg/kg; i.p.) before testing session.*

For all trials, each subject was captured in its home-cage, injected with its treatment and placed in a waiting-cage similar to its home-cage. It was then recaptured, placed in the transport-cage and taken to the test room where it was released into the antechamber of the CPP box. After the end of each trial, the CPP box was cleaned with 70% alcohol. Animals were tested randomly and sessions were held between 07:30-11:30h.

For all trials, the any maze software (Soelting Co., USA) automatically tracked via the top-view camera the marmosets' total distance and average speed traveled within the CPP box, as well as the time spent in each compartment. In addition, an experienced observer with a 95% intra-rater reliability, manually scored on the same program the following behaviors: Vigilance (i.e. the duration of continuous sweeping upward or downward movements of the head while stationary); Locomotion (i.e. the duration of continuous movement through de CPP box) (1, 2).

Statistical analysis was completed with the SPSS software (Windows Version 23.0; IBM Corporation, NY, USA). Data were analyzed using the paired *t*-test for differences in the locomotor and vigilance behaviors; the time in the MPH-paired and SAL-paired on pre and post-CPP(1, 2). A repeated measures one-way analysis of variance (RM ANOVA) was used to analyze the time in the MPH-paired compartment through all the trials. Subsequent multiple pair-wise comparisons were held with Tukey's test whenever applicable. Significance level for all tests was set at $P < 0.05$.

III. RESULTS

We found that marmosets did habituate to the CPP box, as we found a significant reduction on the locomotion ($t_4 = 2.92$, $P = 0.043$; Table 1), and no increase in vigilance through the habituation trials ($t_4 = -2.99$, $P = 0.40$; Table. 1). Also, subjects did not have an initial preference for either side of the apparatus ($t_4 = -0.59$, $P = 0.5$; Fig. 1). After 5 alternate days of MPH, the marmosets spent significantly more time in the MPH-paired compartment in comparison to the SAL-paired at post-CPP ($t_4 = -9.96$, $P = 0.001$; Fig. 1) and to the MPH-paired at pre-CPP session ($t_4 = -4.826$, $P = 0.008$; Fig. 1). As for the use of CBD on extinction we found a significant

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difference between the trials ($F_{8.32}$ = 4.886, P = 0.031; Fig. 2). According to the pair-wise comparisons, we found a significant difference in time in the MPH-paired zone between pre-CPP x post-CPP (P = 0.008), post-CPP x Extinction 4 (P = 0.016) and Extinction 5 (P = 0.033) and Retest x pre-CPP (P = 0.004).

Table 1. Time marmosets spent (mean ± SEM) in locomotion and vigilance on both habituation trials and first and last conditioning trials.

Parameter	Trial			
	Habituation1	Habituation2	Conditioning1	Conditioning5
Locomotion (s)	69±16	55±16*	43±16	40±6
Vigilance (s)	718±43	747±43	730±69	695±95

*P< 0.05 Habituation 1 vs. Habituation 2

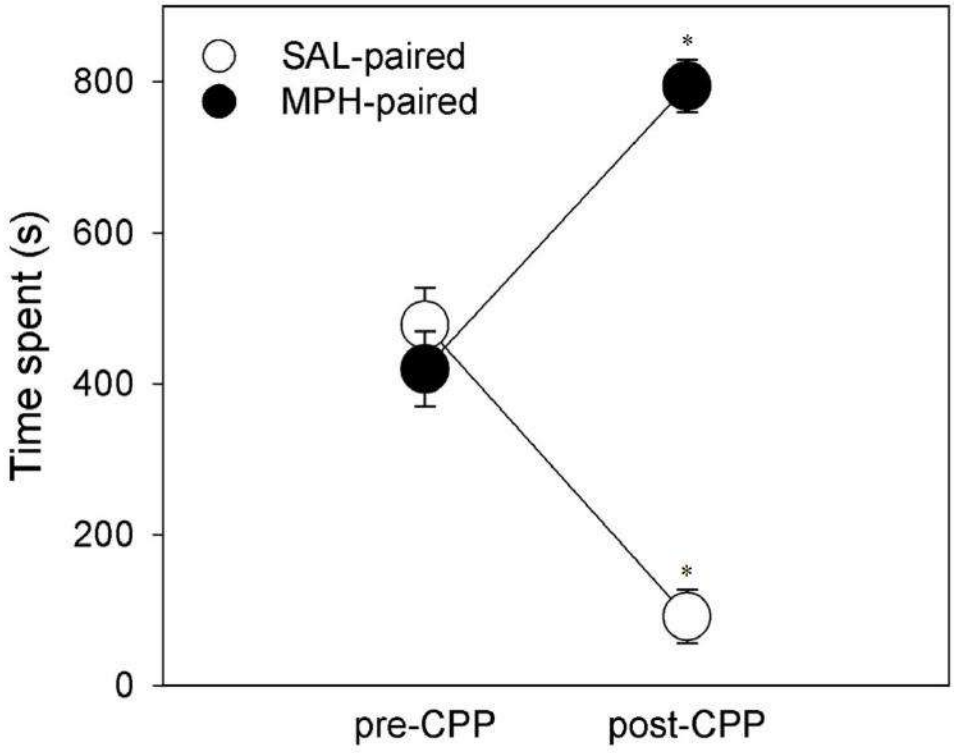

*Fig. 1. Time marmosets (n=5) spent (mean±SEM; in seconds) in the methylphenidate (MPH) paired compartment and the saline (SAL) paired compartment of the CPP box before (pre-CPP; last habituation trial) and after (post-CPP; test trial) the conditioning trials. *P < 0.05 pre-CPP levels.*

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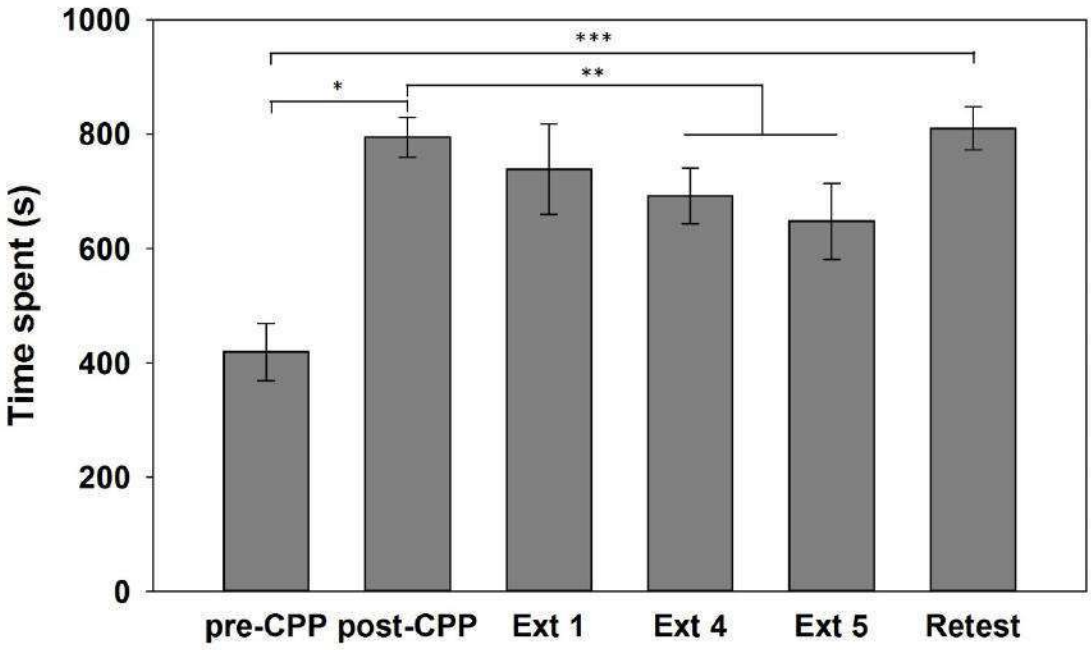

*Fig. 2. Time marmosets (n=5) spent (mean ± SEM; in seconds) in the methylphenidate (MPH) paired compartment of the CPP box before (pre-CPP; last habituation trial) and after (post-CPP; test trial) the conditioning, on the first, fourth e fifth extinction trial (Ext) and on Retest. *P < 0. 05 post-CPP vs. pre-CPP; **P < 0.05 post-CPP vs. Ext4 and Ext5; ***P < 0.05 pre-CPP vs. Retest.*

IV. DISCUSSION

To the best of our knowledge, this paper is the first study focused on the rewarding properties of MPH in NHP using the CPP behavioral paradigm. Results from the present study suggest that MPH has rewarding effect as indicated by the reinforcing effect of MPH-induced CPP in NHP. Our results are in parallel with previous evidence in male rats (16). In this study, the marmosets spent significantly more time in the MPH-paired compartment in comparison to the SAL-paired at post-CPP.

MPH acts as a DA and Norepinephrine (NE) transporter inhibitor, leaving behind high levels of monoamines in the synaptic cleft, which will ultimately increase the level of extracellular dopamine in the brain (17). It is generally accepted that DA action in the Nucleus accumbens mediates the rewarding effects of MPH (18). For example, MPH and cocaine have similar actions at the dopamine transporter (DAT) and produce comparable increases in synaptic dopamine levels in baboons (19).

Though, neurobiological mechanisms underlying the therapeutic effects of MPH in young NHP, particularly marmoset monkey, are not known. One possibility is that the key role of MPH effects involves dopaminergic D1 receptors, mediating the rewarding and reinforcing that produces long-lasting conditioning effects and reinstatement.

Vulnerability to relapse is a chronic condition in drug use disorders (20). Results from our study showed that the CBD administration could affect extinction phase of MPH-induced CPP while did not decrease reinstatement. First we argued that CBD is able to broadly block reward mechanisms as well as affect brain centers that lead to relapse. Animal studies have discovered many beneficial effects of CBD relevant for several relapse-promoting conditions including sensitivity to drug-related contexts and stress, anxiety, and impaired impulse control (21). One study found that daily injections of CBD after conditioning trials but during preference trials diminished preference-seeking behavior in the face of drug-related cues and potentiated the extinction of both amphetamine-induced and cocaine-induced CPP learning. Thus, CBD facilitates the extinction of amphetamine and cocaine addiction and prevents cue-induced relapse (11).

Our findings are in line with previous work showing that CBD (10 and 20 mg/kg, i.p.) did not affect lever pressing induced by heroin during extinction training (13). In another study, CBD does not exhibit an impact on the alcohol addiction intoxication phase in humans, and again, no data were found on the other phases of this addiction (22).

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CBD probably has interaction with dopamine receptors, which play a crucial role in regulating many aspects of behavior and cognition especially reward-seeking. Apart from dopamine, other neurotransmitter systems may be involved in drug reinforcement initiation including serotonin (5-HT), NE, glutamate (GLU), GABA, opioid peptides and endocannabinoids (23). CBD help modulate the endocannabinoid system, it can influence the release of neurotransmitters as well as play a role in the modulation of extracellular levels of DA in the brain (24). In our study it appears that CBD given alone has little effect on CPP. For example, Long-Evans rats treated with 10 mg/kg CBD indicated neither CPP nor CPA (25). It is also important to note that in this initial study, we used only a dose of CBD that is effective during the conditioning and extinction sessions. Therefore, it is possible that lower or higher doses of drugs may have differential effects on factors that facilitate or inhibit the reward systems in NHP.

These results demonstrate that MPH is a reinforcer and that its reinforcing efficacy may be associated with brain's reward circuitry following increased dopamine activity. Daily injection of MPH may have dramatic and longer-term impact on brain and tend to lead to reinstatement. Also these results show that the CBD affect extinction period but could not decrease reinstatement to MPH.

Finally, it is believed that further studies are needed to clarify the real impact of the use of psychostimulants, especially MPH, on the developing of behavioral sensitization and neural mechanisms of relapse. It should be noted that effects of MPH on reinstatement depend on several factors, such as the animal model, drug dose administered, type of experimental parameters and also role of genetic condition as well as sex.

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Interference and Economic threshold level of Alexander Grass in Soybean as a Function of Cultivars and Weed Populations

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***Abstract*—** *In the soybean crop occurs high losses of grains production, in function of weeds. It is noteworthy that among the most damaging weeds in the soybean crop is the alexander grass (Urochloa plantaginea). The objective of the project was to test mathematical models and identify explanatory variables to determinate the level of control of alexander grass in the soybean crop estimated in function of cultivars and populations of the competitor. The experiment was installed in the UFFS experimental area in Erechim, RS in the agricultural year 2016/17. The treatments were composed of soybean cultivars (NS 5445 IPRO, NS 5959 IPRO, SYN 13561 IPRO, SYN 1059 RR e BMX Elite IPRO) and 12 alexander grass populations that competed with each soybe an cultivar. We evaluated plant population, leaf area, ground cover and dry mass of the aerial part of alexander grass. The plant population presents a better fit to the model of the rectangular hyperbole, and this model can estimate the grain productivity losses due the alexander grass interference. The cultivars SYN 1059 RR, BMX Elite IPRO and NS 5445 IPRO were the most competitive in comparing with the others in the presence of alexander grass. The values of economic threshold level ranged from 0.96 to 2.16 plants m2. The increase in grain productivity, commercial price of soybeans, herbicide efficiency and reduction in control cost decrease the economic threshold level for weed control, justifying application of control measures for lower densities of al exander grass.*

Keywords*— *Glycine max, Urochloa plantaginea, Integrated Weed Management.

I. INTRODUCTION

The soybean (*Glycine max* (L) Merril) is a specie with world importance, because contains high protein (40%) and oil (20%) contents, used for animal feed, oil production, soybean meal, biodiesel e disinfectants (Sediyama, 2009). In Brazil, the soybean cultivated area in the latest crop year 2016/17 was around 33.8 million hectares. The main soybean producing states are those of the South Region (Rio Grande do Sul - RS, Santa Catarina - SC e Paraná - PR) and Midwest (Mato Grosso, Mato Grosso do Sul, Goiás e Distrito Federal). In the South region the seeded area was 11.4 million hectares, with average productivity of 3537 kg ha-1, being the highest productivity average in Brazil (CONAB, 2017).

The soybean crop is very demanding in nutrients for its development and at the 30 days after emergence initiates the greater absorption, remaining with a high rate of translocation until the phase of the grain filling (Carmello, 2006). Is required from 450 to 850 mm of water during the crop cycle, varying according to the management adopted during the conduction of the crop, the cultivar, the climate and even the interference of weeds (Carvalho et al., 2013).

For any agricultural crop, the productivity is dependent on many factors, such as those already reported previously, and when it comes to soybean, this productivity is much below than those obtained in experimental areas or crops that adopt high technologies. Among the probable causes for this low productivity are

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the factors of production, such as cultivars, soil fertility, insect management, diseases and weeds, related in such a way that any of them can be limiting to the production (Bastiani et al., 2016). The negative effects of weed interference are manifested on the quantity and quality of agricultural production in consequence of competition for environmental resources, allelopathy, or for being agents that host pests and diseases (Kalsing and Vidal, 2010; Galon et al., 2011).

Among the weeds that infest soybeans, one of the most competitive is the alexander grass (*Urochloa plantaginea*), belonging to the Poaceae family. This specie is found with greater abundance in the cultivated soils of the South and Central regions of the country, being introduced in Brazil in colonial times (Kissmann, 1997).

Weeds compete with crops for the resources available in the environment, such as: water, light and nutrients (Bianchi et al., 2006; Bastiani et al., 2016), Gal et al. (2015), when studying the effect of red light reflection by weeds on soybean, concluded that the crop presented a decrease in root volume, nodulation, root length, among other factors related to gene expression and flavonoid production

For the control of weeds, especially the alexander grass that infests soybean and other annual and perennial crops, we use herbicides in function of the practicality, efficiency and lower cost when compared to other methods of control (Christoffoleti et al., 2006). However, the use of herbicides has generated environmental contamination and also in the food produced, thereby necessitating other forms of weed management in soybean, such as cultural, preventive, biological, mechanical management, among others methods.

Research work involving the competitiveness of crops versus weeds provides the development of alternative strategies based on competition of cultivars, spacing, sowing density, among others (Jha et al., 2017; Datta et al., 2017). Thus, it is possible to define the characteristics that the crops suffer with the damages caused by weeds (Agostinetto et al., 2010; Bianchi et al., 2006; Machado et al., 2015; Galon et al., 2016). Among the available options for the study of competition between plants in a community, we have the nonlinear equation of the rectangular hyperbola, this equation makes the relation between the loss of crop productivity, using the variables plant population, dry mass, ground cover and leaf area of weeds (Rizzardi et al., 2003a; Agostinetto et al., 2010). The model of the rectangular hyperbola is composed by the parameters (i and a) that have biological and agronomic meaning, they can be used as signs of competitiveness between plants when living together in communities (Cousens, 1985).

Nowadays, more productive and sustainable control models are sought for a lower environmental impact, safer food production and reduction of herbicide intoxications to the applicators. In this fundament, the application of herbicides according to the concept of economic threshold level (ETL), is characterized by adopting the control method only when the damage caused by weeds is higher than the cost of the control method used in the management (Agostinetto et al., 2010; Vidal et al., 2010; Galon et al., 2011).

The hypothesis of the work is that there is differentiation in the competition between soybean cultivars with populations of alexander grass plants and this will impact in the decision-making of the economic threshold level.

With this, the research's objective was to test mathematical models and to identify explanatory variables aiming to determine the economic threshold level of alexander grass in the soybean crop, estimated in function of cultivars and weed populations.

II. MATERIAL AND METHODS

The experiment was conducted in the field, in the experimental area of the Federal University of Fronteira Sul, Campus Erechim, in soil classified as Typical Aluminoferric Red Latosol (EMBRAPA, 2013). The rainfall during the conduction of the experiment is presented in Figure 1.

The experimental design was completely randomized, without repetition. The treatments were constituted of five soybean cultivars (NS 5445 IPRO, NS 5959 IPRO, SYN 13561 IPRO, SYN 1059 RR and BMX Elite IPRO) and twelve plant populations of Alexandergrass (0, 2, 6, 8, 18, 26, 18, 30, 36, 94, 70 and 104; 0, 2, 4, 4, 6, 22, 24, 36, 58, 58, 94 and 124; 0, 2, 4, 4, 8, 12, 18, 18, 28, 76, 94 and 116; 0, 4, 2, 4, 8, 12, 14, 14, 24, 30, 84 and 114; 0, 2, 12, 20, 24, 26, 28, 36, 40, 48, 62 and 104, plants m-2) for each tested cultivar, respectively.

In reason of alexander grass is derived of the soil seed bank, the establishment of the populations was variable, because factors as infestation, vigor, humidity, and others, prevent the establishment of exactly the same plants number for area (experimental unit).

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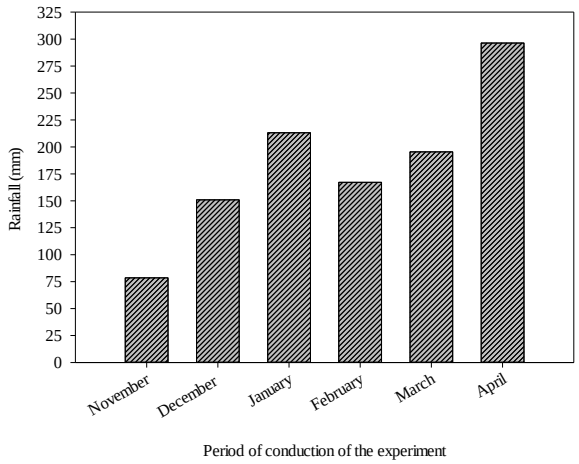

Fig.1: The rainfall (mm) in the period of conduction of the experiment. Data from the Automatic station of Passo Fundo – RS. Font: Inmet, 2018.

The populations of weeds were established from the soil seed bank, by the application of the herbicide glyphosate (3 L ha^{-1}), when the crop had three trefoils and the weed, in the four-leaf stage to a tiller. The period was chosen for being the most suitable for the application of herbicides in post emergence in the soybean crop. The alexander grass plants were protected with plastic cups, in order to not be harmed by the herbicide. The other remnant weeds in the experimental units, which were not part of the experiment, were controlled by weeding.

The experiment was conducted in no-tillage system in the straw, and the vegetation that was composed of black oat + radish was desiccated with the glyphosate herbicide (1080 g ha^{-1} of acid equivalence) before the soybean seeding with the seeder/fertilizer. The experimental units were composed of an area of 15 m^2, being the seeding conducted in six lines, of 5 m long and separated by 0.50 m, making 3 m wide. The sowing density of the soybean cultivars was 14 viable seeds per linear meter or 280,000 ha-1 seeds, which allowed the establishment of 28 m-2 plants.

The evaluated variables of the crop and weed 30 days after emergence - DAE (period that coincides with the application of herbicides in post-emergence of weeds) were: plants population (PP), dry mass (DM), leaf area (LA) and ground cover (GC). The quantification of the explanatory variable PP was performed by counting the plants present in two areas of 0.25 m² (0.5 x 0.5 m) in each parcel. The GC by alexander grass and soybean plants was visually evaluated, individually, by two evaluators using percentage scale in which the value zero corresponds to the absence of GC and a value of 100 represents full coverage of the soil. The quantification of the LA of the species was affected with a portable electronic leaf area integrator, model CI-203, from CID BioScience, using the leaves of the plants present in an area of 0,25 m^2 (0,5 x 0,5 m) and after the determination of this variable, these leaves were used to measure DM. The DM of soybean and alexander grass plants (g m^{-2}) was dried in forced air circulation oven at the temperature of 60±5ºC, until it reached a constant mass.

At the end of the cycle, the grains productivity of the soybean cultivars was quantified, obtained by the harvest of the plants in usable area of 6 m² (3 x 2 m) of each experimental unit, when the humidity level of the grains reached approximately 15 %. After weighing the grains, its humidity was determined and, subsequently, the masses were corrected to 13% of humidity and the values extrapolated to kg ha^{-1}.

The loss percentage of the productivity of soybean cultivars in relation to experimental units free of competing plants were calculated according to Equation 1.

$$\text{Loss (\%)} = \left(\frac{Ra - Rb}{Ra} \right) x100 \quad \text{Equation 1}$$

where: Ra and Rb: productivity of the crop without or with the presence of competitor plants (alexander grass) respectively. The obtained data were adjusted to the nonlinear regression model of the rectangular hyperbola (Cousens, 1985), according the Equation 2:

$$Pp = \frac{(i * X)}{(1 + (\frac{i}{a}) * X)} \quad \text{Equation 2}$$

where: Pp = productivity loss (%); X = alexander grass population, dry mass of the aerial part, leaf area or ground cover; *i* and *a* = losses in productivity (%) per unit of alexander grass plants when the variable value is close to zero and when it tends to infinite, respectively.

For the mathematical modeling procedure in order to estimate the competitive ability of the species and for the ETL calculation, the adjustment of the data to the model was performed with the Proc Nlin procedure of the SAS computer program (SAS, 1989) the variables PP, DM, LA and GC was used for this. For the calculation procedure, the Gauss-Newton method was used, which, by successive iterations, estimates the parameter values, in which the sum of the squared deviations of the observations, in relation to the adjusted values, are minimum (Ratkowsky, 1983). The value of the F statistic ($p \leq 0,05$) was used as an analysis criterion for the data adjustment to the model. The acceptance criteria of the adjustment of the data to the model was due to the higher value of the coefficient of determination (R^2) and the lower value of meddle error square (MES).

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For the calculation of the economic threshold level (ETL), was used the estimates of the parameter *i* obtained from Equation 2 (Cousens, 1985), and the adapted equation of Lindquist and Kropff (1996) – Equation 3:

$$ETL = \frac{(Cc)}{(R*P*(\frac{i}{100})*(\frac{H}{100}))} \quad \text{Equation 3}$$

where: ETL = economic threshold level (plants m-2); Cc = control cost (herbicide and tractorized terrestrial application, in dollars ha^{-1}); R = soybean grain productivity (kg ha^{-1}); P = soybean price (dollars kg^{-1} of grains); *i* = loss (%) in productivity of soybean per unit of competitive plant when the population level is close to zero and H = herbicide's efficiency level (%).

For the variables Cc, R, P and H (Equation 3), was estimated three values. Thus, for the control cost (Cc), the average price was considered, being the maximum and minimum costs altered in 25%, in relation to the average cost. The soybean grain productivity (R) was based in the smallest, average and the biggest productivities obtained in Rio Grande do Sul in the last 10 years. The product price (P) was estimated from the smallest, average and biggest prices of soybean paid per 60 kg sack in the last 10 years.

The values for the herbicide efficiency (H) were established in the order of 80, 90 and 100% of control, being 80% the minimum control considered effective in the weed. (SBCPD, 1995). For the ETL simulations, was used the intermediate values for the variables that were not the object of the calculation.

III. RESULTS AND DISCUSSION

The explanatory variables plant population (PP), leaf area (LA), ground cover (GC) and dry mass of the aerial part (DM) for all the evaluated soybean cultivars presented significant values of F-statistics showing significant differences between the treatments (Table 1, 2, 3 e 4). The obtained results showed that for the soybean cultivars NS 5445 IPRO, NS 5959 IPRO, SYN 13561 IPRO, SYN 1059 RR and BMX Elite IPRO, the rectangular hyperbola model adjusted properly to the data presenting R^2 values over 0,54 e low MES, which characterizes an elevated adjustment to the rectangular hyperbola model.

It was observed, for the majority of evaluated variables, that the values estimated for the parameter tended to be smaller for the cultivars SYN 1059 RR, BMX Elite IPRO and SYN 13561 IPRO, respectively, thus demonstrating greater competitiveness than the others. The smaller competitiveness was verified for the NS 5959 IPRO cultivar, for the variables PP, LA and DM variables, and the NS 5445 IPRO for the LA, which presented the biggest losses of grain productivity, compared to the others (Tables 1, 2, 3, and 4).

The relative competitiveness of the species is defined based on the parameter, that is, the smaller it is, more competitive the specie is, this parameter is used to compare the relative competitiveness between crops and weeds (Swinton et al., 1994; Dieleman et al., 1995).

Table 1. Adjustments obtained for the loss of grain productivity, according to the population of alexandergrass (Urochloa plantaginea) and soybean cultivars, NS 5445 IPRO, NS 5959 IPRO, SYN 13561 IPRO, SYN 1059 RR and BMX Elite IPRO. UFFS, Erechim, 2016.

Cultivars	Parameters[1]		R^2	MES	F
	I	*A*			
NS 5445 IPRO	1.39	89.20	0.95	35.30	161.84*
NS 5959 IPRO	2.50	54.28	0.67	82.29	61.54*
SYN 13561 IPRO	1.58	71.04	0.72	111.60	38.81*
SYN 1059 RR	1.10	81.20	0.85	11.59	250.91*
BMX Elite IPRO	1.26	85.46	0.58	355.80	13.60*

[1] *i* and *a*: productivity losses (%) per unit of alexandergrass when the variable value approaches zero or tends to the infinite, obtained by the equation $Y=(i.X)/(1+(i/a).X)$; respectively; * Significant in $p \leq 0,05$.

The results for the parameter *a* estimate were lower than 100% for the PP explanatory variable for all cultivars, presenting that crop productivity losses can be adequately simulated, based on this parameter for this variable. However, for the other explanatory variables GC, LA and DM the values were higher than 100% or overestimated by the model. These results may be due to the fact that the largest populations of alexandergrass plants were insufficient to adequately estimate the maximum productivity loss. According to Cousens (1991), to obtain a reliable estimate for the parameter *a* it is necessary to include in the experiment very high populations of weeds, over those commonly found in agriculture.

An alternative to avoiding overestimates of productivity losses would be to limit the maximum loss in 100%. However, the limitation will influence the estimation of parameter *i*, which may result in less predictability in the model of the rectangular hyperbola (Streibig et al., 1989).

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In addition, productivity losses greater than 100% are biologically unrealistic and occur when the amplitude of weed populations are too narrow and/or when the highest population values are not sufficient to produce asymptotic responses of productivity loss (Cousens, 1985; Yenish et al., 1997; Galon et al., 2007).

For the explanatory variable PP, the estimated values for the parameter *i* were lower for the cultivars SYN 1059 RR and BMX Elite IPRO, which characterizes greater competitiveness when compared with the others. The lowest competitiveness was verified for cultivars NS 5959 IPRO and SYN 13561 IPRO. This fact occurs because the cultivars have genetic characteristics differentiated related to stature and development cycle, which makes them more or less competitive. This result was also verified by Agostinetto et al., (2013) when evaluated the relative competitive ability of Southern Crabgrass in coexistence with irrigated rice and soybean.

The cultivars BMX Elite IPRO and SYN 13561 IPRO presented values of the parameter *i* equal to 0.01 demonstrating greater competitiveness in relation to the others as a function of GC (Table 2). The highest values for parameter *a* were presented by cultivars NS 5959 IPRO and BMX Elite IPRO, stating higher productivity losses for them. The lower competitiveness of these cultivars may occur due to the slower initial growth, allowing a higher incidence of sunlight on weeds. Consequently, occur loss of competitiveness, a fact also related by Bastiani et al., (2016) when working with soybean cultivars living with barnyard grass.

Table 2. Adjustments obtained for grain productivity loss due to the ground cover of alexandergrass (Urochloa plantaginea) and soybean cultivars, NS 5445 IPRO, NS 5959 IPRO, SYN 13561 IPRO, SYN 1059 RR and BMX Elite IPRO. UFFS, Erechim, 2016.

Cultivars	Parameters[1]		R^2	MES	F
	I	*A*			
NS 5445 IPRO	0.02	181.29	0.73	182.50	31.69*
NS 5959 IPRO	0.02	283.20	0.76	30.48	173.38*
SYN 13561 IPRO	0.01	204.30	0.71	34.03	131.59*
SYN 1059 RR	0.02	164.90	0.77	21.51	132.90*
BMX Elite IPRO	0.01	206.40	0.62	135.90	23.27*

[1] *i* and *a*: productivity losses (%) per unit of alexandergrasss when the variable value approaches zero or tends to the infinity, obtained by the equation Y= (*i*.X)/(1+(*i* / *a*).X); respectively; * Significant in p≤0,05.

For the results of the LA the cultivars SYN 13561 IPRO and SYN 1059 RR presented the lowest values for the parameter *i* being 0.00004 for the two, as well as presented the highest values of the parameter *a* of 114.80 and 155.80% respectively (Table 3). Demonstrating that, although they are more competitive, they also presented the highest maximum losses, in comparison with the other cultivars. This situation may be related to the conduction of the field experiment, as previously reported. Galon et al., (2016) also verified this fact when evaluating the interference and the economic threshold level of beggartick on bean cultivars.

Table 3. Adjustments obtained for the loss of grain productivity, according to the alexander grasss leaf area (Urochloa plantaginea) and soybean cultivars, NS 5445 IPRO, NS 5959 IPRO, SYN 13561 IPRO, SYN 1059 RR and BMX Elite IPRO. UFFS, Erechim, 2016.

Cultivars	Parameters[1]		R^2	MES	F
	I	*A*			
NS 5445 IPRO	0.00900	82.47	0.86	65.54	85.34*
NS 5959 IPRO	0.00008	68.89	0.71	112.60	42.10*
SYN 13561 IPRO	0.00004	114.80	0.66	150.30	26.98*
SYN 1059 RR	0.00004	155.80	0.61	77.26	33.64*
BMX Elite IPRO	0.00010	64.43	0.62	11.67	394.70*

[1] *i* e *a*: productivity losses (%) per unit of alexander grasss when the variable value approaches zero or tends to the infinity, obtained by the equation Y= (*i*.X)/(1+(*i* / *a*).X); respectively; * Significant in p≤0,05.

The cultivar SYN 1059 RR presented the lowest value for the parameter *i* and the highest value for the parameter *a* in the explanatory variable DM, this demonstrates that the cultivar presented the greatest competitiveness and also the greatest loss, in comparison to the others, this fact also occurred in the explanatory variable LA (Table 3 and 4). On the other hand, the lowest competitiveness was found for cultivars NS 5959 IPRO and BMX Elite IPRO with values of the parameter *i* equal to 0.01, being these that presented the lowest values for the parameter *a* being 60.27 and 63.21% respectively. That is, in addition to presenting the smallest competitions, also showed the lowest maximum losses compared to the others.

https://dx.doi.org/10.22161/ijaers.6710 *ISSN: 2349-6495(P) | 2456-1908(O)*

Table 4. Adjustments obtained for the loss of grain productivity, according to the dry mass of alexander grasss (Urochloa plantaginea) and soybean cultivars, NS 5445 IPRO, NS 5959 IPRO, SYN 13561 IPRO, SYN 1059 RR and BMX Elite IPRO. UFFS, Erechim, 2016.

Cultivars	Parameters[1]		R^2	MES	F
	I	*a*			
NS 5445	0.008		0.79	106.6	
IPRO		93.94		0	50.73*
NS 5959			0.91	118.7	
IPRO	0.010	60.27		0	39.80*
SYN 13561	0.007		0.63	154.3	
IPRO		79.80		0	26.83*
SYN 1059 RR	0.005	118.5	0.77		
		0		92.43	27.38*
BMX Elite			0.54		408.40
IPRO	0.010	63.21		11.12	*

[1] *i* e *a*: productivity losses (%) per unit of alexander grass when the variable value approaches zero or tends to the infinity, obtained by the equation Y= (*i*.X)/(1+(*i* / *a*).X); respectively; * Significant in p≤0,05.

The demonstration of the values of economic threshold level (ETL) was carried out using the explanatory variable PP of the alexander grass, because it presented one of the best adjustments to the model of the rectangular hyperbola and for being the most utilized in experiments with this objective (Fleck et al., 2002; Galon et al., 2007; Agostinetto et al., 2010; Kalsing et al., 2010; Galon et al., 2016).

In the average of all the cultivars and comparing the lowest with the highest productivity of grains, it was observed a difference in the ETL in the order of 84% (Figure 2). The greater the productive potential of the cultivars, the lower the PP of alexander grass will be necessary to surpass the ETL, resulting in the adoption of measures of control of the alexander grass so that the profitability of the producer is compensated. Galon et al. (2016), when evaluating the interference and ETL of beggartick on bean cultivars, also observed that the ETL varies according to the bean cultivars that have a greater productive potential, since they can present smaller ETL.

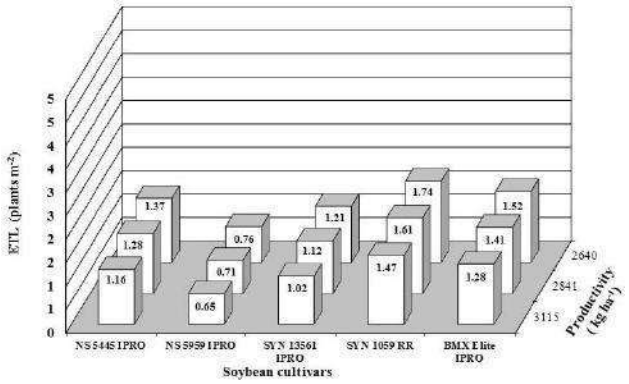

Fig.2: Economic threshold level (ETL) of alexander grass in soybean as a function of grain productivity. UFFS, Erechim/RS 2016/17.

The average results of all cultivars tested, from the highest versus the lowest price paid for soybean, varied 1.6 times higher to the ETL value (Figure 3). Thus, the lower the price paid to the soybean bag, the higher the population needed to exceed the ETL and compensate for the adoption of control measures. When fixed the amount paid per ton of soybean at US$ 470.00, Song et al. (2017), found values of economic level of 0.70 plants m^{-2} for a community of weeds living with soybean, that is, very close to those found for cultivar NS 5959 IPRO (soybean price US$ 482.5 ton^{-1}). In the work done with rice crop, competing with Southern Crabgrass, the authors observed the same effect, the lower the price paid by the sack, the greater the population of the weed necessary to exceed the ETL (Agostinetto et al., 2010).

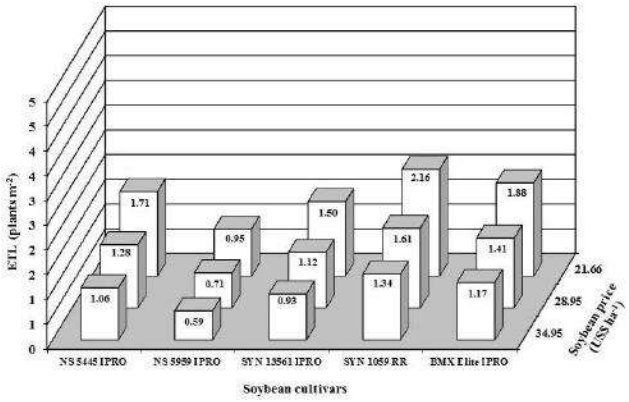

Fig.3. Economic threshold level (ETL) of alexander grass in soybean as a function of the price of soybean sack. UFFS, Erechim/RS 2016/17.

When comparing the average cost of control of alexander grass in all cultivars, which takes into account the cost of application and the price of the herbicide, was verified a decrease of 40% in ETL between the minimum cost when comparing with the maximum cost (Figure 4). In function of the control cost, the higher it is, the greatest are the ETL and larger populations of alexander grass

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plants m^{-2} are necessary to compensate the adoption of control measures. Fleck et al. (2002), when evaluating the ETL of arrow leaf *Sida* in soybean, observed that the higher the cost of control is, the higher the ETL will be, which is in line with that observed in the present study.

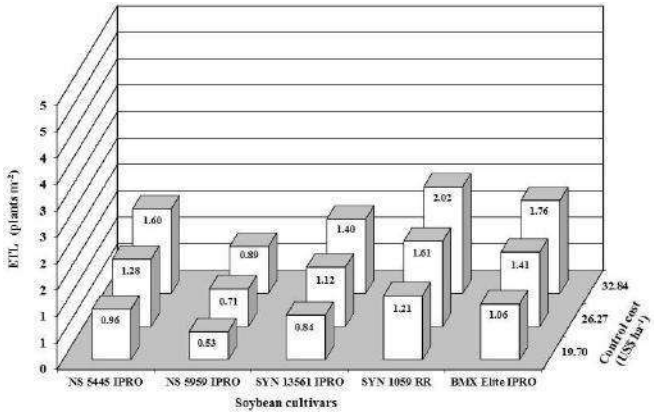

Fig.4. Economic threshold level (ETL) of alexander grass in soybean as a function of the cost of control. UFFS, Erechim/RS 2016/17.

The results demonstrate that the average efficiency (90%) when compared in relation to the highest (100%) or lower (80%) occur changes in ETL values in the order of 11% (Figure 5). The efficiency level of the herbicide influences the ETL, the higher the efficiency, the lower infestations of alexander grass plants m^{-2} are necessary to overcome the ETL and justify the adoption of control. For a control efficiency of 90%, Song et al., (2017), found ETL values ranging from 0.66 to 1.45 plants m^{-2}, for the weeds *Ambrosia artemisiifolia*, *Echinochloa crus-galli*, *Sonchus oleraceus*, *Chenopodium album* and *Beckmannia syzigachne* in competition with soybean, results very close to those observed for the alexandergrass.

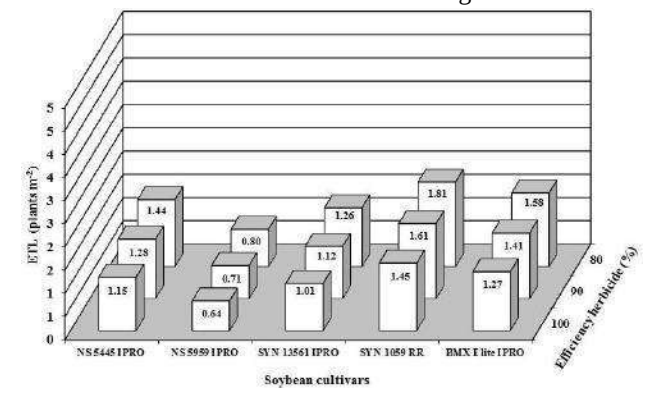

Fig.5. Economic threshold level (ETL) of alexander grass in soybean as a function of herbicide efficiency. UFFS, Erechim/RS 2016/17.

The factors involved in the ETL calculation (herbicide cost, application cost and value of the product sack of the commercialized crop) can be easily estimated by the farmers themselves, but the crop yield potential, herbicide efficiency, loss of productivity per unit of weed, are more difficult to predict accurately, due to variability of environmental conditions, weed size, set of weed species and the effect of cropping modes on them (Fleck et al., 2002).

The ETL quantify crop losses only in a single growing season, with calculations based on a single year (Kalsing and Vidal 2010). However, we do not take into account the factor associated with the possible increase in the weed seed bank, on the long-term profitability in the decisions of the weed control forms, since, due to the ETL that only present the direct damage caused by the weeds and do not the potential damage that can be caused by seed production. (Rizzardi et al., 2003a,b).

However, there are difficulties in approaching ETL use, due to the confrontation of the farmer at the moment of the management decision, for not knowing previously what will be the productivity of grains weed free, thus estimating only in the productivities of previous years and the yield target for the crop. ETL adoption becomes justifiable in crop situations that are managed with other weed management practices, such as the use of appropriate plant arrangement, crop rotation, application of efficient herbicide doses, use of adequate fertilization, use of more competitive cultivars, among others (Galon et al., 2011; Rizzardi et al., 2003b; Galon et al., 2016).

Therefore, the difficulties encountered in adopting the ETL approach serve as a challenge to research, so that weed management systems are developed and optimized for the rational and economical use of chemical control measures, which are normally used, with little or no technical justification. In this sense, the understanding of weed biology and ecology, results in integrated weed management strategies, minimizing the cases of resistance and providing more sustainable technologies in comparison to the current model that is currently failing (Westwood et al., 2017).

IV. CONCLUSION

The results obtained allow us to conclude that the nonlinear regression model of the rectangular hyperbola adequately estimates the unit and maximum productivity losses of soybean grains when infested with alexander grass. The cultivars SYN 1059 RR and SYN 13561 IPRO presented the highest competitiveness with alexander grass, with ETL values ranging from 0.84 to 2.16 plants m^{-2}. The increase in soybean grain productivity, soybean price, herbicide efficiency, and reduction in control cost, causes a decrease in the economic threshold level, thus

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justifying the adoption of control methods in low densities of alexander grass.

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Effects of sedentary behavior in Metabolic Syndrome and its components in adults: A Systematic Review

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Abstract *— **Introduction**: the current society has been involved in activities that require less energy expenditure, this type of activity that requires energy expenditure <1.5 METs, excluding sleep, is called sedentary behavior and is independently associated with physical activity to deleterious health factors , as metabolic syndrome. **Objective**: to investigate, through a systematic review, the effects of sedentary behavior on the metabolic syndrome and its components in adults. **Methodology**: This is a systematic review, using the Trip Database databases through the following descriptors: adults; sedentary behavior or screen time or sedentary life style; cardiometabolic risk or cardiovascular risk or metabolic risk score, published between 2013 and 2018. **Results**: Some cross-sectional studies show a greater chance of developing metabolic syndrome when sedentary time is increased. However, most sedentary time intervention studies with mild physical activity or posture change do not have a significant effect on cardiometabolic markers. **Conclusion**: According to the results of the selected studies, there is an association between high sedentary time and the development* of metabolic syndrome and its components in adults

Keywords *— **Adult, Sedentary Behavior, Metabolic Syndrome.***

I. INTRODUCTION

The current model of society and technological advances can negatively affect the population's way of life, causing the human being to have to work less physically to perform his or her daily life tasks. For this reason, sitting time (watching television, motorized, using the computer, playing video games, hanging around chatting with friends, talking on the phone among other similar activities) who require little energy expenditure, has become increasingly prevalent society current (CHURCH et al., 2011). In this context, the definition of sedentary behavior was defined as a series of states in which the individual remains awake with energy expenditure <1.5 METs (Metabolic Equivalent Term), excluding sleep time (TREMBLAY et al., 2017).

Farias Júnior (2011) describes in his study that the term sedentary behavior is different from the sedentary one within the level of physical activity, since it has specific "categorical" as well as pathological consequences in the health of the individuals. Sedentary behavior is not characterized simply as an absence of physical activities or the attendance of specific scores in its classification (BIDDLE et al., 2009).

Sedentary behavior has been associated with several deleterious health factors such as obesity, type 2 diabetes, cardiovascular diseases and all-cause mortality (YOUNG et al., 2016). Among these factors, the metabolic syndrome has also received differentiated attention, since it is considered as a group of factors, which allies increase the chance of developing type 2 diabetes and cardiovascular disease (HUANG, 2009).

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Metabolic syndrome is classified in several ways, but the definition of the National Cholesterol Education Program (NCEP) is one of the most widely used criteria for the definition of metabolic syndrome, since it encompasses its main characteristics: hyperglycemia / insulin resistance, visceral obesity, atherogenic dyslipidemia and hypertension in addition to using measurements and laboratory results readily available to physicians, facilitating their clinical and epidemiological application (PENALVA, 2008).

The definition of the NCEP ATP III states that the individual is diagnosed with the metabolic syndrome when he has at least three of the following five criteria: waist circumference ≥102 cm for men and ≥88 cm for woman, blood pressure above 130/85 mmHg, fasting triglycerides (TG) above 150 mg / dL, fasting high density lipoprotein (HDL) levels below 40 mg / dl (men) or 50 mg / dl (women), and fasting blood glucose above 100 mg / dl (GRUNDY et al, 2005).

Some research, such as Young et al. (2016), demonstrate an increased chance of developing metabolic syndrome associated with increased sedentary time. However, these data are not conclusive, mainly in quantitative terms to affirm how much and how to reduce the sedentary time, for health benefits, especially the reduction of the risk of developing metabolic syndrome. In this context the objective of this systematic review is to investigate the effects of sedentary behavior on the metabolic syndrome and its components in adults.

II. METHODOLOGY

It is a systematic review of the literature, which is a way of synthesizing the information available at a given moment, on a specific problem, in an objective and reproducible way, by means of a scientific method (BANNINGAN; DROOGAN, ENTWISTLE, 1997). The stages of the research were divided into: theme definition, issue study problem, search strategy, inclusion and exclusion criteria, evaluation of included studies and synthesis of data collected.

Defining the problem of the study question

The question for the study was formulated from the PICO strategy, which according to Santos and Nobre (2007) means an acronym for Patient (population), Intervention, Comparison and Outcomes.

Table 1. Formulation of the PICO research strategy.

1. PATIENT/PROBLEM	2. INTERVENTION	3. COMPARISION	4. OUTCOME
Adults	Sedentary Behavior	-	Metabolic syndrome
QUESTION: What is the influence of sedentary behavior on the metabolic syndrome and its components in adults?			

Search strategy

The search for studies was carried out in the database "TRIP Database" through the PICO strategy, in which the descriptors used were: P: adults; I: sedentary behavior or screen time or sedentary life style; C: has not been applied; O: cardiometabolic risk or cardiovascular risk or metabolic risk score or metabolic syndrome.

The choice of the TRIP Database search tool was based on the fact that it is a free clinical search engine whose primary function is to help physicians and healthcare professionals identify the best scientific evidence available to answer clinical questions. Its roots are firmly in the world of health research, based on scientific evidence.

Inclusion and exclusion criteria

Included in this review were primary cross-sectional, longitudinal, cohort, and intervention studies that were published in English between 2013 and 2018 and evaluated the influence of sedentary behavior, measured by questionnaire or objectively, on the metabolic syndrome and its components in adults.

We excluded from this review articles that do not fit the inclusion criteria, studies that evaluate the population with locomotor and functional limitations and / or individuals with neurodegenerative diseases in general.

III. RESULTS

The search strategy allowed to find 19258 articles, after the application of the inclusion and exclusion criteria, the researches were allocated as shown in Figure 1 (*Prisma Flow*).

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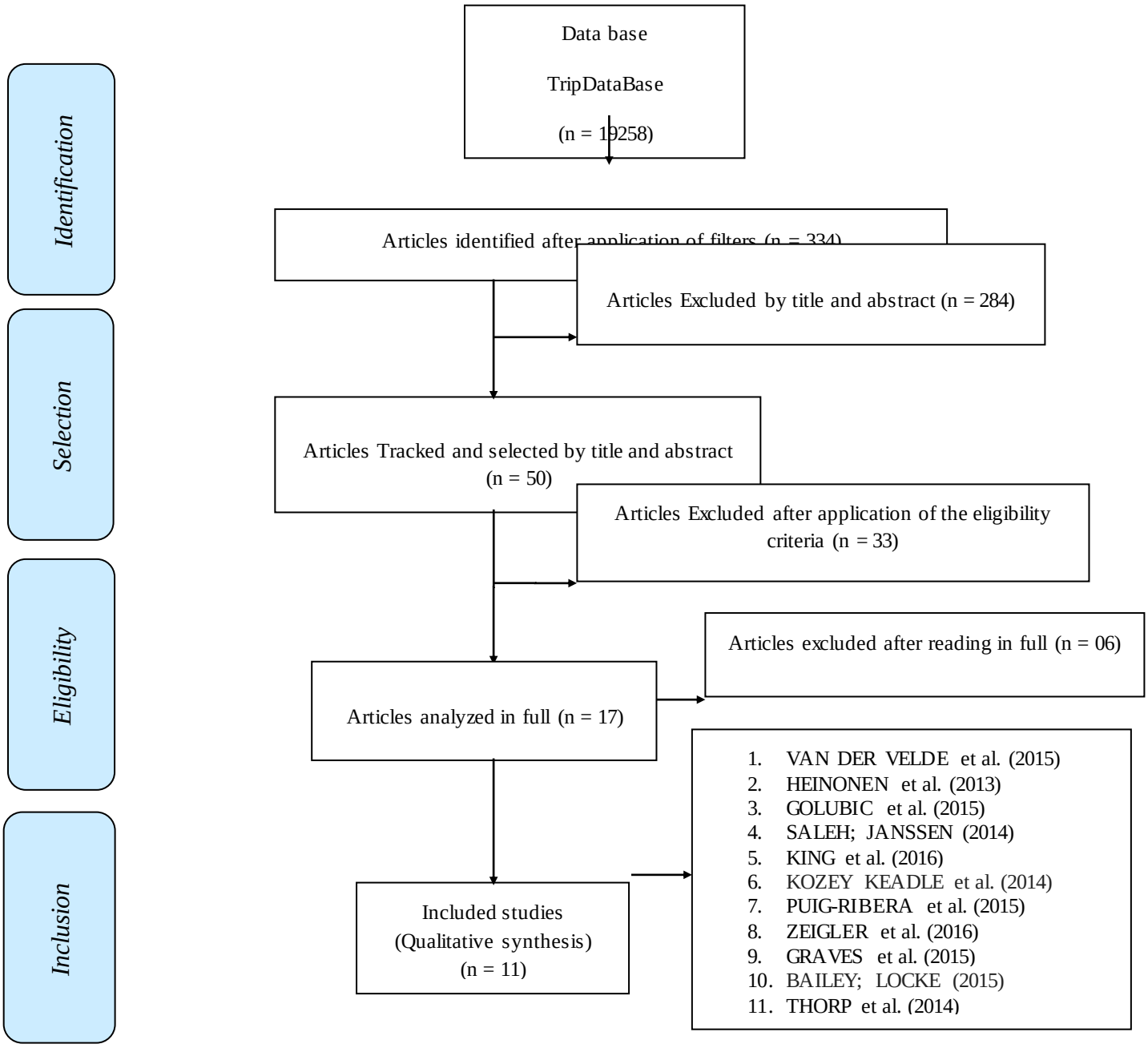
Fig. 1 - Flowchart of the studies selection (Prisma Flow)



Fonte: Autor, 2018 adaptação de Moher et al. (2008).

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Table 2. Synthesis of the productions included in the review about the influence of sedentary behavior on the metabolic syndrome and its components in adults, according to author and year, type of study and sample.

Title of study Author and Year	Type of study	Sample	Results
Moderate activity and fitness, not sedentary time, are independently associated with cardio-metabolic risk in U.S. adults aged 18-49 VAN DER VELDE et al. (2015)	Transversal study	The sample consisted of 543 participants aged 18 to 49 years	Results show that sedentary time was associated with HDL-cholesterol (β = −0.080, p = 0.05) and TG (β = 0.080, p = 0.03). These results became non-significant after adjustment for MVPA and fitness. MVPA was associated with WC (β = −0.226), BMI (β = −0.239), TG (β = −0.108) and HDL-cholesterol (β = 0.144) (all p < 0.05). These results remained significant after adjustment for sedentary time and fitness. Fitness was associated with WC (β = −0.287), BMI (β = −0.266), systolic blood pressure (β = −0.159), TG (β = −0.092), and CRP (β = −0.130) (all p < 0.05). After adjustment for sedentary time and MVPA these results remained significant.
Sedentary behaviours and obesity in adults: the Cardiovascular Risk in Young Finns Study HEINONEN et al. (2013)	Transversal study	Sample was composed of 1993 participants (1084 women and 909 men) between 30 and 45 years	Of the different sedentary behaviour types, TV viewing was most consistently related to higher BMI and WC, both in men and women. One additional daily TV hour was associated with a 1.81±0.44 cm larger WC in women and 2 cm±0.44 cm in men (both p<0.0001). The association with TV was diluted, but remained highly significant after adjustments with all measured covariates, including several potentially obesogenic food items associated with TV viewing. The intakes of food items such as sausage, beer and soft drinks were directly associated with TV viewing, while the intakes of oat and barley, fish, and fruits and berries were associated indirectly. After these adjustments, non-TV sedentary behaviour remained associated with adiposity indices only in women.
Physical activity, sedentary time and gain in overall and central body fat: 7-year follow-up of the ProActive trial cohort. GOLUBIC et al. (2015)	Randomized controlled trial of cohort	The sample consisted of n = 231 at the baseline, n = 222 at 1 year and = 230 at 7 years	MVPA was inversely and independently associated with all indices of total BF (for example, 1 s.d. higher MVPA was associated with a reduction in FM, β = − 0.09 (95% CI: − 0.14, − 0.04) s.d.) and abdominal BF (for example, WC: β = − 0.07 (−0.12, − 0.02)). Similarly, higher fat indices were independently

https://dx.doi.org/10.22161/ijaers.6711 ISSN: 2349-6495(P) | 2456-1908(O)

			associated with a reduction in MVPA (for example, WC: β = − 0.25 (−0.36, − 0.15); FM: β = − 0.27 (−0.36, − 0.18)). SED-time was positively and independently associated with most fat indices (for example, WC: β = 0.03 (−0.04, 0.09); FM: β = 0.10 (0.03, 0.17)). Higher values of all fat indices independently predicted longer SED-time (for example, WC: β = 0.10 (0.02, 0.18), FM: β = 0.15 (0.07, 0.22))
Interrelationships among sedentary time, sleep duration, and the metabolic syndrome in adults SALEH; JANSSEN, (2014)	Transversal study	The sample consisted of 1371 participants	Sedentary time and screen time did not vary across sleep duration quartiles. Participants in the highest quartile of sedentary time were more likely to have the MetS than participants in the lowest quartile (odds ratio = 1.60, 95% CI:1.05-2.45). The odds of the MetS was higher in participants in the highest screen time tertile as compared to the lowest tertile (odds ratio = 1.67, 95% confidence interval:1.13-2.48). Sleep duration was not independently related to the MetS. There were no significant sedentary time X sleep duration interactions on the MetS.
Objectively-measured sedentary time and cardiometabolic health in adults with severe obesity. KING et al. (2016)	Transversal study	The sample consisted of 927 women with severe obesity and mean age of 45 years	That ST, independent of MVPA, is associated with several markers of cardiometabolic health, among adults with severe obesity prior to bariatric surgery.
The independent and combined effects of exercise training and reducing sedentary behavior on cardiometabolic risk factors KOZEY KEADLE et al. (2014)	Intervention study	The sample consisted of 57 overweight / obese (19M / 39F) participants (mean ± SD, age 43.6 ± 9.9 years, BMI 35.1 ± 4.6 kg / m 2), not exercised (<3 days / week for <20 minutes per session) and worked in inactive occupation (self-reporting> 75% day at work was sedentary expenditure)	The within-group analysis provides preliminary evidence that exercising and reducing ST may result in improvements in metabolic biomarkers that are not seen with exercise alone, though between-group differences did not reach statistical significance.
Patterns of impact resulting from a 'sit less, move more' web-based program in sedentary office employees PUIG-RIBERA et al. (2015)	Estudo de intervenção	The sample consisted of 264 workers (42 years of age, n = 171 women, n = 129 administrative staff).	No significant interactions between the moments of the group and the program for BMI, SBP and BDP were identified. The Intervention group significantly reduced waist circumference by 2.1 cm from baseline to follow-up, while the comparison group reduced waist

https://dx.doi.org/10.22161/ijaers.6711 ISSN: 2349-6495(P) | 2456-1908(O)

			circumference by 1 cm. The reductions in waist circumference were not influenced when it was taken into account only by the self-reported cut in occupational session, were more influenced by the number of daily steps (≥1,000).
Effects of Standing and Light-Intensity Activity on Ambulatory Blood Pressure ZEIGLER et al. (2016)	Randomized cross-factorial study	The sample consisted of 09 overweight or obese adults (body mass index, 28.7 ± 2.7 kg, m (-2) adults (30 ± 15 years))	SBP during Standing (132 ± 17 mmHg), WALK (133 ± 17 mmHg) and CYCLE (130 ± 16 mmHg) were lower in comparison with SIT (137 ± 17 mmHg) (all P <0.01). CYCLE was smaller than STANDING (P = 0.04) and WALKING (P <0.01). For DBP, only CYCLE (69 ± 12 mmHg) was lower than SIT (71 ± 13 mmHg; P <0.01). Compared with SIT, WALK, STANDING and CYCLE, reduced SBP load by 4%, 4% and 13%, respectively (all P <0.01)
Evaluation of sit-stand workstations in an office setting: a randomised controlled trial GRAVES et al. (2015)	Randomized controlled trial	The sample consisted of 47 participants, with a mean age of 38.6, were randomized (intervention n = 26, control n = 21)	The effects of the intervention on fasting glucose or triglyceride plasma concentrations were not clarified. No statistically significant differences were observed for blood pressure.
Breaking up prolonged sitting with light-intensity walking improves postprandial glycemia, but breaking up sitting with standing does not BAILEY; LOCKE, (2015)	Randomized cross-over study of three periods and three treatments	The sample consisted of 10 non-obese adults participating in three trials (07 men, 03 women, mean age, 24.0 ± 3.0)	The area of systolic and diastolic blood pressure under the curve did not differ significantly between the conditions nor the responses in the lipid parameters (p> 0.05).
Alternating bouts of sitting and standing attenuate postprandial glucose responses. (THORP et al, 2014)	Randomized case-control study	The sample consisted of 23 sedentary overweight / obese workers (17 males and 6 females, mean ± SD: age 48.2 ± 7.9 years, body mass index 29,6 ± 4,0 kg · m (-2)	Plasma fasting glucose, triglycerides, and waist circumference were not significantly different between the two conditions when adjusted for time.

Legends: TG: triglycerides; MVPA: moderate to vigorous physical activity; WC: waist circumference; BMI: body mass index; CRP: C-reactive protein; FM: Fat mass; MetS: metabolic syndrome; ST: sedentary time; SBP: Systolic blood pressure; DBP: diastolic blood pressure.

IV. DISCUSSION

In this review, as shown in Table 2, most of the studies were interventional, and they evaluated changes in sedentary behavior to measure changes only in the components of the metabolic syndrome. Only 03 articles, transversal, all objectively measured, directly correlated metabolic syndrome with sedentary behavior.

These studies, which directly correlated metabolic syndrome with sedentary behavior, show a positive relationship between these variables, (SALEH; JANSSEN, 2014) showed this association even after controlling for confounding factors (odds ratio (OR) = 1.60) and (KING et al., 2016) also states that sedentary time was independently associated with a higher chance of metabolic syndrome (OR = 1.12). These data corroborate with that of other review studies, which also show this same increased chance (YOUNG et al., 2016).

One research found no association between increased sedentary time and chance of developing metabolic syndrome when controlled confounding factors

https://dx.doi.org/10.22161/ijaers.6711 ISSN: 2349-6495(P) | 2456-1908(O)

(VAN DER VELDE et al, 2015). Thus, despite a tendency to an increased chance of developing metabolic syndrome when sedentary time is increased, data are insufficient to confirm this trend due to a lack of studies, as demonstrated in previous research (DE REZENDE, 2014; CHASTIN et al., 2015).

Regarding the components of the metabolic syndrome (glycemia, fasting HDL and triglycerides, blood pressure and waist circumference), it is also shown in the cross-sectional studies of this research, the chance of developing deleterious health outcomes when sedentary behavior is elevated. However, when researches that involved some intervention on the sedentary time-off are taken into account, only two studies showed a significant post-intervention difference (ZEIGLER et al., 2016; PUIG-RIBERA et al., 2015). These data are similar to those of the review by (DE REZENDE, 2014), where the authors state that there is insufficient evidence to confirm an association between individual cardiovascular risk factors and metabolic syndrome.

V. CONCLUSION

It is concluded, after analysis of the studies, that there is an association between high sedentary time and the development of metabolic syndrome, however, most intervention studies do not show a significant change in cardiometabolic components when sedentary time breaks with mild physical activity. Much of these non-significant results in the intervention studies cited in this review may be due to acute effect studies or rapid interventions.

For this reason, it is necessary that more longitudinal studies be developed to investigate the chronic effect of these interventions, the number of breaks in the sedentary time, and the necessary duration of the same, in order to have significant effects on the improvement of the cardiometábolic components

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SIRT1 and Ki67 immunohistochemical expression in progression of cutaneous malignant melanoma

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Abstract— *The current study evaluated the proliferation index and immunohistochemical expression of SIRT1 on normal skin and cutaneous melanocytic nevi (CMN) and cutaneous malignant melanoma (CMM). Formalin-fixed paraffin-embedded tissue samples from 43 CMN, 22 CMM and 10 normal skin were obtained and clinical data were abstracted from the electronic medicalrecord.SIRT1 and Ki67 proteins expressions were evaluated regarding to clinic pathological behavior in CMM. The level of significance was set at $\alpha = 5\%$ ($p < 0.05$) .Our findings showed that SIRT1 positivity was significantly higher in benign melanocytic nevi than that in cutaneous malignant melanoma ($p=0.002$). As expected, the proliferation index was significantly higher in samples of cutaneous malignant melanoma as compared to the normal skin and melanocytic nevi ($p=0.001$). However, the expression of Ki67 protein was not also significantly related to the expression of SIRT1 ($p > 0.05$). In conclusion, low expression of SIRT1 and high proliferation index may play an important role in progression of cutaneous melanoma.*

Keywords— ***melanocytic nevi; skin lesions; proliferation; sirtuins.***

I. INTRODUCTION

Skin cancer is the third most common human malignancy and its global incidence is rising at an alarming rate, with basal cell carcinoma, squamous cell carcinoma and melanoma being the most common forms[1].There are an estimated 2–3 million cases of skin cancer across the world each year, and although cutaneous malignant melanoma (CMM) only accounts for about 200,000 of these (World Health Organization), it is the most dangerous form, accounting for most skin cancer deaths[2]. CMM diagnosed in early stage can be cured by surgical resection, and about 80% of cases are dealt with in this way[3]. However, metastatic malignant melanoma is largely refractory to existing therapies and has a very poor prognosis, with a median survival rate of 6 months [4].

Malignant melanoma is a tumor that originates from the melanocytes and manifests mainly on the skin[5]. UVR exposure is a major risk factor, especially in light skin populations[6]. Lightly pigmented skin and a large number of melanocytic nevi are associated with increased risk of developing malignant melanoma[6,7] Cutaneous melanocytic nevi (CMN) are benign proliferations of melanocytes that are postulated to result from sun-induced mutations [8],typically BRAF[9]and genes associated melanocytic system[10]. In the majority of such neoplasms, subsequent melanocyte senescence is induced by tumor suppressor proteins such as p16 and the

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nevus therefore ceases to grow and becomes stable or even involutes[11]. The accumulation of alterations in key genes controlling processes such as proliferation, apoptosis, senescence, and response to DNA damage can favor the formation morphologically atypical melanocytes predisposing the risk of developing melanoma[12,13]. Cutaneous melanocytic nevi can progress to the intra-epidermal lesion that can involve some local microinvasion of the dermis. The next phase, the cells can progress invading the dermis, a more dangerous stage in which the cells have metastatic potential, with nodules or nests of cells. Not all melanomas pass through each of these individual phases but develop directly from isolated melanocytes or nevi, and both can progress directly to metastatic malignant melanoma [14].

Silent mating-type information regulation 2 homologue 1 (SIRT1) is a protomember of the sirtuin family (SIRT1-7) that is involved in a variety of biological processes, including genetic control of aging, regulating transcription, apoptosis, stress resistance and energy efficiency during low-calorie conditions[15,16]. To date, the role of SIRT1 remains controversial as previous data suggest that SIRT1 can act as an oncogene or a tumor suppressor, likely depending on cell type, its distribution and biological targets[17–19].

Recent studies demonstrated that SIRT1 levels are reduced in some types of cancers, and that SIRT1 deficiency results in genetic instability and tumorigenesis[20,21]. SIRT1-deficiency resulted in an increased tumor formation in p53-null mice[22]. SIRT1 inhibits proliferation of pancreatic cancer cells expressing pancreatic adenocarcinoma up-regulated factor[23]. On the other hand, SIRT1 has been considered as a tumor promoter because of its increased expression in some types of cancers and its role in inactivating proteins that are involved in tumor suppression and DNA damage repair [24].

The role and functional significance of SIRT1 in cancer development and progression is currently an intense area of research investigation. SIRT1 has been shown to be upregulated in several cancers such as prostate cancer, cutaneous T-cell lymphoma, colorectal cancer and pancreatic[16,25–28].SIRT1 is also overexpressed in non-melanoma skin cancers, including squamous and basal cell carcinomas, actinic keratosis, and especially in Bowen's disease[25,29]. However, several studies have shown that both the overexpression and low expression of SIRT1 has been linked to poor disease prognosis and survival depending on the type of cancer[30–34]. In spite of the controversial role of SIRT1 in tumorigenesis[35,36], it is evident that SIRT1 is significantly involved in the process of tumorigenesis, however, its expression status in melanoma is poorly defined and are required further investigation. In this research, we observed the expressions of SIRT1 and index proliferation in skin lesions, and investigated the association between the expressions and clinicopathological characteristics.

II. MATERIAL AND METHODS

Patients

This retrospective and cross-sectional study analyzed samples of human tissues in 17 normal skins (control), 40 benign cutaneous melanocytic nevi (CMN) and 22 cutaneous malignant melanoma (CMM) with confirmed histopathological diagnosis. Clinic data were obtained from medical records of patients attended at public health centers for Oncology treatment at Montes Claros city, Minas Gerais state, Brazil. The normal human skin samples were obtained from patients who experienced aesthetic or corrective surgical procedures in women's breasts.

Ethical approval for this study was obtained from a relevant local ethic committee (Committee on ethic in research – FaculdadesIntegradasPitágoras: protocol no: 714.865/2014).

Clinic and pathological analyses

All CMM cases were classified according to the American Joint Committee on Cancer melanoma staging[37]. CMM patients were categorized as T1/T2 (≤ 2 mm thickness, n = 5 (22.72%) and T3/T4 (> 4 mm thickness, n = 17 (77.27%). Metastatic diseases were diagnosed in 7 (31.8%) CMM patients. Furthermore, cases of CMM presented the following clinical aspects: superficial spreading (n = 11, 50.0%), nodular (n= 3, 13.63%), lentigo malignant (n = 5, 22.72%), and acral melanomas (n = 3, 13.63%).

According to anatomical sites, CMM samples were classified as low-risk (lower trunk, thigh, lower leg, foot, lower arms, hands, and face) and high-risk (back and breast/thorax, upper arm, neck, and scalp) for death caused by CMM [37,38].

Formalin fixed and paraffin embedded samples were submitted to histopathological analysis. Tissue sections were cut at a thickness of 3–5µm and stained with hematoxylin and eosin (H&E). CMM samples were subjected to analysis of tissue invasion of melanoma cells by Breslow's thickness [39]and Clark's level[40]criteria. According to Breslow's thickness grade, CMM samples were categorized as follows: TI (up to 0.75mm, n = 3, 13.6%), TII (from 0.75 to 1.5mm, n = 7, 31.8%), TIII (1.5 to 4mm, n = 11, 50.0%), and TIV (≥ 4mm, n = 1, 4.5%). According to Clark's level (degree of invasion), CMM samples were categorized as follows: level I (limited to

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the epithelium, n = 2, 8.3%), level II (invasion up to the papillary dermis, n = 6, 25.0%), level III (invasion fills the entire reticular dermis, though without invading it, n = 11, 45.8%), level IV (invasion of the reticular dermis, n = 5, 20.8%), and level V (invasion of the hypodermis, n = 0).

Immunohistochemical reactions

The 5-µm tissue sections were deparaffinized, hydrated and the antigen retrieved. The tissue sections were incubated with 3% (v:v) hydrogen peroxide for 30 min at room temperature to quench the endogenous peroxidase.

After blocking in normal goat serum, the tissue sections were incubated with the primary antibodies anti-Ki67 (Mouse monoclonal, Dako, 1:200 dilution, clone MIB-1, Glostrup, Denmark) and anti-SIRT1 (Clone sc-15404, Santa Cruz Biotecnology, Dallas - TX) overnight at 4°C. The slides were then washed in PBS and incubated with LSABTM-Kit Plus Peroxidase® for 1h. Tissues were stained with a chromogen amino-etil-carbazol, counterstained with Mayer's hematoxylin, cover slipped, and visualized under an optical microscope Olympus® BH2 microscope (model: CX31; RTSF, Miami, USA).Positive and negative controls were applied according to the manufacturer's instructions (DakoCytomation, Glostrup, Denmark).All control, CMN, and CMM samples were examined by two independent investigators who were blind to the clinical data.

Counting of immunostained cells with Ki67and SIRT1

The immunohistochemical staining for Ki67 and SIRT1 were measured manually using custom software ImageJ®, version 1:44, for Windows® to assist in performing the cells counts. Ten images were acquired per case at a total magnification of ×400 using an optical inverted Olympus® FSX100 microscope (model: CX31; RTSF, Miami, USA). Selected fields were those with highest density of Ki67 or SIRT1 positive cells. Ki67 labeling index was performed as follows: % marking = (positive nuclei/[positive nuclei + negative nuclei]) [41,42].

The immune reactivity of SIRT1 was evaluated in the normal epithelial /nevi/neoplastic cells considering the cytoplasmatic and/or nuclear staining, or even absent. It was estimated the proportion of cells labeled with both cytoplasmic and nuclear expression in each one of the photomicrographs. Next, the average of the ratios was calculated for each case, considering individual nuclear and cytoplasmic expression for statistical analysis. It aimed to further determine the best cutoff point to define the expression of the protein as positive or negative in samples to the lesions types and location of this protein, using the receiver operating characteristic curve (ROC curve). In cytoplasmic expression, it was found that any ratio of higher than 36.1% represented a good cut-off for positive cytoplasmatic staining ($p < 0.021$). In the evaluation of nuclear expressions identified that positivity would be better represented in values above 1.8150% markup ($p = 0.198$). In the final evaluation of the positive immunohistochemical expression of SIRT1, cases were further ranked as cytoplasmic or nuclear staining to study statistical inferences.

Statistical analysis

Statistical analyses were performed using SPSS® 18.0 (SPSS Inc., Illinois, USA) and Graph Pad Prism®5.0 Softwares. Results were expressed as mean ± SE or as percentages. P values ≤0.05 were considered statistically significant.

Comparisons of immunohistochemical expressions of studied proteins between the lesions were evaluated using Mann-Whitney and Fisher's exact test. Kruskal-Wallis was used to evaluate the differences between SIRT1 and Ki67 expressions and clinicopathological characteristics of melanoma.The analysis immunohistochemical of the expression of SIRT1 and variables clinicopathological lesion and comparing of the expression of SIRT1 between the types of study samples was performed by Chi-square test and Fisher's exact test with application of ROC ("Receiver-operator curves") curve. The curve ROC was used to assess the sensitivity and specificity as the cutoff point for analysis of SIRT1 expression.

III. RESULTS

SIRT1immunohistochemical expression is reduced in human cutaneous malignant melanoma

SIRT1 immunohistochemical staining was localized in tumor and normal cells (lymphocytes and fibroblasts) with varying intensities.The immunohistochemical staining of SIRT1 in CMM, CMN and normal skin is shown in Figure 1.

Based on the ROC curve, it was simulated a cutoff point to distinguish samples with low and high staining of SIRT1, according to the diagnosis of the sample. Applying the values on a ROC curve, the area under the curve[43,44]was 0.684 (95% CI) with best estimates occurring in the amount of 36.1, which was a sensitivity of 59.1% and specificity of 23.5% ($p = 0.021$).

Tumors with scores above the 36.1 cut-off values were considered positive for the cytoplasmic expression of SIRT1 protein. According to ROC curve analysis, expression percentage for nuclear SIRT1 above the critical value 1.8150% was defined as positivity. Applying the values on a ROC curve, the area under the

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curve [43]was 0.602 (95% CI) with a sensitivity of 27.4% and specificity of 5.9% (p= 0.198).

Normal skin samples (control) showed weak or negative cytoplasmic staining to SIRT1. In normal skin, cytoplasmic SIRT1 staining was weakly and diffusely expressed in suprabasal epidermal keratinocytes, with only faint and focal staining in the granular layer and stratum corneum. The SIRT1 protein was detected in the normal epithelial tissues in 35.29% of normal skin (Table 1).

The SIRT1 protein was present in both cytoplasmic and nuclear compartments of the cutaneous melanocytic nevi. Therefore, SIRT1-positive cases were classified into two categories (nuclear or cytoplasmic SIRT1). SIRT1 was positive in 76.74% of benign melanocytic nevi cases. Among the SIRT1-positive cases, 63.63% were cytoplasmic positive and 36.36% were nuclear positive. In particular, the junctional component of benign melanocytic nevi was positive in the most cases. SIRT1 positivity is observed in the majority melanocytes, especially those arranged in bridging nests at the dermoepidermal junction and the intradermal component.

The SIRT1 protein was present in cytoplasmic compartment of the malignant melanocytic cells. SIRT1 was positive in twelve of 23 MMC (52, 17%), and all SIRT1-positive MMC cases showed cytoplasmic positivity. SIRT1 positivity was significantly higher in benign CMN than that in MMC (p= 0.002). The invasive component of melanoma shows a weak and diffuse SIRT1 cytoplasmic staining. Most MMC displayed high rate of melanocytes expressing SIRT1 in intradermal component. SIRT1 expression was not significantly related to any of the clinicopathological parameters (Table 2).

Ki67 immunostaining was nuclear and nucleolar (Fig.1). The average number of Ki67-positive cells was significantly higher in samples of cutaneous malignant melanoma as compared to the normal skin and melanocytic nevi (p <0.001) (Table1). The normal skin and benign CMN displayed positive Ki67 immunostaining in basal keratinocytes whereas benign CMN was absent in the majority of nevi cells. The expression of Ki67 it found in intradermal component of MMC.

The associations between the Ki67 expression and clinicopathological factors did not have statistical significance (Table 2). Furthermore, the expression of Ki67 was not also significantly related to the expression of SIRT1 (p>0.05).

IV. DISCUSSION

This study investigated the immunohistochemical expression of Ki67 and SIRT1 in normal skin, CMN and CMM samples. In this study, we noted a significant decrease of staining of SIRT1 from CMN to CMM samples. Also, normal epithelial cells showed weak or negative staining to SIRT1 while CMN samples exhibited a higher SIRT1 expression as compared to the CMM samples. Comparatively, the SIRT1 expression was gradually decreased during carcinogenesis and tumour progression of colorectal adenocarcinoma[33]. This suggests that loss of SIRT1 expression in tumoral lesions may be associated with a more aggressive phenotype. However, the role of SIRT1 in human malignant tumors is controversial. Some previous studies have reported that SIRT1 overexpression was associated with shorter overall survival or poor prognostic indicators in breast and gastric carcinoma [35,45,46].

The expression of SIRT1 is relatively higher in hepatocellular carcinoma, breast cancer, and thyroid cancer but lower in colon and lung cancer[35,47–50]compared with their corresponding normal tissues. In cancer, SIRT1 has been reported as either an oncogenic or a tumor suppressive role, depending on the type of cancer and the context of the analysis [17,21,51]. These results suggest that SIRT1 may acts differently depending on the specific organ or type of tumor involved.

We demonstrated that SIRT1 is predominantly localized in the cytoplasm of CMM. SIRT1 cytoplasmic localization is not commonly identified in cancercells and it is unclear if SIRT1 localization has any changes during carcinogenesis. Similar results have also identified aberrant cytoplasmic localization in human cancer cells [52–54].This finding may suggest a new mechanism for SIRT1 function as a cancer-specific survival factor by targeting cytoplasmic proteins.

In contrast to its well-described role in the nucleus, the deacetylation function of cytoplasmic proteins caused by SIRT1 provides important insights into the function of cytoplasmic SIRT1. Zhang, 2007 showed that SIRT1 enhanced IGF-1 signaling by deacetylating the ISH-2 cytoplasmic protein [55]. SIRT1 also deacetylates cytoplasmic cortactin and promotes cancer cell [35,52] In addition, SIRT1 was found to promote the activation of cytoplasmic kinases, including AMPK,.Ras-MAPK, Erk and S6K1 [52].

In the case of certain cancers, including prostate cancer, lung cancer, breast cancer, and melanoma, SIRT1 has been shown to localize to the cytoplasm, while being located predominantly in the nucleus in the corresponding normal tissues[52,53]. This change in localization could theoretically minimize the deacetylation of TP53 in the

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nucleus by SIRT1 while still allowing TP53 to regulate its transcription. Thus, in cancers under these conditions, the oncogenic role of SIRT1 overexpression through TP53 might be minimized, allowing for other targets of SIRT1 to play a more significant role, especially those that are localized to the cytoplasm[17]. Cellular localization of SIRT1 also has been shown to differ among different tissue types in mice [56], which could explain why SIRT1 sometimes exhibits tumor suppressor properties in certain types of cancer but not in others.

In current study, there was no association significant between SIRT1 and Ki67 immunostaining, however, further functional study will be needed to investigate the relationship between SIRT1 and cellular proliferation. Melanoma is known to exhibit aberrant expression of proliferation markers, and these abnormalities are considered important steps in the genesis and progression of melanoma [57].An increasing literature describes the role of proliferation markers in the evaluation of melanocytic tumors[58]. Ki67 staining has been shown positive in multiple lesions, 5% of positivity on melanocytic cells in most benign nevi, although there have been reports of up to 15% positivity in Spitz and dysplastic nevi [59–62]. Conversely, Ki67 staining is reported as positive in 13–30% of the cells in a malignant melanoma, although individual cases can show almost 100% nuclear positivity[62,63]. In our study, we found a lower average than 5% staining in benign melanocytic nevi while in melanoma was greater than 15%. Therefore, Ki67 index was reported to be higher in malignant melanomas than in benign nevi. Correspondingly, no associations between Ki67 and measures of tumor size (thickness and diameter) and invasion (Clark's level) were found. Other studies on cutaneous melanoma have suggested that increased Ki67 expression might be associated with tumor thickness and tumor cell proliferation [62].

Our experiments have some limitations, such as small sample size. The tumor heterogeneity and staining scoring ethod also may to interfere the results. In summary, we need further study on the roles of SIRT1 and Ki67 on clinical and pathological behavior of melanoma.

V. CONCLUSION

Low expression of SIRT1 and high proliferation index may play an important role in progression of cutaneous melanoma.

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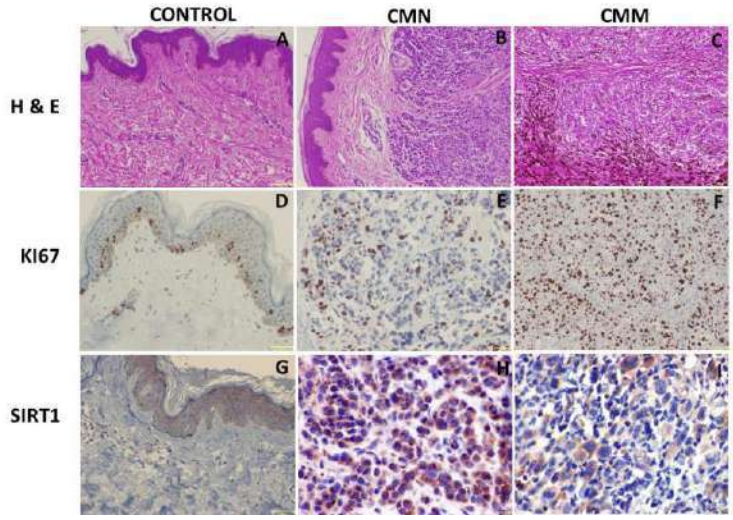

Figure 1. Morphological aspects of normal skin (control), cutaneous benign melanocytic nevi (CMN), and malignant melanoma (CMM) samples (Figures A, B, and C, respectively. H&E; higher magnification of 100x).Immunohistochemical expression of Ki67 (Figures D, E, F) higher magnification of 200x in samples of control, CMN, and CMM.SIRT1 (Figures G, H, and I) higher magnification of 200x in samples of control, CMN, and CMM. Immunostaining: AEC; counterstaining: Mayer's hematoxylin.

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Table 1: Expression of Ki67 and SIRT1 in normal skin (control), benign cutaneous melanocytic nevi and cutaneous malignant melanoma.

Variables	Ki67 Mean (SD)	P	SIRT1+ n (%)	P	SIRT1+ Cytoplasmic n (%)	SIRT1+ Nuclear n (%)	p
Control [a] (17)	0.93 (1.82)	p^{ab}= 0.155	6 (35.3%)	p^{ab}= 0.001 **	6 (100.0%)	0	p^{ab}= 0.151
Melanocytic Nevi [b] (43)	2.04 (4.28)	p^{ac} = <0.001*	33 (76.7%)	p^{ac}= 0.334	21 (63.6%)	12 (36.4%)	p^{ac}= 0.529
Melanoma [c] (22)	16.96 (14.54)	p^{bc} = <0.001*	12 (54.6%)	P^{bc}= 0.035	10 (83.3%)	2 (16.7%)	p^{bc}= 0.287

*Values bearing asterisks show significant association using Mann-Whitney. **Values bearing asterisks show significant association using Chi-square test and Fisher's exact. Level of significance was set at α = 5% (P< 0.05).

Table2: Evaluations Ki67 and SIRT1 immunohistochemical expressions in function of clinic and pathological parameters on melanoma malignant cutaneous.

Variables	KI67 Mean (SD)	p	SIRT1+ n (%)	P	SIRT1 Cytoplasmic n (%)	SIRT1 Nuclear n (%)	p
Anatomical Site							
Lowrisk (18)	13.82 (15.01)	0.631	9 (50.0%)	0.478	8 (88.9%)	1 (11.1%)	0.522
High risk (4)	17.22 (14.09)		4 (100.0%)		3 (75.0%)	1 (25.0%)	
TNM							
I/II (5)	16.89 (11.60)	0.990	2 (40.0%)	0.457	2 (100.0%)	0	0.488
III/IV (17)	16.98 (15.62)		10 (58.8%)		8 (80.0%)	2 (20.0%)	
Clinical Size							
Small (5)	16.89 (11.60)	0.990	2 (40.0%)	0.457	2 (100.0%)	0	0.488
Large (17)	16.98 (15.62)		10 (58.8%)		8 (80.0%)	2 (20.0%)	
Regional Metastasis							
Absent (15)	16.69 (15.74)	0.902	8 (50.0%)	0.867	6 (75.0%)	4 (50.0%)	0.273
Present (7)	17.54 (12.70)		4 (57.1%)		4 (100.0%)	0	
Recurrence							
Absent (18)	17.04 (14.61)	0.646	9 (56.2%)	0.422	7 (77.8%)	2 (22.2%)	0.371
Present (4)	20.86 (15.03)		3 (60.0%)		3 (100.0%)	0	
Level of Invasion							
I-III (17)	14.80 (13.57)	0.206	9 (50.0%)	0.781	7 (77.8%)	2 (22.2%)	0.371
IV-V (5)	24.31 (16.91)		3 (60.0%)		3 (100.0%)	0	
Tumor Thickness							
≤ 2 mm (12)	15.60 (12.38)	0.642	8 (72.7%)	0.211	6 (75.0%)	2 (25.0%)	0.273
≥2 mm (10)	18.59 (17.34)		4 (33.3%)		4 (100%)	0	

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Competitive Interaction between Weeds and Onion Crop

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***Abstract*—** *Among the factors that affect crop productivity are weeds that compete for the resources present in the environment. Then, the objective of this study was to evaluate the competitiveness of turnip and ryegrass infesting the onion crop. The experiment was conducted in a greenhouse, in a randomized complete block design, arranged in a 2x8 factorial scheme, with four replications. In factor A, were allocated the weeds (turnip and ryegrass) and in the B, were allocated populations of these species (0, 1, 2, 3, 4, 5, 6 and 7 pot-1 plants) living with an onion plant. 50 days after transplanting, were evaluated the height, stem diameter, leaf area and dry mass of the aerial part of the onion plants. For the weeds, only the dry mass of the aerial part was determined. In face of the results, it can be observed that the onion has a low competitive capacity, being the turnip the weed more aggressive in the competition, for all evaluated variables.*

Keywords*— *Allium cepa, Raphanus sp., Lolium multiflorum, weed competition.

I. INTRODUCTION

Onion (*Allium cepa* L.) is a vegetable from Central Asia and the Mediterranean, known as the " Queen of Kitchen " because of the characteristic flavor provided to the foods (Sahu et al., 2017). In Brazil, onion is the third vegetable in economic importance owing to the volume produced and rend generated (Kurtz et al., 2016). The Brazilian production in 2018 harvest was approximately 1.7 million ton, with average yield of 26 tons ha-1. Among the Brazilian states, Rio Grande do Sul produced 138,098 tons with an average yield of 20.3 tons ha-1 (IBGE, 2018).

Agricultural crops, including onions, depend on environmental factors for their growth and development. Among the environmental and edaphic factors that influence the productivity of these crops is the interference caused by weeds, which can compete for the available resources in the environment, such as water, nutrients, light and CO2 (Galon et al., 2018). Weeds appear as an obstacle in world agricultural production, causing an increase in the cost of production, reduction in yield and quality of harvested products (Renton & Chauhan, 2017).

Weed interference in vegetables is more intense due to the intensive exploration, frequent preparation, high rates of fertilization, low water restriction and no straw, in the cultivation areas (Souza et al., 2016). In this context, it is favorable the occurrence of fast growing weeds, with a short development cycle and high seed production, significantly increasing the seed bank of the soil (Carvalho et al., 2008). Due to the frequent soil inversion, the germination of positive photoblastic weeds is intensified, because the dormancy overcoming of these seeds occurs due to exposure to light, resulting in the occurrence of high populations of these plants in the area (Silva et al., 2013).

The low competitiveness of onion in relation to weeds is more harmful in the early stages of development, and long periods of competition can reduce in 100% the bulb production, in comparison to the production of an infestation-free farming (Zanatta et al., 2006).

Among the weeds in onion crops, stands out the turnip (*Raphanus sp*.), as an annual winter species, which has a high competitive ability. This fact is due to the high prolificacy, longevity, seed dormancy and germination capacity under adverse conditions of climate and soil. It was found that this species has a competitive capacity of 5 to 10 times greater than ryegrass (*Lolium multiflorum*) when in competition with winter cereals (Costa et al., 2015).

The ryegrass is commonly found in the crops of the southern region of Brazil, this species has elevated seed

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production and easy dispersion, causes losses of wheat production (Agostinetto et al., 2008), in barley (Tironi et al., 2014) and in canola (Galon et al., 2015). It is noteworthy that scarce are the studies that have evaluated the competition effect of turnip and ryegrass on onion culture, thus justifying the present work.

Studies about the competitiveness of crops with weeds allow the development of more sustainable strategies for their management. On this, the objective of this study was to evaluate the competitiveness of turnip and ryegrass when infesting the onion crop.

II. MATERIALS AND METHODS

The experiment was conducted in a greenhouse at the Federal University of Fronteira Sul, in Erechim/RS, in the year of 2018. The experimental units consisted of plastic pots with a capacity of 8 dm3, filled with soil from agricultural area, characterized as Rhodic Hapludox (Soil Survey Staff, 2014). Soil correction was done according to the technical recommendations for onion crop (ROLAS, 2016). Weed seeds were collected in grains commercial areas in the city of Erechim/RS, Brazil.

The experimental design was the randomized block, arranged in a 2 x 8 factorial scheme, with four replications. In factor A, weed species in competition with onion crop (turnip and ryegrass) were allocated and in B the weed densities (0, 1, 2, 3, 4, 5, 6 or 7 plants pot-1) in competition with an onion plant, Baia Periforme cultivar. The experiment was conducted in additive series according to the methodology proposed by Radosevich et al. (2007).

On the center of the experimental unit was planted an onion plant and on the periphery were varied the populations of turnip and ryegrass plants, according to the proposed treatment. The plants deposition were realized by transplanting seedlings that were previously sown in polystyrene trays, and cultivated under the same environmental conditions of the experiment.

The experimental units were maintained equidistant, so that the available surface area for the development of the plants corresponded to the area of the experimental unit.

At 50 DAE after transplant, the height, diameter, leaf area and dry mass of the aerial part of the onion plants were evaluated. The height of plants was measured using a millimeter scale ruler, from the base of the soil to the apex. The diameter of the stem was measured using a pachymeter in a millimeter scale, measuring it to approximately one centimeter of the soil. The leaf area, was used a portable meter model CI-203 Bio Science, quantifying the leaf area (cm2 pot-1) in all plants in each treatment. In order to quantify the dry mass of the aerial part of the species (onion and weeds), the plants were cut close to the soil afterwards they were packed in paper bags and dried in an oven with forced air circulation at a temperature of 65 ± 5 °C until the material reaches constant weight.

The data obtained from the species were submitted to analysis of variance by the F test, in which, when significant were submitted to the linear or non linear regression models for the quantitative factor. The data were submitted by the t test for the qualitative factor, with the exception of the dry mass of the aerial part of weeds that was presented only the standard deviation and the average of four independent biological replicates. All tests were performed at $p \leq 0.05$.

III. RESULTS AND DISCUSSIONS

The results demonstrated that there was interaction between the factors tested (weed species x populations) for all variables evaluated. It was observed that the competition with turnip was more harmful to the onion than the competition with ryegrass (Figures 1, 2, 3 and 4).

The competition caused reduction of height of onion plants when in competition with turnip, with linear decrease in the values, whereas for ryegrass neither an equation was fitted to the data (Figure 1B). As observed in Figure 1A, it was observed that onwards four weeds per pot, turnip was more aggressive in the competition.

When there is an increase in the population of turnip per pot, occurs the decrease in the height of plants, this can be explained by the competition exerted by the turnip roots, considering that the root system is more extensive than the ryegrass and the onion, resulting in a larger surface area of contact with the soil. Due to the competition that occurs with the resources below the soil surface, there is a reduction of the available resources for the growth and development of the crop, and in this case, cessation of plant height growth (Renton and Chauhan, 2017).

According to the results obtained from Koefender et al. (2016), when evaluating onion production of Baia Periforme on monoculture and consortium with lettuce, they observed that in monoculture and spacing of 50 centimeters between plants, there were the best results for the variables tested. As for consortium and smaller spacings, inter and intraspecific competition occurs, reducing the potential for plant development and bulbification of onion (Koefender et al., 2016).

In Australia, turnip is one of the most problematic weeds, mainly because it causes reduced yields in vegetables, problems with multiple resistance that hinder

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control and further increase the damages related to this weed (Ashworth et al., 2016).

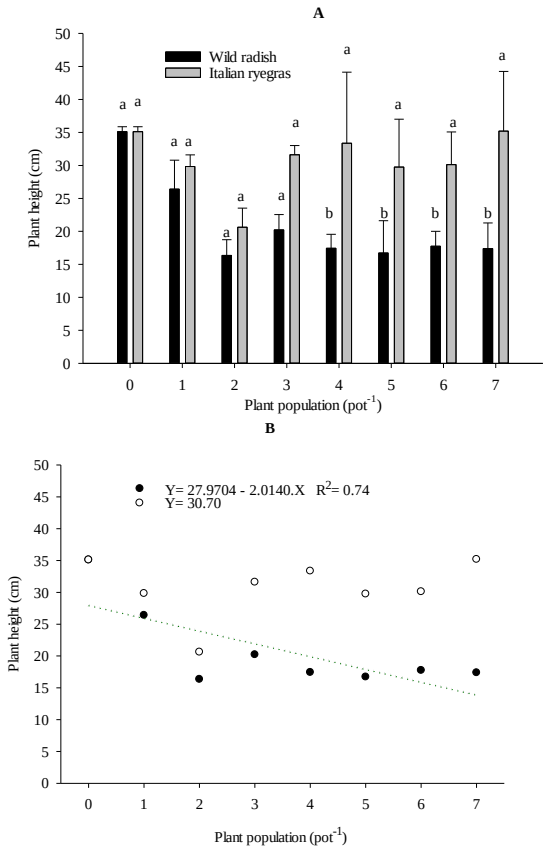

Figure 1. Height of onion plants (cm) as a function of competition with different populations of *Raphanus sp*. (black bars - A and ● – B) and *Lolium multiflorum* (gray bars - A and ○ - B). UFFS, Erechim-RS, 2019.

Turnip competition caused a reduction of 30% in onion stem diameter (Figure 2A) when the free infestation treatment was compared to the maximum population of seven plants of turnip pot-1. It can be observed (Figure 2B) that the diameter decrease occurs in a linear way, while the ryegrass had no adjustment to the equation. Considering that the greater the number of individuals in the weed population, the greater the competition with the crop for the resources present in the environment (Soares et al., 2010). Similar results were observed by Galon et al. (2016) when evaluating the competition of two types of lettuce with ryegrass, with a reduction in stem diameter of 29 and 49% for the smooth and curly types, respectively.

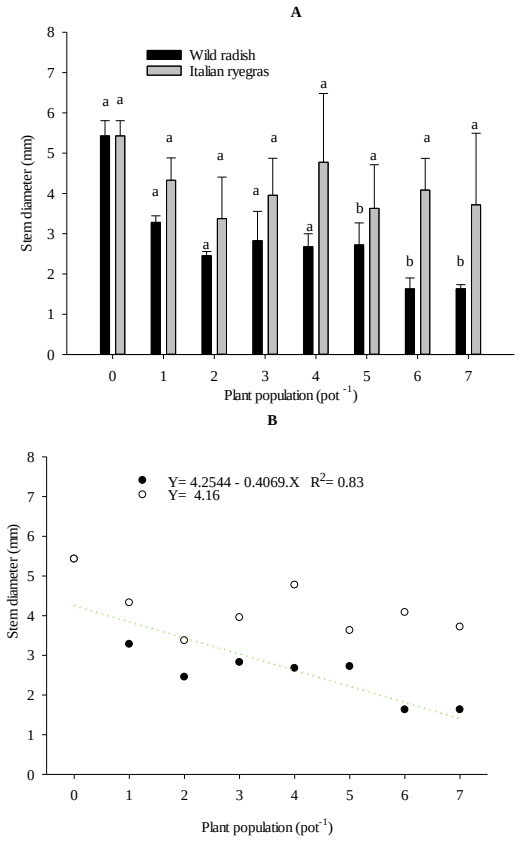

Figure 2. Stem diameter of onion plants (mm) as a function of competition with different populations of *Raphanus sp*. (black bars - A and ● - B) and *Lolium multiflorum* (gray bars - A and ○ - B). UFFS, Erechim-RS, 2019.

For the variable of onion leaf area the competition with turnip was much more aggressive when compared to competition with ryegrass (Figure 3A and 3B). Competitive potential of turnip was observed in relation to ryegrass when these two weeds infested winter cereals (Costa and Rizzardi, 2015). There was a significant reduction in leaf area values of onion in the lowest established competition (one plant pot^{-1}). The interference of one turnip plant caused a reduction of 71% in the leaf area of the onion, and as the population increased, there was an even greater decrease, reaching up to 89% of loss with the maximum population of turnip. The mass of onion bulbs were lower at higher population densities due to increased intraspecific competition for environmental resources (Caruso et al., 2014). In the same way it was observed in the present study, where increasing the turnip population provided a decrease in the leaf area of the onion.

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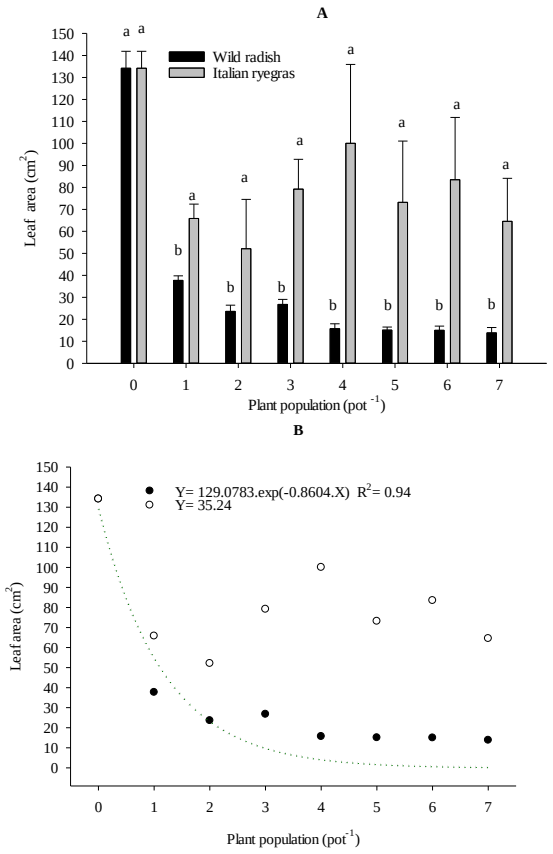

Figure 3. Leaf area of onion plants (cm^2) as a function of competition with different populations of *Raphanus sp*. (black bars - A and ● - B) and *Lolium multiflorum* (gray bars - A and ○ - B). UFFS, Erechim-RS, 2019.

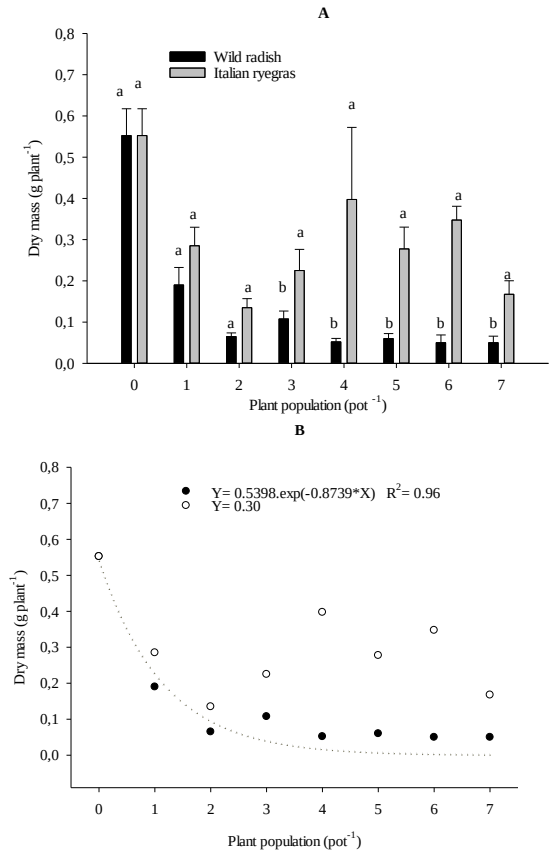

Figure 4. Dry mass of the aerial part of onion plants (g $plant^{-1}$) as a function of competition with different populations of *Raphanus sp*. (black bars - A and ● - B) and *Lolium multiflorum* (gray bars - A and ○ - B). UFFS, Erechim-RS, 2019.

The results demonstrate that there was difference from three plants per pot, with turnip being more competitive than ryegrass (Figure 4A). The dry mass of the aerial part of the onion was directly influenced by the competition, and in the presence of the turnip showed a reduction of 90% of the treatment free of infestation and the maximum population of weeds per pot (Figure 4B). The competition with ryegrass did not fit to the equation, demonstrating an average of 0.3 g $plant^{-1}$.

It is noticed that the onion culture presents less ability to compete with the weeds. The results corroborate with the observed by Qasem (2006), in which it obtained a reduction of 62% in the average yield of onion free of the infestation when compared to the infested treatment. Silva et al. (2013), observed a decrease in the fresh mass of watermelon according to the increase of time of coexistence with weeds, in conventional culture system. Therefore, it can be reported that occurs a similarity of comportment with the watermelon and onion in face of the competition with the weeds.

Due to its rapid growth and establishment, turnip was the weed species that accumulated more dry mass, at all densities, when compared to ryegrass (Figure 5A). In all evaluated variables, greater losses were observed when the crop competed with turnip, demonstrating a larger competitive ability than ryegrass (Figures 1, 2, 3 and 4). These results reinforce the studies that demonstrate the greater competition capacity of the turnip compared to ryegrass (Rigoli et al., 2008; Costa & Rizzardi 2015). Characteristics such as higher leaf area, root size and volume, may contribute to this superiority of turnip in competing with the resources of the ambient (Georgescu et al., 2016).

In contrast to the rapid development of the turnip, the Baia Periforme onion cultivar has slow growth, with a lower accumulation of fresh mass until 56 and 74 days after sowing and transplanting of the seedlings respectively (Vidigal et al., 2010). Thus, the low competitive capacity of the onion may be tied to the slow initial growth.

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For each additional turnip and ryegrass plant, was obtained a linear increase of 0.62 and 3.52 g pot-1, respectively. It is probable that in addition to competition with onion, interspecific competition also occurred, due to the minimal increase of the dry mass of the aerial part of the turnip plants. The same effect was not observed for ryegrass, which presents a rapid increase in dry mass of the aerial part as plant density increases (Figure 5B). Galon et al. (2016) observed that the dry mass of ryegrass demonstrated stability from the density of 707 plants m^{-2}, approximately five times the total density of the present study.

The lower accumulation of dry mass of the ryegrass over the initial period of establishment may have been the characteristic of the ryegrass that most contributed to the low competitiveness with the onion. Cultural management practices, such as sowing density, reduction of line spacing, as well as more competitive cultivars, can support in the management of weeds (Bajwa et al., 2017).

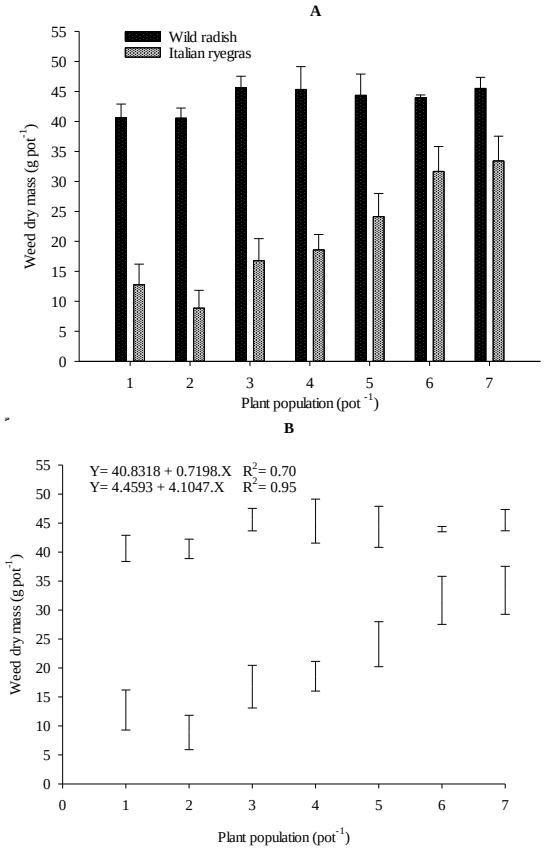

Figure 5. Dry mass of the aerial part (g pot^{-1}) of *Raphanus sp.* (blach bars - A and ● - B) and *Lolium multiflorum* (gray bars - A and ○ - B) as a function of competition with onion and plant population (pot^{-1}). Averages and standard deviation of 4 independent biological replicates. UFFS, Erechim-RS, 2019.

IV. CONCLUSIONS

For all tested variables (plant height, stem diameter, leaf area and dry mass), there were losses of the onion in competition with the turnip.

When comparing the weeds turnip and ryegrass, it is concluded that turnip is more competitive with onion in relation to ryegrass, regardless of the population tested.

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Critical Reflection for the Change of Educational Practice

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Abstract— *This study is based on a doctoral research developed by the Postgraduate Program in Education of the Federal University of Piauí (UFPI), which analyzes the changes in the educational practice of teachers working in rural schools after participating in the Degree in Education of the Field (LEdoC). The clipping presented through this purpose aims to discuss the principle of critical reflection as an important element for the change in educational practice. The discussions that support these stages are supported by theorists such as: Contreras (2012), Freire (2013 and 2014), Molina and Hage (2015), Pimenta e Lima (2012), among others. The data production employed the Richardson-oriented documentary analysis (2012) and conversation wheels from the perspective of Freire (2002). The data production employed the Richardson-oriented documentary analysis (2012) and conversation wheels from the perspective of Freire (2002). The results show that the interfaces between the curricular activities of teacher training, based on the specific knowledge of the formation and the relation between them and the knowledge of the peasant culture, produce critical reflections, contributing to the change of educational practice.*

Keywords— ***Initial teacher training. Educational practice. Critical reflection.***

I. INTRODUCTION

The Degree in Field Education (LEdoC), linked to the Center of Educational Sciences (CCE) of the Federal University of Piauí (UFPI), the background of this research, is aimed at training educators for the rural schools in the area of Nature Sciences, has a regular character and duration of four years, being carried out in a system of semester blocks.

According to the Political Pedagogical Project of the Course (PPC), its intention is to offer the graduates the knowledge necessary to understand nature within a multidisciplinary vision. In addition to learning the scientific knowledge inherent in teacher training, it also aims to provide students with a solid foundation for understanding the dynamics of the field in its historical, cultural, economic and social aspects, enabling the development of pedagogical work committed to the supply and with the social quality of education for the rural population (UFPI, 2013).

The LEdoC has the following guidelines: a) Its object is the school of basic education, with emphasis on the organization of schools and pedagogical work for the final years of Elementary and Secondary Education; b) its objective is to prepare educators to act in teaching, in the management of educational processes and in the management of community educational processes; c) its curricular organization provides for presential courses (equivalent to regular semesters), offered in alternation between school time and community time; d) its curricular matrix develops a multidisciplinary teaching work strategy, organizing the curricular components from the Natural Sciences knowledge areas.

The course has a regular character and is based on two integrated dimensions of formative alternation: Time-University (TU) and Time-Community (TC). TU activities are carried out in the months of January / February and July / August, and during systematic meetings in the interval of each university time, constituent part of the disciplines and the Integrative Seminar. The activities that configure the TC dimension are carried out in the socio-professional space of the student, so that he can reflect on the problems, discuss with the community and colleagues and raise hypotheses about possible solutions. This dimension materializes in the classroom, with each return to TU activities, through discussions and socializations.

The beneficiaries are students from the rural area to work in rural schools located in diverse socio-cultural contexts or in schools located in the city, but which serve students from the countryside, among them teachers from rural schools that do not have higher education, 2018 represent 27.9% of the course's students. These students are selected annually through a specific selection process, which guarantees democratic access to the Course.

In the context of teacher education policies, there are expectations about this course, both in terms of promoting higher education for teachers working in rural schools, thus exceeding current levels of qualified teachers only at the intermediate level or baccalaureate, or in the context of ensuring formative processes that take into account the specificities of the field and its subjects,

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transcending the formal university spaces to enable the meeting of specific knowledge of the formation with the knowledge of the peasant culture, seeking to develop the capacity for reflection and action of the teachers for critical pedagogical rationality.

Considering these contextual issues, we feel instigated to know: how the principle of critical reflection contributes to the change in the educational practice of teachers working in rural schools, based on their participation in the Field Education Licentiate Course, UFPI of Teresina? Based on the assumption that, through the curriculum of the course, work specific knowledge of the training, contextualizing it with the students' reality, favors a critical reflection on the practices developed. Regarding this issue, Freire (2013, p. 40) affirms that "teacher training should contemplate in its curriculum studies of theories that favor the critical reflection on the contexts and the practices developed by the teachers, in such a deep way, that these studies to be confused with practices."

The training is a pedagogical method of course, the social context and the experiences lived as a starting point for an understanding of reality in a process of articulation through the formation of other knowledge are produced and socialized. The proposal of the PPC of the LEdoC / UFPI that is specific to the formation can be articulated with the knowledge of the culture through the integration of activities carried out in the Time University and in the Community Time, a being "function in a strictly articulated way, enabling the the activities are brought by the student of the socio-cultural environment are expanded, constituting sources of reflection and learning "(UFPI, 2013, p.16).

It is important that it be a classroom with the capacity to improve the teaching capacity that develops and that carries out the teaching function and practice that improves the capacity to form a critical, politicized school critique and committed to social justice.

This is an important study because it discusses the formative processes developed in this course, evidencing permanences and ruptures resulting from the confrontation between what is studied in the course and what is done in practice, contributing with the production of scientific knowledge and theoretical reflections on processes based on the conceptions of Field Education, enabling LEdoC readers, researchers and teachers to know about this public policy, as well as their contribution to changing the educational practice of teachers working in rural schools.

Our desire is to contribute to the advancement of discussions about teacher education, to strengthen debates about the specifics of formation and the link with their social subjects and their realities, considering the universality of the formative processes, the specificities of the LEdoC and its characterization, making it possible to recognize it, in order to rethink it from the aspects around which it is developed.

II. METHODOLOGY

We conducted the study guided by the epistemological biases of critical qualitative research, understood as an approach that, in addition to providing an understanding of the real, exposed and translated in the speeches of the interlocutors, also favors the awareness of the people to change the reality of which they are part.

The critical qualitative research is a modality that allows the insertion of the researcher in the context of the research, approaching the problem to be researched, as well as of the interlocutors who live and share a given reality marked by diverse professional and personal experiences, subject to a relationship which is characterized by its dynamic, lively, interactive, contradictory nature.

One of the most relevant aspects of qualitative research inspired by critical theory is the interpretation of information, and it is necessary for the researcher to carefully analyze the object of study, observing the historical context and its relation to the present time, the explicit and implicit information of form to communicate the understanding about the result (KINCHELOE; MACLAREN, 2007).

According to Carspecken (2011), through the production of knowledge, critical qualitative research explicitly links power relations and social injustices, contributing to people's awareness and social change. Thus, it is necessary for the researcher to make a commitment to unveil social inequalities, offering the interlocutors theoretical-practical elements that effectively contribute to social transformation.

For the production of the data we did the documentary analysis of the Pedagogical Project of the Course (PPC), defined by Richardson (2012, page 228) "as the one that has as its object not the social phenomena, when and how they are produced, but the manifestations that record these phenomena and the ideas elaborated from them." The documentary analysis of the PPC consisted of a rigorous study carried out in three stages: in the first one, called pre-analysis, we carried out the selection and superficial reading of the material; in the second, entitled material analysis, we did the codification, categorization and quantification of the information, through careful and repeated readings of the document. In the last step, called the treatment of results, we performed the inferences and interpretations of the document, and selected clippings

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from excerpts to illustrate the analyzes (RICHARDSON, 2012).

In the documentary analysis we use as data the text of the PPC itself of the LEdoC / UFPI and its modes of operationalization, analyzing the philosophical and pedagogical theories and trends that underlie it, the guiding elements of Field Education contained in the document, the curriculum, the bibliographies indicated , the educational practices suggested and developed, as well as aspects that reveal the challenges of teacher training in this course.

The production of data was also carried out through the wheels of conversations, a research strategy that gives the interlocutors critical reflections on their conceptions and practices. As a result, they collaborate with the expansion of the knowledge about the object of study, favoring the socialization and the exchange of knowledge, as well as the shared analysis of the interpretations of the subjects. In Freire (2002) we find the description that the wheel is a space of sharing and confrontation of ideas, where freedom of speech and expression gives the group, and each individual in particular, the growth in understanding their own conflicts.

The wheels of conversation prefigure, in their capacity as data production technique, a way for the research interlocutors to perform a self-reflexive movement, socialization and exchange of knowledge about the object of study. As a data production strategy, the discussion wheels allow participants to be involved and aware of their contribution, and can not be reproduced without the participants' awareness and involvement (WARSCHAUER, 2004).

The field of research comprises two scenarios: the Field Education Licentiate Course (LEdoC), linked to the Education Sciences Center of the Federal University of Piauí, Teresina Campus (Piauí), where the training processes are developed and the municipality of Timon (Maranhão), where the study interlocutors reside and work. The choice of this municipality was guided by the fact that it has the largest number of students enrolled in the Course of Licenciatura in Education of the Field, from 2013 to 2017.

The interlocutors were 05 (five) teachers from the field schools enrolled in the course of the Licentiate course in Field Education, whose entry occurred in the years 2014 and 2015 and currently attend the 8th period of the LEdoC. In the process of selecting the participants of the research, we consider the following criteria: to be a teacher of rural schools for more than five years; being in the last two blocks of the course; preferably acting as a science teacher in the final years of elementary school or acting as a high school teacher in the areas of Biology, Chemistry or Physics. To preserve their identities, they were named: PROF 01, PROF 02, PROF 03, PROF 04 and PROF 05.

III. CRITICAL REFLECTION IN THE INITIAL TRAINING OF TEACHERS OF THE FIELD

Teacher education has been expanding as an educational policy and as a field of knowledge and knows, whose purposes need to be advanced in order to interfere in the educational reality, contributing to improve teaching and learning processes. For us to succeed in training, an important aspect to be considered in its design, as well as in its implementation are the factors that contribute, a priori, to the change in the educational practice.

We know that a formative process does not occur in a linear and simple way, its development occurs amid conflicts, imbalances and changes of conceptions. Thus, to promote the formation of teachers with a focus on changing the educational practice is to develop actions and emotions that can promote aspirations, will, solidarity and knowledge, critical reflection is a fundamental step.

The effectiveness and quality of teacher training initially implies that the curriculum is associated and based on a proposal of subject, society and school based on principles that should inform the formative actions. Illustratively, principles are like the roots of a tree, which draw the sap from the earth (knowledge), nourish the formation and cause it to have flowers and fruit (teacher trained and acting according to specifications expressed in the political pedagogical project of the course).

They are the starting point for formative actions, the curricular organization of the course and the role of the educational institution (HEI), enabling the conditions for the formation to be developed with quality and also the responsibility of the trainers in executing the processes, according to the delineation of the proposal.

The documentary analysis of the CCP of the LEdoC allowed us to know the principles that guide this formation, among them: critical reflection, the relation theory and practice, research as an educational principle, tolerance, respect for differences and diversity and interdisciplinarity. However, in the dialogues held in the conversational wheels, the speakers emphasized critical reflection as one of the most significant for the change in educational practice, which is why it is discussed in this work.

3.1 The principle of critical reflection

Confirming the understandings of the teachers who participated in this study, critical reflection is understood by Freire (2016) as the first condition for a professional to take a committed act, occupies a prominent

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place in the process of training the teachers of the field, since it contributes to improve teachers' lucidity about the social reality, the educational policies and the educational practice they develop.

Also, we reflect: what characterizes a critical reflection? Based on Freire (2016, pp. 53-54) we understand that these are reflections nurtured in dialogue, elaborated in depth in the analysis of social / educational problems, recognizing that reality is changeable, trying to test discoveries and, in the face of the new, not repelling "The old for being old, nor accepting the new for being new, but accepting to the extent that they are valid."

Thus, in addition to reflecting on school educational practice, as the perspective of reflective practice provides, the critical reflection proposed by Freire and discussed in this research, understands that the teacher is a critical professional who reflects on the practice, but also, on the social context in which the school is inserted, as proposed by the perspective of social reconstruction, characterized in the previous chapter.

The PCC of the LEdoC makes several references to critical reflection, according to excerpts from the document: [...] "Empowering graduates to formulate and propose solutions to" problems in the various fields of knowledge; to develop a critical awareness of the socio-historical-political reality "(UFPI, 2013, p. The graduates should have "the capacity to relate the exercise of critical reflection with the integral promotion of citizenship and with respect for the person, within the tradition of defending human rights" (UFPI, 2013, 30).

The formation of critical awareness about the socio-historical-political reality and its relationship with educational purposes contributes to evidence of the education we have, the education we want and the profile of a human being that we wish to form in order to act in society. The absence of such clarifications can erase the concept of change, so uttered today in neoliberal educational policies. It is as Pimenta (2012, 24) states when he says that "education portrays and reproduces society; but also projects the society he wants."

Through dialogue on the wheels of conversation, the teachers demonstrated that the formation promotes broad reflections on the reality in which they live, as they state in their statements:

> After the LEdoC I came to realize that society is a space of exclusion, has always been and continues to be. Whoever supports the status of the most favored classes is us, the poor and hardworking people. The rural school is a learning space for change, provided conditions are guaranteed (PROF 01).
>
> Reality is a dynamic of society and the course has helped me a lot to understand this, that our reality does not have to remain what it is today, but that it can be changed, depending on the way we act. The country school is very important; it must meet the wishes of the students. It should be inclusive and accommodating, geared to the needs of the students. The LEdoC made me understand that it is necessary to develop methodologies that favor learning, that students build knowledge, because, teaching is not transmitting knowledge, it is creating conditions for learning (PROF 04).

According to the interlocutors, the Undergraduate Course in Field Education of the UFPI of Teresina promotes critical reflections on the social reality in which they are inserted and, after their participation in this training, obtained the understanding that reality is socially unjust and dynamic, can be changed from the action of the subjects. They also point out that this perception is a result not only of the studies and practices they carry out in the course, but also of the situations of discrimination that they experience at university, as Prof 05 states: "Society is exclusive. So far in the university we have realized this exclusion. They are different looks questioning what we are doing here. "

In this respect, Contreras (2012, 182) points out that the teacher should reflect on the meaning of his practices and on the need to critically construct a new intellectual work in the service of social transformation, since, as an institutionalized practice, the education is subject to "the influences of heterogeneous groups defending interests that may be in opposition to educational values." He adds that teachers live in a world not only plural, but also unequal and unjust, immersed in pressures, contradictions and setbacks of which it is not always easy to leave, or even grasp them with lucidity. In this scenario it is important to implement training policies that foster

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critical reflections, developed through the relation between theory and practice, aiming to contribute to the personal coherence between actions and convictions that generate changes in the educational practice.

Changing practice requires broader understandings of social issues and their relation to the role of schools and the profile of educated human beings, so that teachers, understanding the power relations that are placed in society, alter the fatalistic view about it and identify themselves as subjects that can contribute to social change.

Freire (2013) argues that the know-how of critical self-reflection and the wisdom of being exercised can permanently help us to make the necessary critical reading of the true causes of human degradation and the raison being of the fatalistic discourse of globalization. In this way, awareness about the educational practice is amplified through critical reflection on the social, historical and cultural contexts in which teachers are inserted. This is what Prof 03 says when he says that "Today, I understand that the reality of society is dynamic and I am living proof of it. I do not know if knowledge is transmission, I'm not sure anymore about that. ".

What do they do, is a challenge for the progress of the LEF propositions, as, once, a new educational projects for the rural schools is needed? with capacity to organize the curriculum, considering the type of society to be built in the field and recognizing the profile of the individual to be formed to live in this space. Moreover, we are convinced of the limits of teacher training that are not applied to the transformation of society, since they agree with Moreira (1995) when he states, dissociated from a larger process of transformation, that teacher training can not be thought of as a lever for change social issues; In addition, by promoting the production and appropriation of knowledge and knows, there will be a preferential role for the less favored groups, for the practice of personal education.

The dialogues show understandings about the role of the rural school and its teachers in the construction of this new project of society aimed at the Field Education, as stated in PROF 01: The rural school is a space of learning for change.] and PROF 04: The country school [...] must meet the students' wishes. It should be inclusive and accommodating, geared to the needs of the students. [...] it is necessary to develop methodologies that favor the learning, that the students build the knowledge. According to the understanding of the interlocutors, the construction of society is also the responsibility of the school, and this should be configured as a space for the education of people to promote the changes that wish to operate within society, and must therefore meet the wishes of their subjects, as well as their training needs for life.

They point out that the role of teachers is to develop learning situations that focus on the construction of knowledge, thus necessitating conditions such as the specific training for teachers of rural schools. On this issue, Lima (2011) states that teachers need to identify the knowledge and knowledge that field subjects possess to think about development policies for where they live, as well as to work on content that is a priority in the school curriculum, all of which with the aim of promoting critical education for learners.

Thus, the (re) construction of the rural schools requires investments in the area of teacher training so that they have the opportunity to (re) elaborate their knowledge and knows and exercise them through a critical and politicized educational practice that promotes change in these institutions, which are predominantly characterized as areas of valorization of homogeneity, competitiveness and exclusion. In this sense, we reinforce the need for education systems to invest in teacher education as a positive strategy for discussing, deepening and appropriating the proposals of the Field Education so that these orientations can become practices and forms of conduct and values practiced by educators . Resolution CNE / CEB n. 01/02, Art. 12, recommends that education systems develop policies of initial and continuous training, enabling all lay teachers and promoting the permanent improvement of teachers, and in art. 13, recommends respecting the diversity and protagonism of students, educators and rural communities.

Considering the fact that we live in a society of exclusion, it is necessary that the formation of teachers be developed in a critical perspective, recognizing the school as an educational institution that should be at the service of the formation of people who think, decide, are responsible, committed and emancipated. Freire (2013) states that critical reflection helps teachers to read the true causes of human degradation. In this way, it is increasingly necessary that teacher education be based on a critical perspective, recognizing the school as an educational institution that is at the service of the formation of people committed to social causes.

It is a question of rethinking school education, redeeming its role as humanizing, recognizing its value for the construction of a fraternal, just society, which implies in overcoming the concept of school only as a space for schooling of people, an institution that, Piaui, has predominantly prioritized the cognitive aspects, to the detriment of a full human formation.

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However, many challenges need to be overcome, since "transforming schools and their traditional practices and cultures that, through retention and evasion, accentuate social exclusion, is neither a simple task nor a few" (PIMENTA, 2012, p.12). In the peasant scenario, these challenges are even greater, as it is a space marked by the absence or insufficiency of public policies in the most diverse areas, including education. Thus, critical reflection contributes to the change in the educational practice, by providing questions not only about society, education, educational practice, but also about educational policies, including teacher education, such as the area of knowledge, example of what they reflect on LEdoC:

> The other day I was thinking. The impact of leaving a high school student for the LEdoC is much higher than the exit from Fundamental to the Middle, because in Basic Education he is more supported, here we are very alone. To be a teacher, you have to be sensitive. It does not justify a teacher to reprove a student for a tenth. This is lack of humanity (PROF 01).
>
> I only think about the problems of this course and I came to the conclusion that one of the main ones is the fact that many students have an aversion to the Sciences of Nature. It adds to this the question of the majority having not had the opportunity to do a basic education of quality. Imagine the difficulty of a person who has not even learned the contents of High School and then arrives here and faces the need to learn the contents of Chemistry, Physics and Biology in just four years? (PROF 02).
>
> For many times I wonder: what were the criteria used to carry out the hiring of these teachers (referring to some LEdoC teachers). At no time was it to bring teachers with elitist and urban vision. I also ask myself: why these teachers, when they arrived at the course, did not study and seek to know this proposal (referring to Field Education) in order to develop it (expressed indignation) (PROF 03).
>
> It seems that the proponents did not also consider the fact that we field students did not have the opportunity to attend a basic education that would enable them to learn the contents of the disciplines of the Natural Sciences area with ease. Imagine our difficulty in learning everything that we did not have the opportunity and in record time (PROF 04)
>
> One of the biggest difficulties I have is learning the content because of the way they are passed on to us. I think teachers should be more sensitive. Teachers who have no ties to the field, who do not recognize the field's knowledge (PROF 05).

The teachers' dialogues point out that, when experiencing training, they make critical reflections about the power relations that permeate the field of educational policies, including training; they question the curriculum, the forms of organization of pedagogical work and the difficulties related to the field of knowledge (Natural Sciences), and especially the coherence between the training proposal and the educational practice of higher education teachers. During the conversations, and also through simple observation, we hear many complaints from academics about the insensitivity of some professors in relation to their difficulties, as well as the distance between the propositions of Field Education and the educational practice of some professionals who work in this course.

Lopes (2002) states that in higher education the teaching and learning system is predominantly centered on teachers, expository classes and assessment, which is limited to the mere verification of memorized contents, resulting in situations of student failure. In the case of the

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Teresina LEdoC, the difficulties arising from the lack of quality of the previous stages are added to these questions.

On the transition from basic to higher education, Costa et al (2014) affirm that learning processes in higher education are new and different for students, since secondary education provides guidance and materials made available by teachers, while higher education requires a greater degree of autonomy of the studies and adoption of own methods of work.

The lack of quality of secondary schools and consequent difficulties to learn the contents of the area of knowledge (natural sciences) was referenced by all teachers studied, either in relation to the absence of a more articulated transition process of a level of education to the other, or because the students did not have the opportunity to learn basic contents in basic education, the question of the course is also added to work with an area considered challenging, as reinforced in other testimonies: [...] in my high school I did not see Physics and Chemistry, because I did it was teaching, so when I got here, it was a surprise for me (PROF 02). [...] When I arrived here at the university I did not have the basic knowledge, my difficulty was this (PROF 03).

In the State of Piaui, the access, permanence and success of the students of the field in public high schools has been an enormous challenge. Data from the QEdu (2017) report that the number of enrollments at this level of education is 103,365 (one hundred and three thousand, three hundred and sixty-five), of which only 6,016 (six thousand and sixteen) are offered in schools located in the countryside, corresponding to 5.8% of the total. Data from this same information platform show that secondary education is offered in schools with poor infrastructure, since only 27% have access to public water, only 1% have access to sewage, 7% have a library and no school has a science laboratory. Added to all this is the fact that most high school teachers do not have training in the field. With regard to the guarantee of learning, data from the Basic Education Development Index (IDEB) 2017 show that Piaui was unable to reach the goals stipulated by the federal government for high school, which was 4.3, the grade obtained was 3.6.

In Maranhao state where reside the interlocutors of this study, enrollment in public schools, in the year 2017, according to QEdu, was 287,254 (two hundred and eighty-seven thousand two hundred and fifty-four) of which only 44. 188 (forty-four thousand, one hundred and eighty-eight) were offered in schools located in the countryside, that is, 15.3%. With regard to infrastructure, 44% of schools have water via the public network, only 3% have sewage, 20% have a library, 4% have science lab. According to data from the Basic Education Development Index (IDEB), in 2017, Maranhão also failed to reach the goals stipulated by the federal government for high school. The stipulated target for 2017 was 3.7, however the grade obtained was 3.4.

The educational data of these two states (Piaui and Maranhão) show enormous challenges faced by rural people, in the sense of access and completion of secondary education, with the essential learning to pursue successfully in higher education. Thus, the universalization of basic education has as limit the overcoming of the structural problems of secondary education, among them the lack of teachers, especially of the natural sciences. In addition, we can not deny that, according to the interlocutors, despite the difficulties, the disciplines of Physics, Chemistry and Biology provided much knowledge that I did not know, but today, thanks to these disciplines, I have knowledge that allows me to act as a teacher (PROF 01) . However, it is necessary for the teaching and management teams of the course to develop parallel, face-to-face and distance learning activities so that students can overcome their difficulties.

As reported by the interlocutors, in Teresina's LEdoC some teachers have a conservative practice that overestimates the learning of the knowledge of the Natural Sciences area and the reproduction of this knowledge in the evaluations, usually in written tests. In terms of performance in the course, the trainees must reach a mean of 7.0 (seven), failing which they will be disallowed in the course, as PROF 02 states: It does not justify a teacher to disapprove a student for a tenth. This is a lack of humanity. Thus, the optics of school exclusion and the devaluation of other contents, such as attitudinal ones, prevail, considering that some teachers value factual and conceptual content (ZABALA, 1998), evaluated by written test. According to Freire (2016), teachers can not and should not put themselves in a position of superiority to those who teach a group of ignorant people, but in a humble way, as one who communicates a relative knowledge (scholarly knowledge / academic knowledge) to others who possess other knowledge that are equally relevant.

A similar situation was also observed in the Field of Education course at the Federal University of Rio de Janeiro (UFRJ), where the researchers Arruda and Oliveira (2014) identified that among the challenges that needed to be overcome, the need was highlighted of the university structure classes and evaluation proposals through a differentiated curriculum, as recommended by alternation training, since the content and practice focus has been limited to the reproduction and / or appropriation

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of scientifically validated knowledge by the academy, leaving aside the knowledge of the rural people.

In spite of the difficulties, the training of teachers in the scope of the Course of graduation in Field Education of the UFPI of Teresina develops a body of specific knowledge, whose purpose is the preparation of a qualified professional to understand the historical, social, cultural and educational contexts in the which educational practice is developed, aware of the rationality that underlies its pedagogical practice.

The PPC of the LEdoC / UFPI refers to the critical reflection on the pedagogical doing as a relevant action for the change of the educational practice. This perspective deals with the propositions of Freire (2013), which includes critical reflection as one of the most significant principles of teacher education, since, through "right thinking about doing", teachers revisit the educational practice they develop - spontaneously and producer of a naive knowledge - and begin to develop a critical educational practice - based on epistemological curiosity (2013, 39). This process necessarily implies that teachers in the field reflect on the practice they already practice, as they refer to in their dialogues on the wheels of conversation.

> In general, LEdoC has contributed a great deal to my pedagogical practice. Some things I did in the past, today I do not do it anymore, because I already have knowledge acquired in the course that make me think and analyze about before and how I have to do now (PROF 01).
>
> With my participation in the LEdoC there have been some changes. Now I always try to think like I did before and how I should do now. [...] Then I kept thinking ... but I can not keep doing the same things over and over; I am rebuilding what I already knew (referring to her educational practice as a teacher) (PROF 03).
>
> I no longer accept this monthly or bimonthly proof business. Nowadays I do not have any doubts, it only serves to exclude students. After the LEdoC I started to worry more about the criteria, to criticize some instruments (PROF 05).
>
> After LEdoC I started to worry even more, especially as a teacher in the field, to develop my work according to what I am learning, because despite the difficulties we learn a lot to take to school (PROF 04).

The training of teachers, by promoting the production and expansion of knowledge and pedagogical knows and the professional area, contextualized from the reality in which teachers work, contributes to the preparation of a critical professional reflective, with capacity to analyze and change the practice development. Expressions like: "[...] Now I always try to think like I did before and how I should do now. [...] Then I kept thinking ... but I can not keep doing the same things "[...]. (PROF 03). "After the LEdoC I began to worry ..." (PROF 04) "[...] I already have knowledge acquired in the course that makes me think and analyze about before and how I have to do now" (PROF 01) were constant during the dialogues on the talk wheels.

According to their reports, participation in LEdoC formative processes and their opposition to their educational practice has promoted critical reflections on the necessary coherence between the training principles and the actions developed in the classroom, collaborating to rethink the forms of work organization pedagogical and learning assessment processes, as recorded: [...] I do not know if the knowledge is transmission, I am no longer sure of that. (PROF 03). [...] I no longer accept this monthly or bimonthly proof business. Nowadays I have no more doubts, they only serve to exclude the students. (PROF 05).

The two interlocutors mentioned above reflect critically on the current structure of the education system of the rural schools, where the educational work is developed predominantly from the transmission and storage of contents that are measured through evaluation processes in which the monthly and bimonthly evidence stand out as the main instruments used. On this aspect, we question: what logic supports educational processes that overvalue the transmission and memorization of content? Does this proposition contribute to the citizen and human formation necessary to the peoples of the countryside? Does it expand the production of knowledge and its use to solve latent problems in today's society?

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Our understanding is that the success of the curricular proposals of the Degree courses in Education of the Field need changes in the institutions of higher education where they develop, toward a paradigmatic revision. In this way, the training processes must provide critical reflections in which teachers are aware that, by adhering to this perspective (memorization / transmission), even indirectly, they value competitiveness, school exclusion, social exclusion and reinforce the interests of groups that hold greater power and privileges in society.

The analysis of the dialogues of the interlocutors of this research leads us to understand that the change in the educational practice involves critical reflections, implying the readiness of the teachers to put themselves in favor of the change and (re) learning of the teaching knowledge, especially the pedagogical knowledge, built in the daily practice, from the exercise of teaching. Ericone (2001: 43) states that "it is not the presentation of a new idea that causes change; you have to be convinced that the new one is somehow better than the previous one. " This fact explains why many government reforms designed "for" teachers are not adhered to by them; also shows that the training processes occupy a prominent place in the change in the educational practice, since they must convince the teachers that they really are necessary and important and prepare them for the execution of the other proposal.

In this perspective, Pimenta (2012, p. 14) emphasizes that "transformations of teaching practices only become effective as teachers increase their awareness of their own practice, of the classroom, and of the school as a whole. presupposes theoretical and critical knowledge about reality. " Thus, being a teacher and participating in formative processes, based on critical reflection and relationship theory and practice, broadens their understanding of the historical, social, cultural and organizational contexts in which they develop educational activities, extending the possibilities of changing educational practice.

The fact is that the LEdoC has the potential to guarantee teachers of rural schools the knowledge of teaching, fundamental to an educational practice that welcomes the interests of society, as well as the interests of the subjects involved in this process, especially students' interests. However, it is necessary that their training proposal be embraced and developed by all teachers of the course, but not only by them, as this should be a collective struggle, involving learners, their families and other social bodies and representations that fight for social justice . It also needs to be articulated with other intersectoral public policies involving universities, education secretariats, social movements and peasant populations to be strengthened in their purposes.

Summarizing the discussions on this subtopic, we note that the principle of critical reflection carried out by the teachers of the Undergraduate Course in Field Education of Teresina UFPI covers four dimensions, as shown in Figure 01.

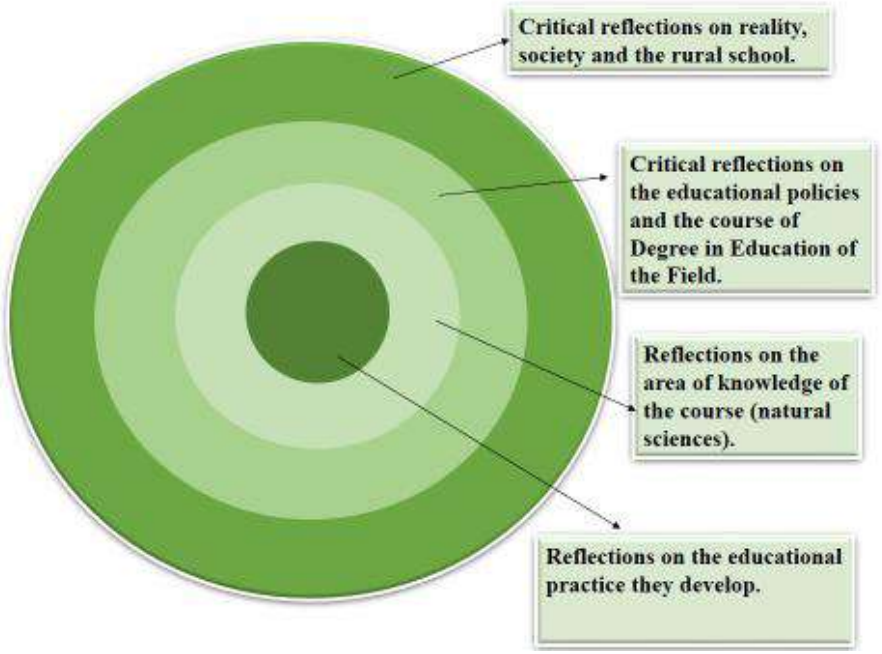

Fig.1: Dimensions of the critical reflection of LEdoC students

Source: Data of the researcher (2018)

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These four dimensions help teachers to think about the conditions they live in, to identify power relations and contradictions around public policies, to analyze the area of knowledge of the course, to know the different dimensions that characterize one's own educational practice, to recognize their weaknesses and potentialities and understand the role of their practice in the field schools.

The Degree in Field Education aims at, among other demands, the constitution of an educational practice in which teachers base their work on dialogue with critical pedagogy, with culture as a formative matrix, structured from the relation theory and practice. In this sense, self-formation, pedagogical accompaniment and orientation, and the socialization of knowledge among peers constitute fundamental actions to achieve this goal.

Thus, the study points out that teacher training needs to reach breadth and depth of knowledge so that the lessons learned by it are meaningful and take into account not only the specific knowledge of the training, but also knowledge and practices that enable teachers to understand the educational and social context in which the school and the subjects are inserted, respect and appreciation of the different cultures and knowledge, among the knowledge of the peasant culture, and the teaching commitment with social transformation.

IV. FINAL CONSIDERATIONS

The aim of the study was to discuss the principle of critical reflection as an important element for the change in the educational practice of teachers working in rural schools, after their participation in the Field Education Degree at UFPI in Teresina.

The synthesis that we are now organizing is inspired, even if at a glance, in the theoretical aspects that underlie it, without detracting from the methodological direction and the support of the data and what its analyzes have signaled about the contributions of critical reflection to the change in educational practice .

The research points out that being teachers of rural schools and being part of initial formation processes allows unique conditions for reflections on the educational practice, contributing to the expansion of their capacities to think and question their knowledge and professorial actions, seeking consistency between action and theoretical foundation of teaching. Thus, the thesis of Freire (2014, p.40) conforms to the fact that: in the formation of teachers, the "fundamental moment is that of critical reflection on practice, because it is critically thinking about the practice of today or yesterday that the next practice can be improved. "

The Degree in Field Education (LEdoC) has an innovative way of organizing pedagogical work, as well as teaching and learning. It breaks with the traditional organizational and curricular structures of higher education, contributes both to the re-signification of teacher training processes and to the (re) construction of educational practices that favor the construction of a critical view of contradictions experienced by peasant populations and reveals the capacity of intervention in this reality.

Thus, the interfaces between the curricular activities of teacher training, based on the specific knowledge of the formation and the relation between them and the knowledge of the peasant culture, produce critical reflections, contributing to the change of the educational practice.

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Extraction of bio-oil via wet based from *Nannochloropsis oculata*

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Abstract**—***Current research has shown a great interest in microalgae due to its ability to capture CO2 from the atmosphere, a harmful gas to the environment, and to store a high added value oil. However, the extraction of the oil from microalgae represents a stage of high energy demand, and it is necessary to develop a viable process in this aspect. In this context, the present work aims to extract the bio-oil from the microalga of the species Nannochloropsis oculata via humid base, in order to remove the drying step of the extraction process. For this, an experimental planning of the factorial type (3²) with two central points was used, totalizing 11 experiments for each solvent (ethanol and hexane). The variables studied in the planning were the time of application of the ultrasound and the time of extraction by Soxhlet. As a result, extraction with the application of ultrasound for 60 min, followed by Soxhlet for 8 h with hexane showed better yield (20.29%) of bio-oil. The production of bio-oil under the same conditions with ethanol was 16.83%. The lowest energy expenditure in relation to the production of 1 g of oil occurred under the conditions of application of 60 min of ultrasound and 4 hours of solid-liquid extraction. The energy expenditure was also compared to the dry and wet basis with the two solvents. In the dry base extraction, the yield was lower than the wet basis. By the analysis of GC-MS it was observed that drying influences the profile of fatty acids, reducing the percentage of monounsaturated and polyunsaturated fatty acids. It is concluded that the wet basis extraction is the best option, since drying deteriorates the bio-oil and does not influence significantly the yield of the bio-oil.*

Keywords**—renewable energy, energy, statistic.**

I. INTRODUCTION

Energy security is a concern for an environmentally sustainable economy, hence the need to seek alternative renewable energies that may have the potential to meet human needs and future environmental constraints [1]. Thus, microalgae emerge as a possible solution, due to their ability to reduce atmospheric CO_2, in the face of today's notorious environmental problems, such as the greenhouse effect [2].

They are also more advantageous when compared to terrestrial plants, since they require less water and can even reuse residual water in their growth, thus reducing their overall consumption [3].

This growing interest, due to their attractive potential in the current scenario of reduction of energy and food resources [4], also suggests another relevant feature, that they are important sources of triacylglycerols (TAGs) and high value compounds such as carotenoids and acids long-chain polyunsaturated fatty acids (LC-PUFAs) [5]. These pigments are likely to undergo rapid commercial success in functional foods, cosmetics, aquaculture, pharmaceuticals, or food technology [6].

In relation to production, this can be carried out throughout the year and can grow rapidly in a wide range of habitats under photoautotrophic conditions [7]. However, it is also important to mention that microalgae have high photosynthetic efficiency as a characteristic [8], which provides high efficiency and productivity when analyzing oil produced per unit area [9].

Thus, in light of the above, it is possible to verify that microalgae have characteristics that are very attractive from a productive, socioeconomic and environmental point of view. The specific interest of the genus Nannochloropsis is due to the ease of cultivation, a small size that allows a high growth rate, relatively mature technology for large-scale cultivation systems [10] and its high capacity to synthesize lipids [11].

Let us cite that several species of Nannochloropsis are grown successfully on a large-scale using sunlight by companies such as Solix Biofuels, Aurora Algas, Seambiotice Proviron [12]. *Nannochloropsis oculata* has been widely used because it is resistant, easily accessible and widely distributed in the oceans [13]. However, there are technological challenges to overcome, one of which is

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the optimization of the processes of bio-oil extraction to make it feasible, from an economic, environmental and energy point of view, allowing a large-scale production. It is necessary to develop energy-saving and scalable lipid harvesting and extraction processes so that the biofuel industry and algal bioproducts are prosperous [14]. For example, the extraction of oil from microalgae represents a step that requires high energy demand. For, most of the time, water removal is necessary, which makes the process expensive [15]. It is therefore necessary to develop a viable process from this point of view in order to obtain more economically and environmentally sustainable products.

Achieving the objectives of socioeconomic and environmental sustainability is to demand changes not only in the way energy is supplied, but in the way, it is used [16]. Reducing the quantity required for product delivery is thus an essential complement to the efforts of the set of energy supply and resource technologies aimed at reducing environmental impacts.

The objective of this work is to extract the bio-oil from the microalgae of the species *Nannochloropsis oculata* via humid base in order to remove the drying step of the extraction process to reduce the energy expenditure of the bio- oil from microalgae *Nannochloropsis oculata*.

II. MATERIAL AND METHODS

2.1.Farming

The microalgae strain *Nannochloropsis oculata* was maintained at a mean temperature of 288 K (15ºC) in a greenhouse in the growing room, with culture medium adapted to the methodology of [17] and [18]. In the composition of nitrate, sodium nitrate (150g.L^{-1}), iron chloride (13g.L^{-1}), EDTA (10g.$L^{-1)}$ and traces metal solution (1 mL.L^{-1}); in the composition of the phosphate solution, sodium phosphate (16g.L^{-1}) and vitamin B12 (2mL.L^{-1}); in the composition of the silica solution, sodium silicate (60g.L^{1}).

The cultivation was carried out at the Labor Engineering Laboratory, located at the Federal University of Espírito Santo, in the municipality of São Mateus, state of Espírito Santo, Brazil. The medium was prepared using seawater (water collected at sea) along with the essential nutrients, in a ratio of 1 mL of each nutrient for each 1L of microalgal culture (Figure 1).

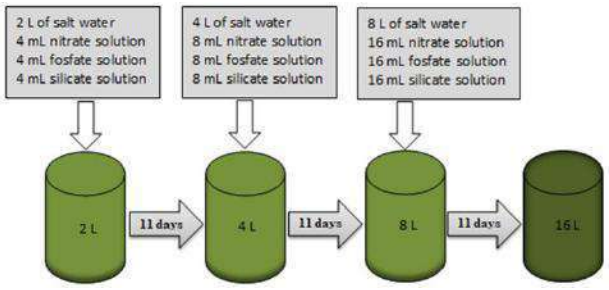

Fig. 1: Flowchart of microalgae cultivation on laboratory scale

In order to elaborate the growth curve, in an automated way, temperature, pH and luminosity sensors were used during 11 days, being the data measured, sent and stored in a spreadsheet, resulting in a database and from the execution and analysis of the growth curve was specifically defined as the 5th day as suitable for the duplication of microalgae.

The experiment was performed in a 4-gallon 16L bookcase, divided into 2 workbenches. Each bench consisted of 2 gallons exposed to 4 LED bulbs, each 18W bulb. The aeration system was carried out in an ascending and constant manner, by an air pump, which aided in the formation of a bubble column. The required power of the pump was 3.5W with a flow rate of 6L.min^{-1} (Figure 2).

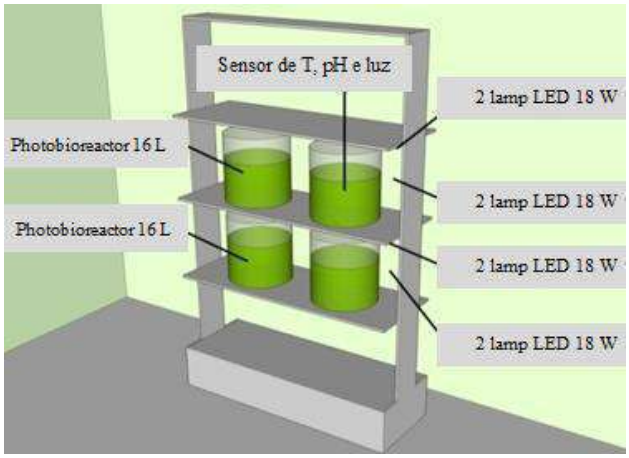

*Fig. 2: Laboratory scale cultivation bench * The increase or decrease of the microalga concentration was observed by the tone of the medium on a scale of 0 to 10, with 10 being more concentrated and 0 being less concentrated*

2.2. Separation of biomass

In order to validate the use and determination of the appropriate concentration of the Tanfloc SG® flocculant, capable of separating the microalgae *Nannochloropsis oculata* from seawater, a previous test was carried out. It was performed in a Jar Test equipment containing acrylic vats with a total capacity of 2L. In each jar of the Jar Test

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was added 1.5L of microalgae and 7.5mL of Tanfloc SG® solution with different concentrations. In the 1st well was added a solution with a concentration of 20g.L^{-1} in the second solution with 30g.L^{-1}, in the 3rd one was added 40g.L^{-1} and in the 4th one was added 50g.L^{-1} (test performed with rotation 100rpm for 10min).

After identifying the concentration of Tanfloc SG® suitable for separation, it was applied in the separation of all cultures and after flocculation a vacuum filtration was applied to remove the algal biomass from the medium.

To measure the moisture variable, the method was used until constant mass. Thus, the mass of 10g was determined and subjected to drying in an oven at 373K (100 ºC) and the masses cleared on an analytical scale until reaching constant values. Finally, these were cooled in a vacuum desiccator [19].

2.3. Extraction of bio-oil by Soxhlet

Lipid extraction was adapted as performed by [20]. 5g of algal biomass were weighed in analytical balance and transferred to a 50ml Erlenmeyer flask. Subsequently, 25ml of solvent was added and then taken to an ultrasonic bath at a frequency of 25kHz and after ultrasonication, the oil was extracted into the Soxhlet extractor.

Soxhlet extraction was performed according to method 920.39 [21], using an experimental design of factorial type (3^2), with two more central points, totaling 11 experiments for each solvent (ethanol and hexane). The variables studied in the planning were the time of application of the ultrasound and the time of extraction by Soxhlet.

After the extraction time, the flask was removed from the extractor and the solvent was evaporated in a rotary evaporator. Subsequently, the flask was transferred to a greenhouse, at 373K (100ºC) and subjected to drying (mass determination was carried out until reaching constant value). The flask was transferred to a vacuum desiccator and cooled [19]. Then, the bio-oil yield was calculated by the percentage difference between the initial and final mass in relation to the initial mass, the results of which were compared to each experimental condition in order to identify the best operational condition for extraction of bio-oil as a function of lower energy expenditure.

Finally, after identifying the operational condition with the highest yield in relation to the energy expenditure, four cultures with 64 L were performed, aiming to analyze the influence of the drying and the type of solvent in the bio-oil extraction.

2.4. Extraction by Bligh and Dyer

The extraction of the oil was also carried out by the method of Bligh and Dyer, in which it was carried out in the cold, using a mixture of chloroform, methanol and water in exact proportions. This mixture provides the extraction of all classes of lipids [22]. 15g of bio-oil was added in a beaker of 250mL was determined on analytical balance. Once determined, 15mL of chloroform and 30mL of methanol were added by stirring for 5 min on a magnetic stirrer. After, 15mL of chloroform was added, stirred for 2min. After stirring, 15mL of water was added by stirring for 5min. A vacuum filtration was then performed. The filtrate was collected on a separatory funnel, and 1mL of a saturated NaCl solution was added thereto. After standing for 24h the chloroform-rich lower phase ($CHCl_3$) was removed, rotating the phase at 33-35°C with a rotation of 50rpm for 15min.

2.5. Fourier Transform Infrared Spectroscopy (FTIR)

Samples of the obtained oils were analyzed by Fourier Transform Infrared (FTIR) spectroscopy, conducted in the 4000 to 400cm^{-1} waveband to identify the functional groups present in the material. The AgilentCary 630 FTIR Spectrometer model spectrometer [23] was used. The sample was placed directly in the hole of the crystal in which the reading of the ATR accessory occurs.

2.6. Gas Chromatography

The methylation was performed according to [24], about 40-90mg lipid mass was determined in a test tube and 4mL of NaOH (0.5 mol L -1) in CH_3OH was added. The tubes were heated in a boiling water bath until the fat globules dissolve (3-5min). Subsequently, the tubes were cooled in running water and 5mL of the esterifying reagent (NH_4Cl (10g), H_2SO_4 (15mL) and CH_3OH (300mL) were added).

The tubes were shaken and heated again in a boiling water bath for 5min and after cooling in running water, 4ml of saturated NaCl solution was added, then shaken manually. After stirring, 5mL of hexane was added with vigorous stirring and the tubes were allowed to stand for 24h and the supernatant aliquot was evaluated by gas chromatography coupled to mass spectrometer.

The components of the liquid product were analyzed using gas chromatography (GC) coupled to mass spectrometer model GC-MS-OP 2010 (Shimadzu), according to [25], with adaptations. Containing the following specifications: 333K (60°C) oven column temperature, Spitless type injection, injection temperature of 503 K (230°C), split ratio 10, flow control with linear

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velocity, column flow of 1mL.min^{-1}, helium loading gas 99.9995% purity. The furnace column started the temperature of 333K (60ºC), by waiting time of 2 min, followed by a rate of 15 reaching 408K (135ºC), for a time of 1 min, followed by a rate of 3 reaching 488K (215°C), with a holding time of 10 min. The model of the column is the DB-5 with length 30.0 m, diameter 0.25 mm, thickness of the film 0.25µm. A MS conditions, 513K(240°C) ion source temperature and interface temperature 513K(240°C), initial mass band of 40 and final 1000.

III. RESULTS AND DISCUSSION

3.1. Cultivation

It was possible to observe that in the first day the microalgal population was in the adaptation phase or lag phase, with low growth. Between the 1st and 4th day the cellular divisions occurred more rapidly, designating its exponential phase. Between the 4th and 7th day, we can see that there was a reduction of divisions and a certain stabilization between the growth rate. This behavior is characteristic of the stationary phase. Finally, the decline phase began on the 7th day of cultivation, in which it was identified by the brown coloration and decantation of the microalgae (Figure 3).

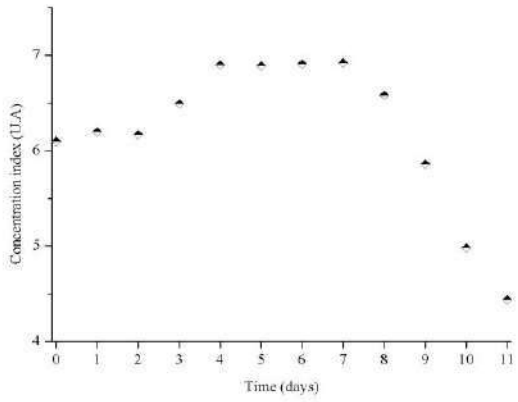

Fig. 3: With the sensing of the culture of the microalgae it was possible to obtain the growth curve from the staining of the culture medium of the species Nannochloropsis oculata

It was noted that the growth of microalgae increases exponentially until some factors begin to deplete. The concentration of nutrients is one of the most important factors, since it decreases over time in a culture medium [26]. Once all the resources (nutrients) are consumed, the cultures end up dying. Observing the growth curve, the duplication of the algal culture took place between the 4th and the 7th day, since the cell concentration reached the limit within this range and from the 7th day, the microalgae began to die. It is concluded that the amount of nutrients used in this work was sufficient for a culture time of up to 7 days. By means of the sensors, the pH was also evaluated during the 11 days of cultivation, with a variation between 7.2 and 7.6 during the whole crop (Figure 4). Therefore, the pH was favorable to the growth of microalgae, as it remained slightly basic throughout the days of cultivation, not reaching cellular enzymes.

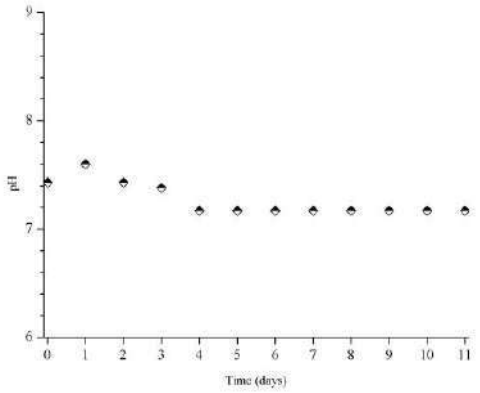

Fig. 4: pH variation as a function of the culture time obtained by the sensor

O pH is an important environmental parameter because it exerts influence on cell growth and product formation [27]. It is directly linked to the good cellular functioning of microalgae, in that sense, its control is of vital importance for the better development of the crops.

Besides the pH and concentration of nutrients, the temperature also has a direct influence on the reproduction of microalgae, as it can cause changes in many biosynthetic pathways [27]. The temperature has significant impacts on the growth rate, cell size and biochemical composition of microalgae [28]. Thus, attention on this parameter is extremely important, since it also has effects on the production of biomass.

The temperature was monitored, presenting variations between 298.5K (25.5ºC) and 290.4K (27.4ºC), such variation being not significant (Figure 5). It is observed that temperatures below 291K (18ºC) can decelerate growth, whereas above 308K (35ºC) may be lethal for most species [28]. Therefore, this culture parameter was considered adequate, since it was within the range appropriate to microalgal growth (Figure 5).

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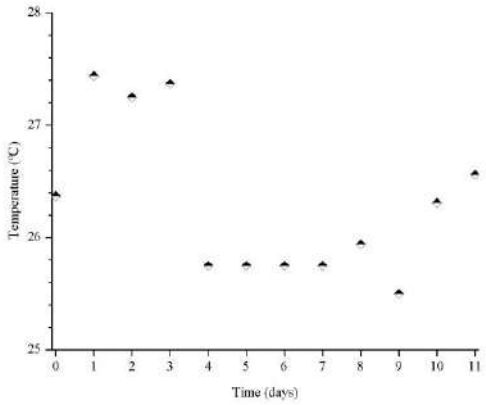

Fig.5: Temperature variation as a function of the culture time obtained by the sensor

From these analyzes it was concluded that the pH and temperature did not limit the growth, fact occurring with the decrease of the concentration of nutrients in the culture medium over time.

3.2. Separation and production of biomass

The flocculation, dedicated to the separation of the biomass from the medium, only occurred with the concentration 50g.L^{-1}. This concentration was adopted as a satisfactory condition for separation of the whole crop, and for each 64L culture, about 0.48L of Tanfloc SG® solution was consumed.

The moisture content of the sample was approximately 60% and this parameterization was performed to estimate the biomass production and to avoid errors of biomass mass determination in the experiments.

As a result, the yield of algal biomass was 88 g in 64L of culture, equivalent to a growth rate of 0.09g.L^{-1}.day. This measure achieved a productivity higher than that of other species comparatively. This is a possible conclusion from the data obtained by [29], which obtained a growth rate of 0.04g.L^{-1} day for the species (Chlorella sorokiniana, Bracteacoccus minor, Radiosphaera negevensis, Chlorosarcinopsis negevensis and Chlorococcum novae-angliae). in a photobioreactor with high levels of CO_2.

Biomass production in this work was also higher than that reported by [30], in which they cultivated the species *Nannochloropsis oculata* in open ponds during winter and spring reaching a concentration of 0.05g.L^{-1}.d^{-1} biomass.

It is important to mention that the extraction and processing of biochemical microalgae compounds requires the handling of large volumes of raw material, largely due to the small biomass / liquid ratio, typically <0.1% solids [31].

3.3. Extraction of bio-oil

In Table 1 it is possible to note the data on the bio-oil yield and energy expenditure referring to the extraction with the solvent ethanol and hexane under experimental planning conditions.

Table 1: Factorial Planning 3² Experiment planning matrix for the extraction of bio-oil by ultrasound and Soxhlet with ethanol solvent.

Experiment	Exhibition Ultrasound(min)	Extraction Soxhlet (h)	R (%)	Energy Expenditure (kWh.g^{-1}oil)	R (%)	Energy Expenditure (kWh.g^{-1}oil)
			Ethanol		Hexane	
1	30	4	11.45	7.14	17.21	4.76
2	30	6	11.62	11.11	17.25	7.14
3	30	8	11.82	14.28	17.32	9.09
4	45	4	13.32	6.25	18.35	4.54
5	45	6	13.52	9.09	18.42	6.67
6	45	8	14.15	11.11	18.51	9.09
7	60	4	15.72	5.26	20.18	4.17
8	60	6	16.21	7.69	20.26	6.25
9	60	8	16.83	10.00	20.29	8.33
10	45	6	13.58	9.09	18.41	6.67
11	45	6	13.61	9.09	18.45	6.67

For the statistical analysis of the result, the effects of each independent variable (linear and quadratic terms) were calculated, as well as the possible interactions, in the response. The determination of the significant parameters of the regression model was performed by means of a hypothesis test using the t-student distribution (significance level 5%) (Table 2).

https://dx.doi.org/10.22161/ijaers.6715 *ISSN: 2349-6495(P) | 2456-1908(O)*

Table 2: Time effects of exposure to ultrasound and Soxhlet extraction on the yield of bio-oil extracted with ethanol.

Variable Response	Factor	Effect	t(5)	p-value	Effeito	t(5)	p-value
		Ethanol			Hexane		
R (%) R²= 0.99	Average	13.85	.02	740.26	0.000	18.64	.01	2770.71	0.000
	X_1	4.62	.05	95.43	0.000	2.93	.02	171.21	0.000
	X_1^2	-0.28	.04	-7.49	0.000	-0.32	.01	-24.16	0.000
	X_2	0.77	.05	15.89	0.000	0.12	.02	7.27	0.000
	X_2^2	-0.09	.04	-2.66	0.04	0.00	.01	0.08	0.94
	X_1X_2	0.37	.06	6.24	0.000	0.00	0.02	0.00	1.00

For the yield response with ethanol, it was verified that the linear and quadratic terms of the time of exposure to the ultrasound (X_1) and time of extraction by Soxhlet (X_2), as well as the term of interaction between the variables are significant for the model, since they had a p-value lower than 0.05 (red terms). The linear factor of the time of exposure to the ultrasound (X_1) has the greatest effect and the quadratic factor of the time of exposure to the ultrasound (X_1^2) has the smallest effect on the yield of the bio-oil extracted via the wet basis with ethanol. Evidencing that depending on the type of biomass, it is desirable to pretreat the biomass prior to the extraction of the lipid.

That is, pre-treatment or disruption of microalgae cells induces the extraction of lipids, releasing them from the encapsulated cellular structures [32].

With respect to the yield of bio-oil extracted with hexane, it is noted that the quadratic effect of the extraction time by Soxhlet (X_2^2) and the time interaction of exposure to ultrasound and extraction by Soxhlet X_1X_2 were not significant for the range of determined conditions by the planning of experiments (30 min $<X_1<$60 min and 4h$<X_2<$8h). The other terms had a p-value of less than 0.05 and were significant in this study.

The linear factor of time exposure to ultrasound (X_1) has the greatest effect and the quadratic factor (X_1^2) has the smallest effect on the yield of the bio-oil extracted via wet basis with hexane. Since the statistical models for predicting the time of exposure to ultrasound (X_1) and time of extraction by Soxhlet (X_2), with significant terms, are exposed in Eq.1 (ethanol) and Eq.2 (hexane). models $30<X_1<60$ and $4<X_2<8$ and $R^2 = 0.99$ are valid.

$$\text{Yield } (\%) = 10.58 + 0.01\ X_1 - 0.38X_2 + 0.01X_1^2 + 0.01\ X_1X_2 + 0.02\ X_2^2 \quad (1)$$

$$\text{Yield } (\%) = 16.67 - 0.03\ X_1 + 0.035\ X_2 + 0.01\ X_1^2 \quad (2)$$

Analyzing Figure 6 below it is verified that the higher yield of bio-oil via wet basis with ethanol (greater than 16% relative to wet biomass) is achieved when using biomass exposure to the ultrasound for 60min and extraction in Soxhlet for 8h, being the optimal region for the production of bio-oil with ethanol from the microalgae *Nannochloropsis oculata*. And the highest yield of wet-based bio-oil with hexane (greater than 20% relative to wet biomass) is achieved when using biomass exposure to the ultrasound for 60min and extraction time in Soxhlet for 8h, being also the optimal region for the production of bio-oil with hexane.

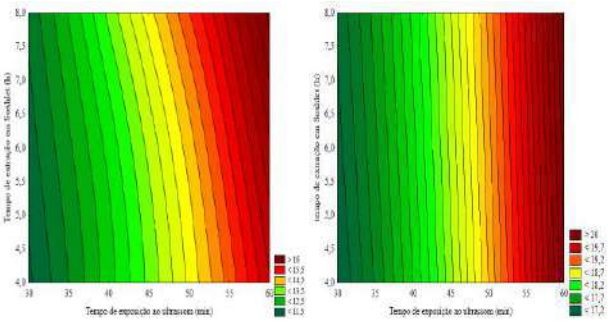

Fig. 6: Contour surface for the yield of the bio-oil wet basis using ethanol solvent as a function of the time of exposure to the ultrasound and extraction time in Soxhlet extractor.

Statistically considering the result obtained, the effects of each independent variable (linear and quadratic terms) were calculated, as well as possible interactions in the response, energy expenditure per g of oil ($kWh.g^{-1}$). The determination of significant parameters of the regression model was performed using a hypothesis test using the t-student distribution (significance level of 5%) (Table 3).

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Table 3: Time effects of exposure to ultrasound and Soxhlet extraction on energy expenditure per gram of bio-oil extracted with ethanol.

Variable Response	Factor	Effect	σ	t(5)	p-value	Efeito	σ	t(5)	p-value
		Ethanol				Hexane			
R (%) R^2= 0.99	Average	9.11	0.09	96.56	0.00	6.66	0.04	160.40	0.00
	X_1	-3.19	0.24	-13.07	0.00	-0.75	0.11	-6.94	0.00
	X_1^2	-0.40	0.19	-2.15	0.08	0.11	0,08	1,30	0,25
	X_2	5.58	0.24	22.84	0.00	4.35	0.11	40.43	0.00
	X_2^2	0.31	0.19	1.68	0.15	-0.01	0.08	-0.15	0.89
	X_1X_2	-1.20	0.30	-4.00	0.01	-0.09	0.13	-0.64	0.55

As a response to the energy expenditure per gram of oil, it was found that the linear terms of the time of exposure to ultrasound (X_1) and time of extraction by Soxhlet (X_2), as well as the term of interaction between the variables, are significant for the model, since they presented a p-value inferior to 0.05 (terms in red). It was also found that the quadratic terms of the exposure time to the ultrasound (X_1^2) and extraction time by Soxhlet (X_2^2), are not significant for the model, since they had a p-value greater than 0.05 (terms in black).

The linear factor of the extraction time in Soxhlet (X_2) has the greatest effect and the linear factor of the time of exposure to the ultrasound (X_1) has the smallest effect on the energy expenditure per gram of the bio-oil extracted via the base with ethanol.

For the energy expenditure per gram of oil extracted with hexane, it was verified that the linear terms of the time of exposure to the ultrasound (X_1) and time of extraction by Soxhlet (X_2) are significant for the model, since they presented a p-value less than 0.05 (terms in red). It is observed that the quadratic terms of the time of exposure to the ultrasound (X_1^2), time of extraction by Soxhlet (X_2^2) and interaction between the linear terms are not significant for the model, since they presented a p-value superior to 0.05 (terms in black).

The linear factor of the extraction time in Soxhlet (X_2) has the greatest effect and the linear factor of the time of exposure to the ultrasound (X_1) has the smallest effect on the energy expenditure per gram of the bio-oil extracted via the base with ethanol.

The mathematical models for predicting the time of exposure to ultrasound (X_1) and time of extraction by Soxhlet (X_2) with the significant terms are shown in Eq.3 and Eq.4. The model is valid only $30<X_1<60$ and $4<X_2<8$ and $R^2 = 0.99$.

$$\text{Energy Expenditure (kWh.g}^{-1}\text{ oil)} = 0.88 - 0.15\ X_1 + 3.24\ X_2 - 0.02\ X_1X_2 \quad (3)$$

$$\text{Energy Expenditure (kWh.g}^{-1}\text{ oil)} = 0.08 + 0.03\ X_1 + 1.11\ X_2 \quad (4)$$

In the Figure 7 shows the behavior of the estimated contour surface for the energy expenditure of biomass production, separation and extraction of the bio-oil via wet basis with ethanol and hexane. The lowest energy expenditure per g of oil extracted with ethanol was in the condition of the experimental design, which exposed the biomass for 60min and the extraction via Soxhlet for 4h, being the optimal region. And for the production of bio-oil extracted with hexane was in the condition of the experimental planning that exposed the biomass by 60min and the extraction by Soxhlet, by 4h, being the optimal region.

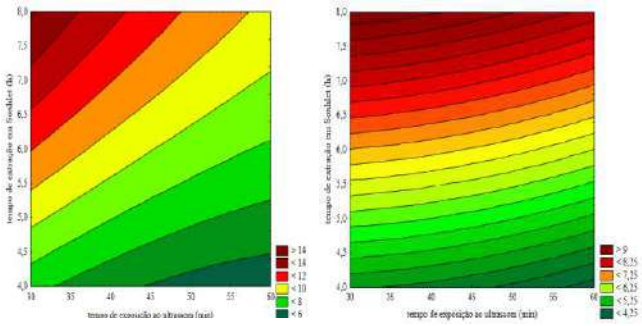

Fig. 7: Response surface of energy expenditure in the production of bio-oil via wet basis with ethanol and hexane

Thus, as in the extraction via wet basis with hexane, the lowest energy expenditure per g of oil for the production of bio-oil extracted with ethanol was in the condition of the experimental design, which exposed the biomass for 60min and the extraction via Soxhlet for 4h , therefore, it was adopted as operational conditions for comparison between wet and dry extraction with the different solvents (Table 4).

https://dx.doi.org/10.22161/ijaers.6715 *ISSN: 2349-6495(P) | 2456-1908(O)*

Table 4: Energy expenditure in the production of bio-oil for each extraction method.

Extraction method	Biomass	Solvent	R (%)	Energy expenditure
Ultrasound and Soxhlet	humid	ethanol	15.72	5.25 kWh.g^{-1}oil
Ultrasound and soxhlet	dry	ethanol	14.58	141.55 kWh.g^{-1}oil
Ultrasound and Soxhlet	humid	hexane	20.18	4.25 kWh.g^{-1}oil
Ultrasound and soxhlet	dry	hexane	19.92	101.09 kWh.g^{-1}oil
Bligh and Dyer	dry	chloroform/methanol	17.82	122.56 kWh.g^{-1}oil

In the extraction method that used the ultrasound in conjunction with Soxhlet, the yield varied between 14.58 and 20.18%. This variation in yield was due to the condition of the biomass (dry or wet) and the type of solvent. In this method the best yield occurred with and extraction via wet basis using hexane as solvent.

It may be noted that hexane is the most popular apolar solvent in oil extraction because it is relatively inexpensive and has a high affinity to the oil, exhibiting a better extraction efficiency compared to the use of non-polar solvents such as ethanol [33]. However, factors such as toxicity and damage to the environment caused by products from fossil sources need to be better investigated.

The yield of the method using the Soxhlet ultrasound was much higher than the yield [34] obtained when using only ultrasound with fresh biomass (5.7%) for 30min. They highlighted the importance of Soxhlet in the bio-oil yield. These authors also evaluated the extraction by Bligh and Dyer with fresh biomass and obtained a yield of 0.48%. Such yield was lower than that found in this work by the same method. Already [17], they obtained a superior yield (22.75%) to that found in this work by the extraction by Bligh and Dyer. It should also be noted that, in addition to the extraction methods, the culture conditions influence the storage of lipids in microalgae.

The yield of bio-oil was also compared to other methods, since [35] obtained a yield of 71.13% by supercritical CO_2 extraction and [36] by hydrothermal liquefaction (HTL), using water under high temperatures and pressures (200-350°C, 5-20MPa) yielded between 23-59% lipids. It should be noted that the yields found in this study are close to those of the authors cited.

By analyzing the energy expenditure and the yield of the methods, it can be seen that drying does not have a significant influence on the yield of the bio-oil, since the production of bio-oil was very close when using dry and wet biomass. Also, among the methods, no significant variations in yields were observed.

3.4. Analysis of the products by Spectroscopy in the Infrared Region (FTIR)

The FTIR spectra of the bio-oil samples via wet and dry basis extracted with ethanol can be seen in Figure 8a and hexane in Figure 8b. FTIR analysis was performed to compare dry base wet extraction with different solvents and to certify that the effect of ultrasound waves ruptured the cell wall.

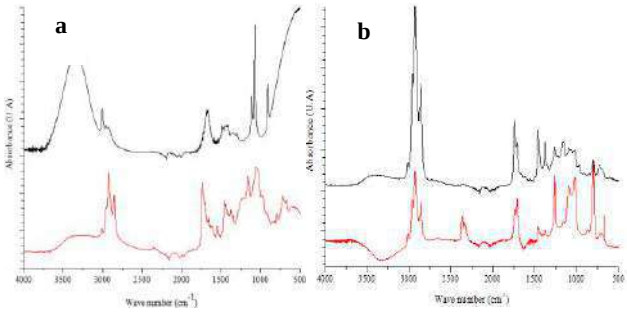

Fig. 8: FTIR spectra of the bio-oil samples via wet and dry basis a) extracted with ethanol b) extracted with hexane.

The spectra were divided in the regions of 4000 to 1300cm^{-1} (region 1), from 1300cm^{-1} to 900cm^{-1} (region 2) and from 900 to 500cm^{-1} (region 3), the 1 was pointed as a region of functional groups, where there are generally few absorption bands, which refer to the stretches of the main functional groups, such as OH, NH and C = O [37]. Thus, by the analysis of the spectra, it was possible to observe that the effect was positive due to the presentation of bands characteristic of carboxylic acids and ester. This is because the oil is a mixture of fatty acid esters of glycerol, and the fatty acids are long chain carboxylic acids [38].

In region 1 it was possible to analyze the spectrum and to identify a broad band in 3326cm^{-1} superimposed on other bands, indicating the presence of OH in the bio-oil sample and indicating the presence of carboxylic acid, water and ethanol. The OH band in the samples that have carboxylic acids always appears superimposed on the

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stretching bands of CH bonds, both those involving sp^3 carbon and those associated with sp^2 carbon. Also, in region 1 of the spectrum, a band at 1622cm^{-1}, which is attributed to the stretching of the C=O bond, confirms the presence of oil in the sample [37].

Also, in region 1, two bands are identified, one at 1439cm^{-1} and the other at 1368cm^{-1}, referring to the asymmetric and symmetrical stretching of CH_3 and also, a band at 1328cm^{-1}. [38] also cites that the CH_2 band is common in long-chain fatty acid spectra in the wavelength range at 1345-1118cm^{-1}.

Analyzing the region 2 of the sample studied, known as fingerprint or fingerprint [39], it is found that it is between 1,300-900cm^{-1}. In this region a band is observed in 1247cm^{-1} referring to C-CO-O and one in 1095cm^{-1} referring to O-C-C. In region 3, only one band at 881 cm^{-1} of the absorption of the angular deformation outside the CH plane was identified.

With the above, comparing the spectrum of the extracted bio-oil from the wet biomass with the drought, an absorption band between 3400-2800cm^{-1} higher when extracted via humid base is observed. The higher OH band, in the bio-oil sample extracted via wet basis, is due to the OH pools of water from the biomass moisture. Also, analyzing the bands in the spectra, it is noticed that the moisture of the biomass during the extraction does not alter the bonds of the molecules of the final product, since the bands referring to the groupings are identical.

Examining the spectra of Figure 10 it will be seen that the absorption bands are located at the same wavelength. This indicates that the two samples have the same functional groups. It was observed that the extractions by wet basis with both ethanol and hexane were satisfactory, since the samples had bio-oil, so an extraction was carried out following the Bligh and Dyer method as well (Figure 10).

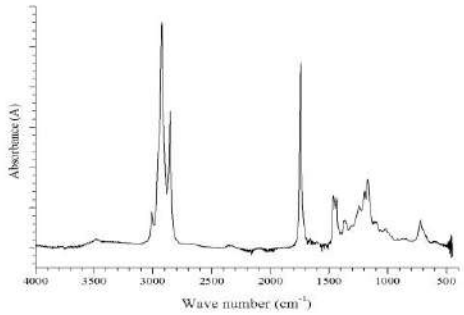

Fig. 10: FTIR spectrum of the bio-oil sample extracted by Bligh and Dyer

It is observed that it is possible to note that the groups in the sample extracted by the Bligh and Dyer method are bio-oil clusters, as well as in the hot extractions. However, the C-H uptake peaks between 3000-2800cm^{-1} and C=O at 1750cm^{-1} are very high compared to Soxhlet extraction with both ethanol and hexane.

Bligh and Dyer extraction or cold extraction was performed and analyzed by FTIR to identify possible changes in the bio-oil chains, since Soxhlet extraction is used at an elevated temperature. However, no change in the structure of fatty acid chains was observed by the FTIR spectra. It is verified that they have the same bands in all the extractions executed in this work.

3.5. Gas Chromatography

The chemical composition of the oils and fats is expressed by the fatty acids present [40]. The bio-oil obtained was analyzed by gas chromatography coupled to a mass spectrometry detector (CG / MS), in order to evaluate the fatty acid profile present in the samples in the different methods studied. Thus, considering 90% similarity for the identification of the compounds compared to the mass spectra obtained from the samples with the NIST 08 library of the equipment worked, it is noted that all products are composed of fatty acids, such as expected [41]. It is known, however, that the products differ in composition and fraction of fatty acids (Table 5).

In the composition of the extracted bio-oil wet basis with ethanol the linoleic acid (C18:2) stands out, while in the composition of the bio-oil extracted via dry base, with the same solvent, the predominance is oleic acid (C18:1) . However, the composition of the extracted bio-oil wet basis with hexane predominates the C16: 1, whereas in the composition of the bio-oil extracted by dry basis with the same solvent the predominance is C16:1.

With similarity of 90% no fatty acid C22:6n-3 (DHA) was identified. As for drying, it is responsible for the removal of a large amount of water present in the biomass of microalgae [42]. However, it should be noted that this operation may affect the quality of the product and cause lipid oxidation. In their work, [43] also showed that drying may cause changes in the fatty acid profiles of microalgae, with the double bonds breaking when the biomass is subjected to dry base extraction.

According to [44] and [45], low levels of polyunsaturated fatty acids are desired for the production of biodiesel because it reduces the need for treatments such as catalytic hydrogenation. The reverse trend is observed with EPA, whose content increases with temperature. Therefore, it is possible to obtain the content

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of the FAME classes according to the extraction process used.

Table 5: Profile of fatty acids for different methods and solvents

Tipo de biomassa	Tempo de retenção	%	Fórmula
Biomass humid Ethanol	25.03	2.10	C20:4
	25.23	3.48	C20:5
	25.82	1.14	C16:1
	26.55	17.21	C16:0
	31.77	41.34	C18:2
	31.95	27.45	C18:1
	32.55	6.78	C17:0
Biomass dry Ethanol	26.461	11.19	C16:0
	31.54	35.47	C18:2
	31.723	50.51	C18:1
	32.486	2.83	C18:0
	32.629	0.80	C17:0
Biomass humid Hexane	25.216	2.39	C20:4
	26.532	26.99	C20:5
	26.532	53.63	C16:1
	32.224	1.04	C16:0
	32.538	13.08	C18:2
	37.851	0.94	C18:1
	38.858	1.93	C17:0
Biomass dry Hexane	25.82	4.89	C16:1
	32.54	61.86	C16:0
	37.85	4.16	C18:1
	38.86	9.82	C17:0
Biomass dry Methanol e Chloroform	26.48	10.94	C16:0
	31.58	51.46	C18:2
	31.75	34.55	C18:1
	32.51	3.05	C18:0

Analyzing the fatty acid profile previously discussed in Table 5, only long-chain polyunsaturated fatty acids, such as arachidonic acid (AA 20:4), which originates from linoleic acid (C18:2) and eicosapentaenoic acid (EPA C20:5), in wet basis extraction with different solvents. Noting therefore that the biomass drying has a significant influence on the production of polyunsaturated fatty acids.

For example, the values found with wet basis extraction are close to those of [46], with a yield of 19.13±0.08 to 37.83±0.37% eicosapentaenoic acid (C20:5) of *N. gadinata*.

However, when analyzing the thermal effect on the yield value, [34] concluded that the distribution of fatty acids depends on the treatment of the sample. It is notable that the profiles are different depending on the temperatures. Generally, when the temperature increases, the amounts of polyunsaturated fatty acids tend to decrease [42].

By the composition of the samples it is also noticed that the solvent is important in the extraction of lipids, especially long chain polyunsaturated. Figure 11 shows the mass spectra obtained by the mass spectrometer model GC-MS-OP 2010 (Shimadzu), which confirms the identification of the methyl ester substance of eicosapentaenoic acid.

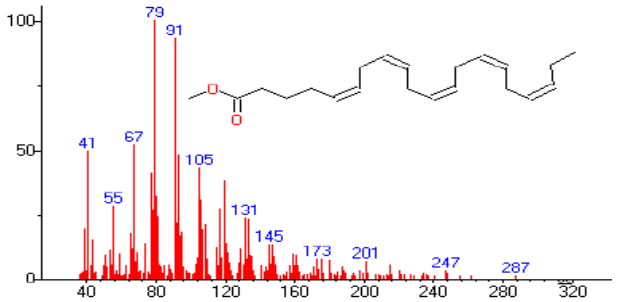

Fig. 11: Espectro de massas do metil éster do ácido eicosapentaenoico (C20:5)

However, it is noteworthy that the solvent-based extraction processes ideal for microalgae vary according to the cellular construction and chemical interactions of lipids and solvents used for extraction [47]. These techniques are capable of quantitatively extracting lipids from countless different samples. The only possible problem is the use of chloroform (toxic and suspected carcinogen [48]. Therefore, it is not feasible for large-scale applications, and some studies have investigated the use of other organic solvents such as hexane, ethanol, these solvents are highly flammable [44].

In the work of [34], they also extracted lipids with fresh biomass by the Bligh and Dyer method and ultrasound with low frequency (20kHz) without solvent for a time of 30min, which obtained 3.4 and 33.8% of C20:4 and C20:5, respectively in Bligh and Dyer extraction.

They also extracted the polyunsaturated fatty acids of type C20:4 and C20:5 with fresh biomass, with supercritical CO_2, having a yield of 0.58 and 3.59%,

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respectively [35]. Corroborating, in their study, [45] obtained with supercritical CO_2 0.60 and 4.53% of C20:4 and C20:5, respectively. Quantities lower than that found in the present study by the use of ultrasound with Soxhlet, independent of the solvent.

Comparing the profile of the fatty acids in Soxhlet extraction and Bligh and Dyer extraction, it was observed that in Soxhlet extraction with ethanol 35.47% of C18:2 was obtained, while in cold extraction the content of linoleic acid was 51.46%. Therefore, Soxhlet extraction, as well as drying influence the profile of fatty acids, breaking the bonds, and decreasing the percentage of monounsaturated and polyunsaturated fatty acids.

IV. CONCLUSION

The approach used in the present study was technically feasible for lipid extraction from microalgae cultivated via wet basis, with a significant reduction in energy expenditure. As explained, hexane allowed a better extraction of the oil when compared to ethanol under the same conditions.

The experimental study clearly demonstrated that the application of ultrasound waves in biomass, followed by Soxhlet extraction, can be used to extract lipids from moist Nannochloropsis oculata microalgae with an extraction yield similar to dry basis.

The yield of the wet basis extraction using hexane as the solvent was the largest of the other solvents and this efficiency can be justified by its affinity with oil, since both are apolar. However, the yield for the two types of solvent under the same operating conditions was close, not justifying the use of hexane over ethanol because of its toxicity.

The efficiency of the wet basis extraction with both solvents was considerably higher than the conventional lipid yield procedure if we consider the costs, the energy expended and the shorter distillation and extraction times needed used in the process the poly- unsaturated biomass cannot be subjected to excessive heat.

On the other hand, the methods that dry the biomass produce bio-oil with a higher percentage of saturated and monounsaturated fatty acids, being an important profile for biodiesel production, since the polyunsaturated chains affect the stability of the fuel, making it less resistant to oxidation.

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The 5s Program in School Spaces a Proposal For Quality Improvement

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Abstract *— In an increasingly competitive market, companies have shown a constant interest in improving their processes. In this sense, the 5S program is a tool that addresses these issues of process quality, promoting organization of spaces, elimination of waste and optimization of time. In this perspective, this study proposes the implementation of the 5S program in a private elementary school in the city of Manaus-AM, in order to optimize the spaces to improve its use, to develop a sense of organization in school employees and to promote the efficiency of quality of services provided. This research was based on the qualitative approach and used the case study as a methodology. The tools used were the 5s Program, the Ishikawa tool, the Brainstorming and a questionnaire. The result showed that the 5s program can promote quality in the processes, optimization of the physical space of the school secretariat that was the scenario of application of the program and the personal development of the collaborators.*

Keywords *— **Quality program, 5S, Quality in school.***

I. INTRODUCTION

Companies are looking for effective and easy-to-apply solutions to improve processes and physical spaces and the 5S program offers an easy and practical solution. Composed of five senses: use, discipline, organization, standardization and cleanliness.

This study demonstrates the stages of implementation of the 5S program in a private school for children, located in the city of Manaus-AM. The quality of school services was evaluated through indicators of space optimization, organization of the environment, accessibility and use of resources, based on the 5S program to guide their daily actions.

For [1] there are several quality systems that can be applied to reduce costs, optimize time and increase competitiveness. Among these, the 5S program.

The implementation of the 5S program requires the commitment of the team, that is, participate in the training, understand the proposal of the program and participate in the implementation stages. The school secretariat was the chosen place for the application of the program, since in the previous evaluation it was the chosen sector, due to the disorganized conditions of the cabinets, unidentified materials, toys mixed with expedient material, computer screen supported under a ream of paper, plastic chair inappropriate for that function the ideal would be an executive chair. The quality tools of 5S programs as a quick and effective solution to prepare and organize the secretariat that used to implement the quality program to provide a better quality in the services offered by the school.

In this sense, this work aims to describe the stages of implementation of the 5S program in the school secretariat.

II. THEORETICAL FOUNDATION

The school quality program offers a proposal to improve all processes involved in the school to provide a quality service [2]. It is important to make a prior analysis of problems and formulate solutions that will improve all sectors of the school.

The school has several sectors such as secretary, board, pedagogy, kitchen, bathrooms, sports court. These sectors need to provide a clean, organized and secure environment for teachers and students [3].

2.1 SCHOOL QUALITY PROGRAMS

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The school quality program has the purpose of evaluating the quality of school education through indicators [4]. Quality indicators are tools that accompany the system proposed by school education, are used to evaluate organizational performance and thus measure and point out possible operational failures.

Its goal is to improve the quality of teaching. Through indicators the National Institute of Educational Studies and Research (INEP), conducts research to prove the quality of teaching in schools.

The concept of quality is widely diversified for William Edwards Deming, quality means continuous improvement, that is, we can always improve a process in order to make it better [5].

In order to obtain a quality education this quality has to be evaluated at various levels and by all sectors of a school. The school is composed of a pedagogical structure, administrative, within the administrative are provided services such as cleaning, organizing, cooking, craftsman [6].

In order to evaluate the quality of the school we can use many tools, one of them are the indicators, this tool helps us to know how the quality of the processes is. The school space must offer adequate conditions, because it is where the pedagogical practice develops, the classrooms, bathrooms, canopy, library, secretariat and sports court require conditions conducive to the well-being of teachers and students.

The 5S program can be applied in schools with the aim of promoting quality and excellence in services. This program can be applied at both the administrative and pedagogical levels which will have promising effects [7].

According to the Ministry of Education, quality in elementary schools is paramount for the formation of a conscious and productive society.

The need for a program that provides the tools needed to optimize each sector of the school. The 5S program responds to this need its structuring encompasses several sectors.

2.2 5S PROGRAM

The 5S program is a tool that contributes to promoting quality in the work environment. This tool generates possibilities for improvement in the processes of production and administration. Finally, a culture of organization is created where everything is arranged in its proper place, promoting the reduction of waste and the optimization of time and space [8]. The prologue to the 5S program went to Japan in the 1950s. William Edwards Deming is developing a paper to help the census and to apply new techniques that made the job easier.

Kaoro Ishikawa professor at the University of Tokyo in May 1950 develops a proposal to contain the waste to help the reconstruction of the country devastated by war in this context he created the 5S program [9].

The five senses proposed by the program are based on eliminating waste and gaining competitive advantages in the service or product offered. In Brazil, the program was officially known through the foundation Christiano Ottoni, the pioneer to adopt the tool was the business branch, in order to avoid wastes, increasing its productivity and maximizing its profits.

The organization, besides creating a good impression, the program contributes to the productive work environment, which allows efficiency in the internal and external routine for its employees, suppliers and consumers. The 5S program is based on the following principles:

Seiri (Sense of Use): its concept is to combat the accumulation of unnecessary objects, identify and adopt measures to eliminate the excess of items to no avail. By adopting our sense, we have as responsibilities to maintain the environment only with the necessary and to avoid wastes.

Seiton (Concept of Organization): its concept is to specify a place for each object, allocating it and keeping it in its proper place. The organization is an important step to achieve the optimization of a process, the objects must be organized according to their demand of use, it is also very important to save in the right place after the use giving flow as soon as there is need to use the material again, and it will be found easily.

Seiso (Sense of Cleanliness): the concept is to have a clean environment, that brings comfort, comfort and be pleasant to its users. Each employee must keep their workplace clean and organized, be responsible for picking up the garbage, preferably separate the materials that can be recycled and reused, and promote workshops to minimize the environmental impact. Working in a harmonic environment is critical to people's physical and mental health.

Seiketu (Hygiene Sense): its concept is the preservation of health, establishing normal and adequate conditions for the well-being, adopting cleaning methods that aim to avoid infectious diseases. Dust and dirt creates an environment conducive to the proliferation of bacteria,

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food remains allows the proliferation of rats and cockroaches making the environment unhealthy and harmful to health.

Shitsuke (Sense of Self-Discipline): it is the sense that allows the person to become responsible, helps to fulfill deadlines, conducting a self-management and promoting a work of excellence for organization. It stirs up culture, reshaping ideas and behavior of people in general.

2.3 ORGANIZATION OF SCHOOL SPACE

In the organization of the school space, three dimensions must be taken into account: Physical dimension: that refers to physical space, furniture, lighting, ventilation. Functional dimension: which correspond to the various functional forms that the environment can acquire. Time dimension: the way to organize time [10]. The director must guarantee infrastructure and the conditions of a hygienic, pleasant and safe environment.

The school organization is formed by a set of interactions [11]. The waste and lack of organization, poor use of time, employee demotivation, stress are one of the main causes of decline in job performance.

The 5S program can be used as a tool to organize the school space. Providing quality in various sectors of the school and positive changes in the use of material [12].

The effects of using the 5S program are satisfactory and the implementation of this program assists and promotes the change in the behavior of students, teachers and school staff. What changes there were, after the applications of the program. more accessibility to the material plus efficiency in administrative services.

In view of all these issues mentioned above, this paper presents the proposal to evaluate the implementation of the 5S program in a private elementary school in the city of Manaus-Am. The method adopted for the development of the work was the one of research, with qualitative character.

The main tools used to improve processes in schools are the analysis of the real needs of the school and the application of the tools to solve the problems encountered.

2.4 DIAGRAM OF ISHIKAWA

The Ishikawa tool is a graphical tool that helps to manage and perform quality control in several productive processes, whose main objective is to identify the causes and effects of a given problem [13].

It was idealized by chemist Kaoru Ishikawa (1915-1989), born in Tokyo and an industrial family. He worked as a naval technician in the army (1939-1941), later in the "Nissan Liquid Fuel Company" until 1947, lectured at the same university that graduated (University of Tokyo) in engineering, in 1947 entered to the group of researchers, the Japanese Union of Scientists and Engineers (JUSE), whose principle is to research quality control (ASQ, 2019). Developed by Americans, Ishikawa incorporated and developed management concepts from Dr. William Edwards Deming and Dr. Joseph Moses Juran for the Japanese system.

Perhaps Ishikawa's most important contribution was his role in the growth of Japanese quality strategies. Which are specifically Japanese characteristics. Developing courses taken by executives and managers.

Cause and effect, known as Ishikawa diagram is an easy-to-handle tool for analyzing and developing problems (JUSE, 1962). Very important for several processes, identifying problems and how to prevent them.

2.5 BRAINSTORMING

Bainstorming is a tool used to encourage creativity, the purpose of this tool is to seek ideas to solve a problem [14]. It is a technique used in group dynamics that explores the creativity and ability of that particular group according to their interests. Braintorming is applied as a quality tool crafted as group dynamics, teamwork flows as ideas are exposed, the climate of involvement and motivation generated ensures quality in the decisions made by the group.

Alex Faickney Osborn (1888-1966) Born in the Bronx in New York, he was an advertising executive and was the creator of an important creative technique called Brainstorming. The main objective of this technique is to promote creativity in a group [15].

Brainstorming is a tool used for problem solving of a given group, promoting and stimulating creativity is selected a problem and ideas are exposed to solve this problem [16].

III. TOOLS AND METHODS

The methodology used to carry out this work was a descriptive case study of a qualitative approach. It was developed with a field research that describes the proposed implantation of the 5S program in a school of Infantile Teaching in the city of Manaus-Am. It focuses on identifying situations, events and organizations as a

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type of research for qualitative research. In this approach, all the facts and phenomena are significant and relevant, being worked, mainly, through questionnaires, observations, data collection and case studies.

In this case what are the steps of applying the 5S program in a kindergarten? The collection period was from April to June 2019. This period covers the bibliographic survey, and the proposal for the execution of the program in the school.

The work carried out the following steps: Diagnosis of the situation, formalization of the research, pre-implantation research, through a questionnaire, meeting with employees, lecture about the 5S program, choice of the sector, proposal for implementation and compilation of the data.

The diagnostic stage of the situation was an on-site visit to evaluate the situation of the school in relation to its physical spaces. The formalisation of the research through the authorization of the school with the direction, for the pre-implantation research was used a questionnaire containing five closed questions. The implementation of the program followed the following steps as shown in figure 1 below:

Fig. 1: Steps of the 5S Program Implementation Process

The main methodological tools used to support the implementation of the plan were: Data collection, through the questionnaire of closed questions, the use of the tool of the cause and effect diagram, following the method of Ishikawa, Brainstorming.

3.1 DATA COLLECTION THROUGH QUESTIONNAIRE CLOSED QUESTIONS

The objective to apply the questionnaire is to identify the knowledge of the employees in relation to the 5S program. Because it is a study tool that facilitates an indirect approach with employees, the questions are based on their experiences with the quality tool.

For this, five closed questions were elaborated, which approached the knowledge and interest of the tool, the informant chooses his answers according to the three options, objective, although narrow the freedom of the answers, makes the researcher's understanding easy. The questionnaire was the main instrument in this study and is found in the annex.

With the questionnaire, the booklet was presented (in an annex) guiding the essence of the research, its particularities and the necessity of the program for the school, expressing the interest of the collaborators, so that it responds and returns within a pre-established period.

3.2 APPLICATIONS OF THE ISHIKAWA TOOL

We use the Ishikawa Diagram quality tool to identify which unwanted results. The process works to assess the degree of user dissatisfaction. Figure 2 show Ishikawa, the purpose is to describe the cause and effect of the problem found in the teaching service.

Fig. 2: Cause and Effect Diagram

3.3 BRAINSTORMING

In the meeting Brainstornig was presented, to awaken the creativity of the collaborators, the concepts of the dynamics were to explore ideas related to some problems, so the participants could interact exposing their opinions, letting them flow, without criticism. After the debate, the ideas were clarified according to the author's point of view, avoiding the emergence of interpretations. The proposed ideas were annotated so that they could be evaluated and revised, eliminating duplicates. By consensus among the participants, we exclude non-purpose ideas and those selected, the most variable should be registered in visible places such as: painting, poster, etc.

3.4 CASE STUDIES APPLIED TO SCHOOL PROCESSES

Since the objective is to answer questions that are characteristic of a specific context, the approach chosen to conduct this research is qualitative, this type of research seeks to answer very particular questions on a level of reality. For the qualitative approach to be based on the dynamic relationship, all facts are important,

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mainly through the questionnaire, booklets, observations, ethnographic studies and case studies.

Functional spaces in countries like Japan are quite common to have a process standardization.

The secretariat is an important functional space of the school. The secretary is responsible for student documentation, files and processes as well as the issuance of letters, issuance of statements and certificates.

The case study studies an event in action and is defined by recognition rather than by theoretical definition. Besides observing and describing, it is necessary to analyze, give opinion, so that the reader knows that the opinion of the researcher is being given and that there may be other inferences.

Therefore, considering the objectives of this research and that there is no intention to generalize results, but contribute to the knowledge and understanding of a specific context, promote reflections and decision making, this study is characterized as a case study.

3.5 CHARACTERISTICS OF THE STUDY APPLICATION SCENARIO

It is a private kindergarten school, located in the eastern part of Manaus-AM, which has been in education for twelve years. He currently has twenty-eight students and eight collaborators. The microenterprise is family run, and operates in the morning and evening periods, has adequate infrastructure and didactic materials according to its teaching proposal.

Mission: To provide excellent teaching to its students through invocation and interactivity. Vision: To meet the needs that the teaching scenario requires. Values: Commitment, respect, solidarity, creativity, providing quality services to the community in general.

IV. PROPOSAL FOR THE IMPLEMENTATION OF THE 5S PROGRAM IN SCHOOL OF CHILDREN'S EDUCATION

It was contacted that the school does not have a quality program. For this purpose, a proposal for the implementation of the 5S program was elaborated, in order to highlight the benefits and benefits that the tool provides to the work environment.

4.1 PLANNING

The action planning steps of the proposal to implement the 5s program in the school were:

Step-1 Diagnosis of the Situation: The diagnosis was made with an on-site visit where all sectors were observed, and the information noted for the formulation of the action plan.

Step 2 Research Officialization: After the formalization of the school to participate in the research was scheduled a date to return a meeting with all school staff to present the project. This meeting had the objective of arousing the employees' interest in the 5S quality program.

Step-3 Pre-implantation research: A questionnaire was applied with all the employees of the school to evaluate if the school already had a quality program, to investigate if the employees know about the 5S program, were questioned about improvements in the work environment and their pre-disposition to future changes.

Step-4 Meeting with employees: After the questionnaire was completed, a meeting was scheduled with all employees to define which sector the program would be applied to.

Step-5 Lecture about the 5s program: A lecture was distributed with the distribution of booklets for the employees highlighting the fundamentals of the 5S program and how it will be applied in the school. The importance of the lecture is to train multipliers of this quality program. The use of printed educational materials to share knowledge is common practice in quality programs. Manuals containing content of the 5S program, leaflets and booklets are able to promote expressive results for participants in educational activities.

Step-6 Choice of the sector: After the lecture a meeting was held where a vote was proposed to choose in which sector the 5s program would be applied. The sector chosen was the secretariat, as it was quite disorganized. A group dynamics was performed using the Brainstorming tool where the employees put their ideas to solve the problem of the secretary's disorganization, the ideas were filtered and after that a point was made.

Step-7 Deployment: the deployment proposal.

4.2 EXECUTION SCHEDULES

The timeline is the graphical arrangement of the time that was spent in the execution of the project, according to the activities to be accomplished. It serves to assist in the management and control of this work, allowing a quick visualization of its progress Figure-3 Execution schedule.

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Stage	Assignment	Period	Responsible	Status
1	Diagnosis of the situation	April	Researcher	Completed
2	Research Officialization	April	School management	Completed
3	Pre-deployment research	May	Researcher	Completed
4	Meeting with employees	May	School management	Completed
5	Lecture 5S	May	Researcher	Completed
6	Industry choice	May	Workers	Completed
7	Proposal	June	Researcher	Completed

Fig. 3: Execution schedule

4.3 STAGES OF IMPLEMENTATION OF PROGRAM 5S

A lecture was given explaining in detail the 5S program, the importance of the tool for the work environment, guiding the implementation stages to the employees according to the need, in the scenario of the secretariat. The resources used for this talk were: Data show, sound box, microphone, notebook.

SEIRI- Sense of Use - To get the good sense of use we have to organize the material of work and separate the unnecessary things and directs them to where they can be used, conserving the materials useful.

The proposed sense of use was divided into two stages: recognition and action.

1st stage recognition: in this stage a diagnosis was made in the registry in order to identify objects that do not have utility for this sector and separate them according to their classification: donation, repair, recycling or disposal.

Step 2 action: In this stage was presented the school's management a list of materials not used in the secretariat. The management was responsible for forwarding the material for donation, repair, recycling or disposal.

SEITON- Sense of Organization - To reach this sense of organization we have to organize the materials that will be used most often always available in a suitable place. The well-organized material avoids the act of looking for what is a waste of time. Thus, the ordering of this material optimizes the time by improving the quality of the secretarial work.

In this phase the sector will be organized based on the definition of specific space for each object, the objects and places where they should be stored, identified with labels, thus promoting a standardization and facilitating the access of the employees to the materials and also improving the flow in the work with this will not waste time looking for the objects or the files because they are tagged and flagged.

SEISO- Cleaning Sense - Preserving the clean working environment is essential for quality of life, as a healthy environment promotes health and well-being. The concept is to show employees that keeping the office clean, guarantees quality in the service offered and that when receiving new employees, suppliers and students the environment is pleasant and free of impurities, which can hamper the development of the routine of tasks.

SEIKETSU- Hygiene Sense - The prevailing thinking in this stage is: For quality to be standardized and looked after. Health and well-being are important to maintain quality in the secretariat's services. It is also important to take care of mental health and promote a harmonious and quiet work environment caring for interpersonal relationships at this stage is also important, avoiding extravagant behaviors, which compromises good fellowship with co-workers.

SHITSUKE- Self-Discipline - The practice of this sense is based on maintaining the concepts acquired with the 5S quality program to implement this phase was given suggestions to the secretariat staff:

- Separating organic waste from recyclable;
- Comply with the norms established by the "5S";
- Delivering deadlines and dates of delivery of tasks and tasks;
- Properly wear the uniform;
- Greet everyone in a polite manner;
- Respect and talk whenever there is a difference of opinion;

Shitsuke is important to maintain the 5S program because with self-discipline the employee can maintain the quality of the services provided by the secretariat and practice this quality program on a regular basis.

V. ANALYSIS OF RESULTS AND INDICATORS

The 5S program proposal provides an analysis of the results when implementing the quality tool to achieve the objectives proposed by the researcher. The purpose of the implementation proposal is to maximize the teaching service and eliminate the problems encountered according to the cause and effect tool.

In the secretariat was identified a great flow of employees, a positive aspect, since we can solve in a practical way the problems encountered. With this the following senses were proposed: SEIRI (Utilization), SEITON (Organization), SHITSUKE (Self-discipline).

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Figure 4 below shows the registry of some places proposed for deployment:

Fig. 4: Places proposed for deployment

SEIRI (sense of use): Identify objects with labels, to avoid the act of searching and wasting time, because they are labeled and flagged.

SEITON (sense of Organization): Separate necessary materials, keeping only the materials useful. Recycle bin with organic and recyclable waste identification to facilitate pickup and keep the environment clean.

SHITSUKE (sense of self-discipline): To have quality you need to standardize, take care of mental health and interpersonal relationships is important at this stage. Having good habits and adapting to change are key to deployment.

In the study it was identified that the school does not do any satisfaction research with the employees and clients, it was suggested that the manager apply a research before the implantation so that we could measure the degree of satisfaction of before and after in relation to the school environment. All the proposals have been accepted, but will be implemented during the holidays. By June is the holiday month and the end of the semester, it would not be possible to implement. Even considering the 5S program of low cost and easy application, it was not possible to implant in this period. After implementation, continuous improvement in the secretariat sector is expected.

VI. FINAL CONSIDERATIONS

The implementation of the 5s program seems to be easily applicable in organizational environments, however, experience has shown that it is not enough to execute the senses at random, it is necessary planning, commitment and change of habits within the organizational system. It can be said that the implementation of the 5s program becomes complex because even if it is necessary, people still have difficulties adapting or are not willing to change. Thus, the staff must be in agreement with what this quality program proposes to perform, as deep changes in attitudes and behaviors are required, focusing on improvements in the organizational processes that will occur only with the effective participation of all employees of the company. organization.

Therefore, since it was a small school and without many financial and personnel resources, after a meeting with the management of the school, it was decided to propose the implementation of only three of the senses of the 5s program, SEIRI, SEITON and SHITSUKE, since the other two senses, SEISO and SEIKETU, would bring greater expenses, the school did not have these resources.

It is hoped that with the implementation of SEIRI, the school will develop a sense of conscientious use of expedient materials, discarding the unnecessary and adopting measures to combat waste, managing to keep only what is necessary in its work environment and thus generating economy expenses with these record materials. With the implementation of SEITON, the objective is to optimize space, organizing the materials and furniture in order to obtain a more pleasant environment, streamline the flow of people and facilitate access to documents, folders and records.

With SHITSUKE, the development of the sense of responsibility, commitment and organization of the employees of the school is desired. This sense needs to be worked out with employees, since all other senses need willing, motivated, and active people to execute them.

It is important to highlight the contribution of the school to this study through the consent and information provided, making feasible the proposal to implement the 5s program. Likewise, it is necessary to emphasize that the implementation of quality programs are necessary for the continuous improvement of organizational environments and that only through work and joint effort can it be possible to abandon old habits and obtain organizational and personal development.

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Applying the Lean Concept through the VSM Tool in Maintenance Processes in a PIM Manufacture

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Abstract*— *Lean concepts were usually focused exclusively on the manufacturing areas, leaving aside administrative areas. However intense competition has led many organizations to begin to realize that these concepts would also be beneficial to competition with the implementation of lean thinking in their offices. This study addresses the Lean Office theme, a derivation of Lean Manufacturing. The vision of the Lean concept of identifying and eliminating wastes enables improvements in the flow of service call handling at a manufacturing plant in the Manaus Industrial Pole - PIM, using the concepts that were initially developed for manufacturing, making adaptations to the administrative areas, preserving the essence of the concept and applying lean thinking to improve the flow of care. For analysis of the current state through Value Stream Mapping -VSM, timing and 5S Concept.

Keywords*— *Value Stream, Lean Thinking, Lean Office.

I. INTRODUCTION

After the Second World War, the Japanese of the renowned Toyota saw that it was necessary to create an orderly process of finding and eliminating waste in a decisive way, aiming at productivity and becoming more competitive, adopt Lean Manufacturing, a methodology for production improvements and efficiency in companies, inspired by the Toyota Production System. According to the history, the bibliography presents the lean concepts directed only in the manufacturing areas, leaving aside the administrative areas.

However, the constant dispute in the market led them to begin a perception that Lean concepts would also be useful in the competition with the implementation of lean thought and its application in the administrative areas, being called Lean Office.

The company in the segment of white lines with its sector and maintenance that acts in the service of technical services in the conservation of equipment and machines have been presenting a great waste of time and information. With this scenario, the environment is favorable for Lean Office deployment, using the holistic vision of the Lean Office to identify the waste and possibilities of improvements in the flow of maintenance calls at a Manauara factory in the white line industry.

II. THEORETICAL FOUNDATION

A survey of theses, case studies, and books with themes related to the present work were constructed. We conducted research and reading with textual considerations with the purpose of absolving the work context, favoring a detailed view of the current state in the sphere of research for subject matter. It can develop an important theoretical basis to carry out the analyzes that are indispensable in the following activities. The main concepts will be presented captured from this research process, being of maximum relevance for the accomplishment of the work.

2.1 LEAN MANUFACTURING

When Lean philosophy emerged it had as its priorities the manufacturing environments, focused on combating the wastes that were seen and physically known in manufacturing [1]. The initiative of the search for the elimination of waste that is of no value to the customer is aimed at transferring speed to processes based on the Toyota Production System, which in the 50s through the executive Taiichi Ohno created and implemented a production principle where its priori was find the waste and eliminate, with the main objective to reduce costs and increase delivery time while maintaining product quality for the customer, this system became known as Lean

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Production, produce more with less. Following the origins of Lean Manufacturing the essence of Lean Manufacturing is the reduction of 7 (seven) wastes: defect (in product), overproduction (overproducts), stock (products in standby), processing (unnecessary), transport (unnecessary of machines), waiting (of the employees for processing equipment and / or previous activity [3].

The effects of improvements in the manufacturing area have raised the need to take these lean concepts to the administrative areas, but to migrate this concept has required more attention in the identification of waste because they are not tangible. In the administrative areas most of the activities being generated of information consist of complexity in their identification. In the offices how to identify a wait? It can be identified as a report waiting for an analysis that may also have another wasted stock, already produced and stopped waiting for analysis. The Lean Office [4] or the Lean Office are applications in the administrative areas with the intention of improving these processes using the principle of lean thinking in the accomplishment of non-physical activities, since in this case a flow of value of information and knowledge, its focus is to eliminate the costs of these processes of the organization, in order to guarantee the leaner operation of the business [5]. In order to improve processes, the Lean concept can be applied from small businesses to multinational companies, because perfecting the processes is the solution to improve the organization's productivity and performance, this realization may be possible using the Lean concept [6].

2.2 VALUE STREAM MAPPING - VSM

Value Stream Mapping (VSM) is a business strategy tool where you can and can see the whole of the process. Properly showing the opportunities for improvement in each stage of the process. Performing Value Stream Mapping is also able to identify delays and bottlenecks in activities in the process stages [7]. With this it is possible to be able to understand which are the phases that do not add value in the process, with this vision to present a current state of the process, where each phase and its activities are described in detail so that the possible wastes in the process can be analyzed [8].

The future state is presented with the improvements [9], where one of the most important purposes allows to go beyond individual improvements, a systemic form. The appropriate tool to look at the processes of value association horizontally, emphasizing the activities, actions and their connections in order to indicate value and makes it run from the suppliers, the beginning of everything and including the final customers. The industries have different production capacity variations per operation, finding which of these processes are the most difficult and their impact on the outcome at the end, thereby adapting the information they need to more effectively manage the industry and the process as a whole [10].

Using the Value Stream Map (VSM), there are benefits that make it possible to more accurately find the various activities and interests that do not add value in the process. Eliminating these wastes brings greater productivity to the process, allowing the company to be more flexible and competitive.

2.3. CONCEPT 5S

The concept of 5S aims to improve the organization as a whole by means of easy-to-conceive fundamentals and the ability to present significant results [11]. It is a tool based on simple concepts and that can bring great benefits to organizations, the principles of 5S is based on 5 (five) Japanese words with the initials that names the program are the words: Seiri being the sense of Use, Seiton sense of Organization, Seiso sense of Cleanliness, Seiketsu the sense of Self-discipline. The Sense of Use (SEIRI) denotes applying materials, tools, equipment, data sensibly and with good judgment [12].

In order to reject or reallocate everything considered unnecessary to carry out the activities, the effects of the use of the Sense of Use are promptly demonstrated with space utilization, favors cleaning and maintenance of the site, improved inventory control, reduced costs and favored environments for the good use of the other senses of the 5S program.

For [13] Organization Sense (SEITON) considered so that all things are available so that they are within easy reach for immediate use, standardization through labels, panels, shelves and furniture that facilitates and improves practical and fast reach . With this reduced time, easy access to tools, reduction of expendable and unsafe points.

Sense of Cleanliness (SEISO) a very specific sense in the elimination of dirt and residues, objects that are foreign or dispensable to the place. Maintain floor cleanliness and furniture. This sense of cleanliness goes beyond the physical aspect, involving the personal relationship, preserving a work environment with transparency, justice, sincerity and consideration, this sense results in healthy local, accident reduction, better tool conservation and improved relationship.

Sense of Standardization and Health (SEIKETSU) set lighting standards, colors. Locating boards among others that can be standardized. Its results are to facilitate the localization with identification of objects and tooling,

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good physical and mental sense, focus on the improvement of common areas and safety.

Sense of Discipline or Self-Discipline (SHITSUKE) achievement and individual commitment with previous senses. Combined ethical and moral standards of each person. Fulfill activities without the presence of leadership. The effects are daily activities performed pleasantly, valuing the implementation of functional and administrative methods [14].

2.4 ANALYSIS OF TIMES AND METHODS

For decision of the Standard Time of an operation it is necessary to discuss with the ones involved the method of work to be executed, seeking the collaboration of those involved in the process [15]. Determine the method of operation and divide the operation into elements, carry out training with those involved to carry out the work according to the defined method, make necessary notes for observations sheet for final improvements, organize a schematic representation of the product and the location perform a preliminary timing with time sampling to obtain the data needed for analysis, perform the timekeeping and decide the mean time (TM). Measure the operation rhythm factor and set the normal time (TN), yield tolerances for fatigue and personal obligations, allocate the measured data in control chart to examine its quality, set the standard time of operation (TP) . For [16] chrono-analysis is advised when the precision of the activities (process) is to improve productivity, to achieve in detail what happens in the process, authentic process capability, balancing action, inefficiency targets, mutual influence between activities of work and waste of time [17].

III. TOOLS AND METHODS

Due to the difficulty that the team was facing to improve the attendance of maintenance calls, a study of the current situation was started. The administrative of the sector was in the external part of the Manufacturing, the person responsible (call center), for receiving the calls and registering the Maintenance Orders (OM), example in Figure 1, this administrative team all away from the Manufacturing, the employees responsible for executing the so-called technical team were in manufacturing pending the Oms.


MAINTENANCE REQUEST

In_____Building

In Room No._____

Nature of Work Required: _____

Date_____

Signature

WORK COMPLETED

Date_____

By_____

FORM 35A SCHOOL SERVICE, INC.

Fig. 1: Sample Maintenance Request Form, Source: [18].

The OMs were requested by telephone, radio or by e-mail to the call center, which registered in bases: (excel, sap and backlog) in the system for the indicators to generate the indexes, the supervisor waited for release of the excel worksheet by the call center . With the spreadsheet released he distributed to the technical team, with the OM sheet in hand the technical team checks the material to be used and the appropriate tools for the execution of OM.

Technical team moves to the service location, performs the service and returns to the maintenance sector with the OM completed, due to the administrative sector is far from the maintenance sector, the completed OMs are archived, these have not been closed in the worksheet nor in the system that generate the indicators, at the end of the day the OMs were still open generating an indicator with service not performed by the sector, Figure 2 shows the software used.

Fig. 2: Example of Maintenance Control.

The backlog is a time indicator that is used in Maintenance Management, it measures the accumulation of pending completion activities. Delay in finalization generated an unfavorable indicator for the sector, this

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does not mean that necessarily all the activities that make up the backlog are delayed and this generates a bit of conflict. To evolve the processes it is necessary to understand all the procedures of the organization mapping, measuring and recording, then the best tactic must be identified to reach the goal of improvement.

With the help of the VSM, shown in Figure 3, the entire process was mapped, its activities in details of the call, service provider to the final customer, making it possible to identify the delays and bottlenecks in the service activities, understand where and what activities do not add value in the process. This way you can make the necessary improvements in the flow.

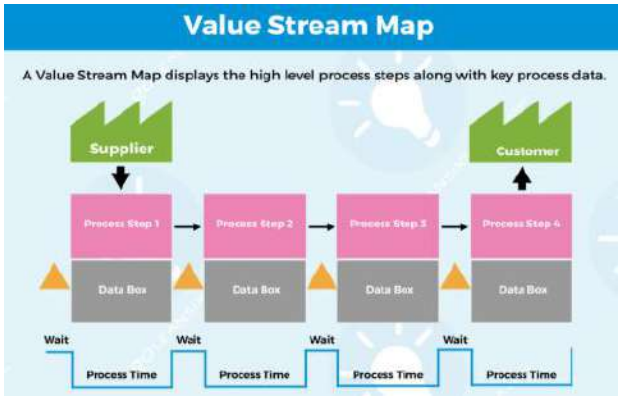

Fig. 3: Example of VSM, Source: [19].

In order for the service to have adequate improvement, timing of the steps was performed with the technical team involved, in order to standardize and train the team to perform the service according to the best method for carrying out the activities. Time samples were taken from each step of the activities and recorded for future analysis, as in the example of Figure 4, chronoanalysis was used.

Process Capacity Sheet	Approved by: R. Quan	Part # 25-59001			Application JN-01		Entered by: Wayne Xi	Date May 08, 2007
		Part name Base Unit			Number of parts 1		Line Machine Shop #2	
Step	Step name	Machine #	BASIC TIME MANUAL	AUTO	COMPLETION	TOOL CHANGE CHANGE	TIME	PROCESSING CAPACITY/SHIFT	Remarks
1	Cut	C100	6	32	38	500	2 min.	720 p	
2	Rough Grind	GR100	7	12	19	1,000	5 min.	1,440 p	
3	Fine Grind	GR200	7	30	37	200	5 min.	724 p	
4	Measure Diameter	TS100	8	4	12	—	—	2,325 p	
		Total	28						

Fig. 4: Example of timing sheet, Source: [20].

The flow of the product through the production lines must be controlled so that the programs are fulfilled on the dates previously established. The standard operating times

Provide the Production Control with the means to calculate the time required for the manufacture of the product, as well as the coordination of labor, material and equipment [21].

In his work [22] he considers chrono-analysis as the method used to time and perform analyzes of the time that an operator takes to perform a task in the productive flow, allowing a time of tolerance for the physiological needs, possible breaks of machinery, among others. An example of chronoanalysis is shown in Figure 5.

		Queue	Booth
General Clinic	Mean	00:06:22	00:02:09
	Std. Deviation	0.00187	0.00073
	Minimum	00:00:00	00:01:06
	Maximum	00:10:19	00:05:15
Specialty Clinic	Mean	00:03:32	00:01:05
	Std. Deviation	0.00310	0.00039
	Minimum	00:00:00	00:00:32
	Maximum	00:10:16	00:01:50

Fig. 5: Example of Chronoanalysis, Source: [23].

According to [22], the use of chronoanalysis is indicated when there is a need to improve productivity and to understand in detail what occurs in the production process. Through it it is possible to identify the inefficient points of the process as well as the wastes of time. This makes it easier to carry out a process improvement study and increase productivity.

After an exhaustive attempt to improve the service, a planning of the construction of the sector for maintenance was requested alongside the tooling to allocate the next administrative team of the technicians team, place with warehouse, rooms, tools and equipment for corrective, preventive and predictive maintenance . Implemented the 5S with the administrative team, technicians and managers in the new area aiming to install only what was necessary for the daily activities and schedule of the sector.

Team of Technicians and Administrative Staff with the support of managers to conduct a study focused on improving the handling of maintenance calls resorted to Lean Office. In order to have maximum understanding before starting the project, a training was conducted with those involved in the project, directing the knowledge of the Lean concept and aiming maximum use of the tools, that the gains with the information be reversed in attitudes that facilitate the implantation, encourage them to be continuously exercised.

IV. IMPLEMENTATION OF VSM IN THE COMPANY

For the implantation of the lean thought in the administrative area a work team was formed, composed by: the own collaborators of the area, a Champion in Lean Office and a Master Champion.

https://dx.doi.org/10.22161/ijaers.6717 *ISSN: 2349-6495(P) | 2456-1908(O)*

Scheduled team meeting involved in the study of the current situation with experts in lean thinking, so that a plan of activities could be traced, to start the study was carried out by the champion the training to knowledge of the application and necessary tools and disseminate the knowledge of the methodology Lean.

4.1 LEAN OFFICE

Training with the team involved in the project so that everyone can have the vision of how an administrative environment can be identified and optimized, informing the tools used to apply lean office concepts, fundamentally the VSM tool and Timing. The seven wastes that need to be seen in the mapping to be eliminated or reduced: Super Production, Waiting, Transport, Misfeed, Stock, Unnecessary movement, Defects, Creativity Void

For the planning phase were traced and divided into steps with their respective responsible: Prerequisites, initiation, development, completion and closure. Where reported on how the identification of the problem was conducted.

4.2 USING THE VSM

Using VSM as an instrument to analyze the current state of the process of handling maintenance calls that were having difficulty managing open orders, delayed execution, waiting to perform services, accumulation of orders completed, delayed delivery of completed orders to closure, steps that needed to be improved and VSM being the tool that helped identify the activities that were wasted and those that need to be improved in reducing lead time in care. Figure 6 shows a portion of the VSM of the current process.

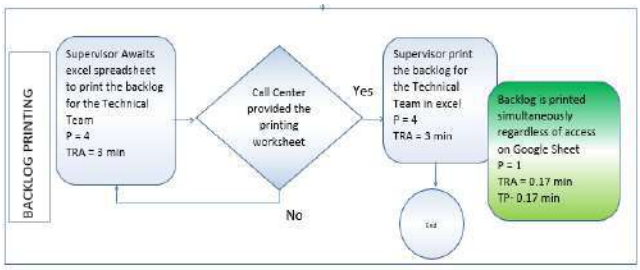

Fig. 6: VSM Current State of Service Process

The concepts of lean mentality become direct skills for employees and this sharing concept are benefits that reduces waste, the team with the vision Lean can see the wastes in the flow.

Based on the observations of the activities and how they were being carried out, it was possible to identify some problems.

In principle, it was seen that those involved did not have a well-defined routine, waiting to send the services generating several wastes such as waiting, transport, incorrect processing, unnecessary handling, defect and zero creativity.

4.3 CHRONOMETRATION

In order to verify the time, a timing was made to measure the current state and how the calls were being performed, the time used from the time the call was received to the OM closing. Identify possible waste in the current process.

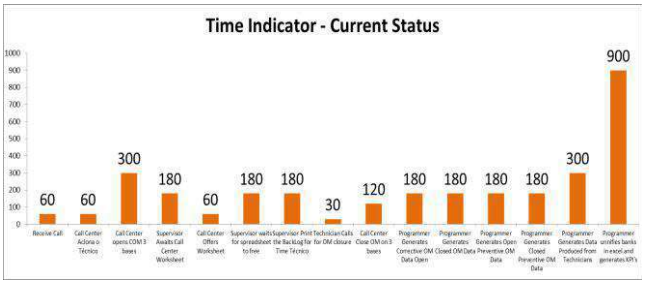

Fig. 7: Current Status Chart

After measurement it was observed that the current state time was high causing the indicies to be out of the sector target.

4.4 USE OF 5S IN THE IMPLEMENTATION OF VSM

The sector received an area with strategic location within the manufacturing, this was one of the stages that hindered the attendance - displacement and time, so that the new place has facility in preparation for the attendances.

The 5S implementation was extremely important in order to organize the new area, valuing the execution with functional methods and making the environment pleasant, with the individual commitment of the team.

V. DATA ANALYSIS

Made the timing of the activities to be based on the time used in the proposed process (future). Follow up of the call center receiving the call and registering the OM until the execution and closing. The scenario: future state.

After measurement it was found that the state of the future state was reduced, so the measurement indicators were in the sector target. The result shown in Figure 8 was time eliminated at the closure of the OMs, bringing a gain of time in the overall process.

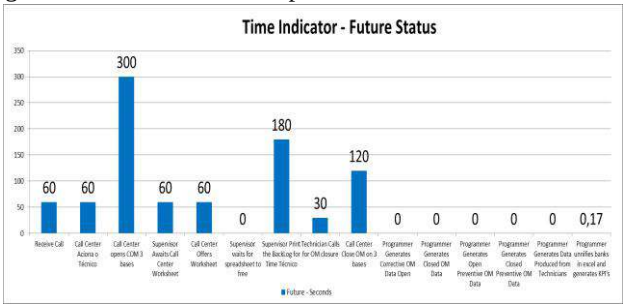

Fig. 8: Future Status Chart

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Mapping of the Value Stream (VSM), followed the process from its beginning to the final phase, that is, from the request of the customer, the arrival of the service and its closing, going through all the stages where the activity is developed until completion, which is the attendance, conclusion and closure. Made the presentation of the current state, drawn to the proposal of the future state as it should ideally be with its due improvements shown in Figure 09. Backlog could be printed simultaneously regardless of access to google sheet, in that phase of the flow we eliminated the waiting time of the team, call center closes the OMs in the bases (excel, sap and backlog) and all the indicators are generated in google sheet, in this phase of the flow we eliminate the time that the programmer had to compile the data for the indicators. Gain of 34.9 minutes. 73% reduction in ART. Reduction of 13, for 7 activities. Gain of 75% Lead Time. Reduction 8 people for 6 people involved.

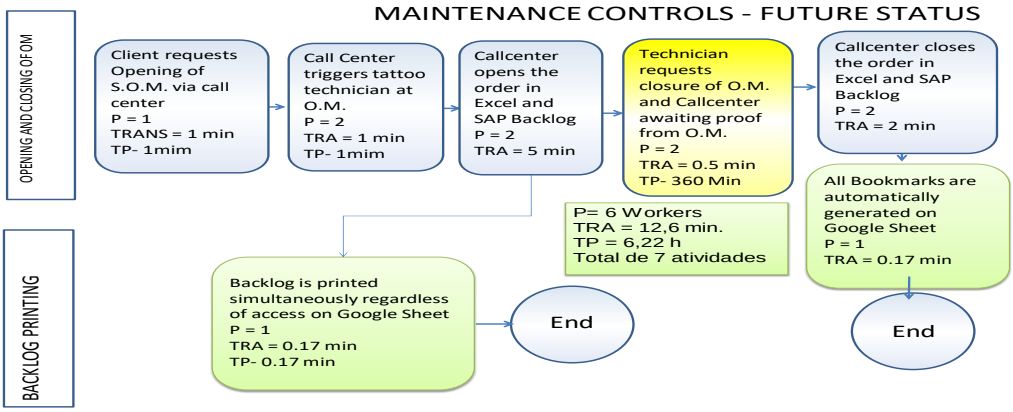

Fig. 9: Value Flow Mapping - Future State

The backlog is a logarithm that discloses the workload in a given period. It is possible to calculate in which periods of the year the maintenance team will have a higher or lower service action. The Sector is responsible for maintaining and conserving so as to sustain conditions according to specifications, making a systemic action to meet the objectives.

Indices of occupation of the Technical Team and their respective activities, the results reflect in cost reduction, employees with the availability to better develop their activities, satisfied operating environment and developing their activities with reduction of interruptions. Equipment and machines with performance and useful life more applied. Trained employees, hygiene and safety at work, a combination of technical and administrative actions designed to maintain, relocate and install and even make modifications to equipment and machinery when necessary.

Reliability Index of a specific machine To achieve productivity with efficiency and with a reduced number of interventions, working preventively, aiming to meet the availability and reliability of the operational equipment following the planning of both the organization and the sector itself, controlling their costs for equipment, analysis of occurrences and abnormalities of equipment and machines, control of performance indicators, standardization, updated history of equipment and machines. Figure 10 shows reliability tracking.

Fig. 10: Reliability Tracking

Sector responsible for generating operational conditions for equipment, machinery, facilities and services to work correctly, to be able to achieve goals and objectives of the organization serving customers at reduced cost and without quality losses. Maintain the life of the equipment by managing the costs through appropriate maintenance systems.

VI. FINAL CONSIDERATIONS

The study carried out to improve the handling of maintenance calls where we used the Lean Offce as a basis for design, had to overcome the lack of knowledge of lean thinking in the administrative areas, where the team considered that the concept only served Manufacturing. After the Lean Office training, the team was motivated with the knowledge of the concept for the administrative areas and determined to create favorable conditions for the implementation of the project.

By presenting the analyzes carried out, one can make sure that the planning of implementation of the lean office

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in Maintenance follows the main literary recommendations for the area of knowledge. In the course of the implementation were made the appropriate adjustments and adjustments in the method and following the guidelines of literature and research can affirm that the team was able to assimilate and disseminate the knowledge of the Lean Office in the sector and to be able to comment, the other sectors how much the concept of benefits, with the data of their presented results.

The industry had its indicators checked and the Lean Office was indicated for other projects, because the team assimilated so well the concept that could identify where the Lean Office could be deployed, became the base for the administrative projects. Champion's challenge for the team to retain lean thinking in their administrative areas and to promote improvement continues to cultivate a change-friendly environment with the holistic vision of the Lean Office.

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Application of a Model in the Evaluation of Competitiveness in Sustainability in Factories of the Pharmaceutical Sector

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***Abstract*—** *The competitive scenario for companies has been changing over time, by increasing competitiveness in terms of cost, quality, reliability, agility and, more recently, environmental issues. The aim of this paper is to evaluate the sustainability competitiveness of companies in the pharmaceutical sector by applying a model that relates the adoption of lean manufacturing practices and practices in environmental management in production processes. The model grouped the companies into clusters, distributing them in quadrants according to the quantity of produced waste and residues in their manufacturing processes. It was applied to a sample of 32 pharmaceutical processing industries in Brazil, in the states of São Paulo, Rio Grande do Sul and Paraná. The work is classified as applied, exploratory and qualitative and the survey method was used in order to collect data. The results show that most of the companies surveyed (53.13%) adopt practices for waste and residues reduction in their manufacturing processes, promoting to these companies a competitive differential in reliability of delivery, flexibility, quality and cost of their products. Thus, this research contributes to the pharmaceutical companies, giving them a better understanding of their competitive state in sustainability, from the adoption of practices in lean manufacturing and environmental management in their manufacturing processes.*

***Keywords*— Competitiveness, Environmental management, Lean Manufacturing, Pharmaceutical industry.**

I. INTRODUCTION

The search for improving operational efficiency has been a vital requirement for companies that wishes to stay alive in a competitive market. The performance improvement in production processes has been one of the many strategies applied by companies in order to stay competitive in our increasingly globalized market (ALVES, ALVES, 2015). Furthermore, the pursuit of leadership is often an ambition of most companies in the Market nowadays. In past times, one of the conceptions of business leaders was to have their profit at maximum level, without concerning for other important factors to the final customer. A few years ago, these concepts changed, then for a company to reach the level of leadership, it is necessary to provide other conditions which go beyond profit and cost reduction, such as: increase in the product quality, reliable supply and service, increase the speed of deliveries, and activities related to pre-sale and after-sale (AGOSTINHO, 2014). These new conditions represent great challenges for companies. In this way, manufacturing itself has an important role in this complex and competitive environment. One approach that manufacturing can have, in order to play the leading role in the competitiveness of companies, is to relate and apply projects of lean production and environmental management in their manufacturing processes themselves. Therefore, it is necessary to have a greater sense of sustainability that implies a decrease in waste and residues and provides a better visibility of added value for the market. To overcome these challenges, many manufactures are focused on lean manufacturing. Thus, manufacturing contributes to the competitiveness of companies with the reduction of waste in their manufacturing processes (BHAMU; SANGWAN, 2014). Environmental management is another important issue in this analysis of competitiveness. Environmental protection and improvement are the new key strategies of companies for competitiveness nowadays (JORGE; MADUEÑO; MATINEZ-MARTINEZ; SANCHO, 2015).

In this scenario, this paper aims to present a classification and a competitive evaluation of companies that implemented lean manufacturing and environmental management in their manufacturing processes. The research was performed using a sample of 32 companies in the pharmaceutical industrial sector. According the 2018 annual activity report from Sindusfarma, there are 427 factories producing medicines for human use in Brazil. The logistics chain in the pharmaceutical sector in Brazil consists of suppliers of raw materials,

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manufacturers of medicines (manufacturing industries), distributors, and consumer markets (hospitals, health centers, pharmacy networks, etc.). Then, the research presented in this paper has its outline in medicine manufacturers.

The present work is classified as applied, exploratory and qualitative, and the survey was used in order to collect data through the application of a research questionnaire.

To reach these objectives, this paper initially presents a relevant bibliographical context, addressing aspects related to lean manufacturing, environmental management and competitiveness. The exploratory analysis with the discussion of the results of the research is done through the data resulted from the application of a model that related competitiveness to the adoption of practices in lean manufacturing and practices in environmental management in the production processes (RODRIGUES; AGOSTINHO, 2018). For the classification, the method used in this paper grouped companies into clusters for lean manufacturing and environmental management and attributed a correspondence with competitiveness.

The contribution of this research comes from the assumption that there are not much scientific literature that relates the competitiveness of pharmaceutical companies with adoptions of techniques of lean manufacturing and environmental management in the manufacturing processes.

II. LITERATURE REVIEW

The market is the major driver of internal changes in companies and it plays an important role in terms of external pressure on the innovation process, overcoming organizational inertia, stimulating creative thinking and mitigating management problems.

The starting point is to address the competitiveness of companies within their marketplace and thereby enable companies to expand or keep a sustainable market position on a sustainable basis, with the ability to continually review their competitive strategies(AGOSTINHO; BATOCCHIO; SILVA, 2008). In order to obtain a good competitive performance in its market, a company may reach a good performance internally, reconfiguring its internal and external competences (HART; DOWELL, 2010). Internally, through the determination of their competitive capacities, with the effectiveness of the flow of values throughout the processes of transformation (SILVA and FONSECA, 2010). Companies that adopt the structure of resource productivity, achieve external competitive advantage in cost, product quality, reliability, production rate and flexibility of product and process, aiming to adapt to customer needs (SINGH; GARG; SHARMA; GREWAL, 2010, JABBOUR, JABBOUR, GOVINDAN, TEIXEIRA, FREITAS, 2013, FULLERTON, KENNEDY, WIDENER, 2014, BÜYÜKÖZKAN, KAYAKUTLU, KARAKADILAR, 2015).

Companies implement lean manufacturing in order to keep their competitiveness against their competitors by improving the productivity of their manufacturing systems (ROHANI and ZAHRAEE, 2015). Lean manufacturing is one of the support elements to achieve productivity and then competitiveness (KOVACH; STRINGFELLOW; TURNER; CHO, 2005). The adoption of practices in lean manufacturing by companies, in manufacturing processes, aims to reduce waste and the activities that do not add value (CUA; MC KONE; SCHROEDER, 2001; SHAH; WARD, 2003; LANDER; LIKER, 2007; PIL; FUJIMOTO, 2007; SINGH; GARG; SHARMA; GREWAL, 2010; DÜES; TAN; LIM, 2013; JABBOUR; JABBOUR; GOVINDAN; TEIXEIRA; FREITAS, 2013; WALTER; TUBINO, 2013; ROOSEN; PONS, 2013; ROHANI; ZAHRAEE, 2015). In processes, waste and activities that do not add value to products lead to decreased productivity and increased manufacturing costs (ABILAASH; ARAVINTHKUMAR; SATHISHKUMAR, 2016).

The practices in lean manufacturing that lead to the reduction of waste and the activities that do not add value refer to: (i) just in time and pulled production system (CUA;MC KONE; SCHROEDER, 2001; SHAH; WARD, 2003; HOPP; SPEARMAN, 2004; SHAH; WARD, 2007; DÜES; TAN; LIM, 2013; WALTER; TUBINO, 2013), (ii) reduction of inventories in process (KING; LENOX, 2001; HOPP; SPEARMAN, 2004; DE TREVILLE; ANTONAKIS, 2006; JABBOUR; JABBOUR; GOVINDAN; TEIXEIRA; FREITAS, 2013), (iii) production in small batches (CUA, MC KONE, SCHROEDER, 2001, SHAH, WARD, 2003, DE TREVILLE, ANTONAKIS, 2006), (iv) reduction of the variability in the manufacturing process (HOPP, SPEARMAN, 2004, DE TREVILLE, ANTONAKIS, 2006), (v) autonomation with processes free of errors and defects (KING; LENOX, 2001; DE TREVILLE; ANTONAKIS, 2006; ROTHENBERG; PIL; MAXWELL 2009; WALTER; TUBINO, 2013), (vi) continuous improvement (CUA;MC KONE; SCHROEDER, 2001; SHAH; WARD, 2003; TOWILL, 2007; WALTER; TUBINO, 2013), (vii) reduction of the set-up in the operations (CUA; MC KONE; SCHROEDER, 2001; SHAH; WARD, 2003; SHAH; WARD, 2007; WALTER; TUBINO, 2013) and (viii) reduction of the manufacturing

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lead time (HOPP; SPEARMAN, 2004; SHAH; WARD, 2007; DÜES; TAN; LIM, 2013). These practices are achieved with the application of a variety of tools such as heijunka, six sigma, kanbans, first in first out (FIFO), value streaming mapping (VSM), takt time, single minutes dye exchange (SMED) and five-S principles: these tools are vital components to define the lean culture (ROOSEN; PONS, 2013).

Lean manufacturing provides low-cost production, faster production speed, flexibility and reliability to the manufacturing processes. In this way, manufacturing reaches competitive outputs in cost, quality, reliability, speed of production and flexibility of products and processes in order to be adaptable to the needs of the customer (SINGH; GARG; SHARMA; GREWAL, 2010; JABBOUR; JABBOR; GOVINDAN; TEIXEIRA; FREITAS; 2013, ROOSEN, PONS, 2013, FULLERTON, KENNEDY, WIDENER, 2014, BÜYÜKÖZKAN, KAYAKUTLU, KARAKADILAR, 2015).

According to Dias (2017), "[...] cost, quality of products and services, level of quality control, human capital, technology and capacity for innovation are elements that, when interlinked, dictate the level of competitiveness of companies. Recently, environmental management has been strongly inserted in this context due to the competitive advantages of its application ". In essence, lean manufacturing aims to keep value within companies, maximizing productivity by reducing waste in their manufacturing processes (ROOSEN, PONS, 2013).

Bánkuti and Bánkuti (2014) affirm that environmental management becomes a strategic factor for companies due to the globalization and the care with the environment.

When it comes to strategy in the environmental management, the economy versus ecology struggle should be eliminated as the adoption of environmentally correct practices is not related to the mere increase in costs (PORTER, VAN DER LINDE, 1999 apud BÁNKUTI; BÁNKUTI, 2014, p. 173). There are many benefits that come along with a corporate environmental management, such as cost optimization of the used resources, profit increase due to product innovations and market share increase, improvement of the company's image, product portfolio increase, among others (ORSATO 2002 apud BÁNKUTI; BÁNKUTI 2014).

According to Andrade (1997) apud Bánkuti; Bánkuti (2014) for companies to adapt to the standards of competitiveness, contemplating environmental postures needs, they need to establish three stages of strategies: (i) reactive strategy: taking into account environmental legislation and targeting environmental aspects as costly and without financial return; (ii) offensive strategy: seeking to be ahead of competitors in relation to the optimization of pollution and environmental resources, not only those imposed by law and then obtaining a competitive advantage; (iii) innovation strategy: preventing environmental impacts, seeking environmental excellence, renewing products and processes involving environmental issues and corporate strategy.

According to Medeiros et al. (2015), "... companies that implement the environment as a competitive advantage need to adopt an environmental management model, since the strategy itself cannot ensure competitiveness. When a company adopts a socio-environmental strategy, it establishes a political decision that involves the whole organization, involving its principles and values throughout its manufacturing process, leading to a risk reduction in the production process. This strategy is good when it eliminates the risks exploiting the opportunities and recovering the deficiencies. "

Environmental management allows possibilities of value and competitive advantage through public understanding and cost savings, reducing damages to the environment due to manufacturing processes. Furthermore, it brings benefits when using clean technologies (Porter, 1992 apud MEDEIROS et al., 2015) and generates a differential factor of competitiveness, since with its protection to the environment, that will lead to positive results for future investments (MEDEIROS et al., 2015). Environmental performance has a direct and significant influence on the competitive performance of small and medium-sized enterprises (SMEs), according to studies performed by Jorge; Madueño; Martinez; Sancho (2015). Environmental preservation has been recognized as a competitive advantage by companies (ALVES; ALVES, 2015).

According to Dias (2017), it is possible to mention some competitive advantages that are perceptible when environmental management is applied, such as: (i) the environmental performance and a more effective growth; (ii) the use of environmental requirements in order to develop product design, making it more adaptable to manufacturing process; (iii) reduction of energy generator devices use, resulting in a reduction of the manufacturing costs; (iv) reduction of raw material costs and/or production resources; and (v) the use of renewable materials, reducing the use of energy due to their recycling processes.

Practices in lean manufacturing and environmental management are synergistic when the goals are the

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reduction of waste and inefficiencies. In the manufacturing processes of companies it is possible to develop a management system that involves both principles of lean manufacturing and environmental principles (ALVES, ALVES, 2015). This will lead companies to a better performance in the markets (YANG; HONG; MODI, 2011).

The Fig. 1 illustrates a synthesis of the literature review, which relates the practices in lean manufacturing and environmental management to the competitiveness of companies, taking into account the reduction of waste and residues in manufacturing processes.

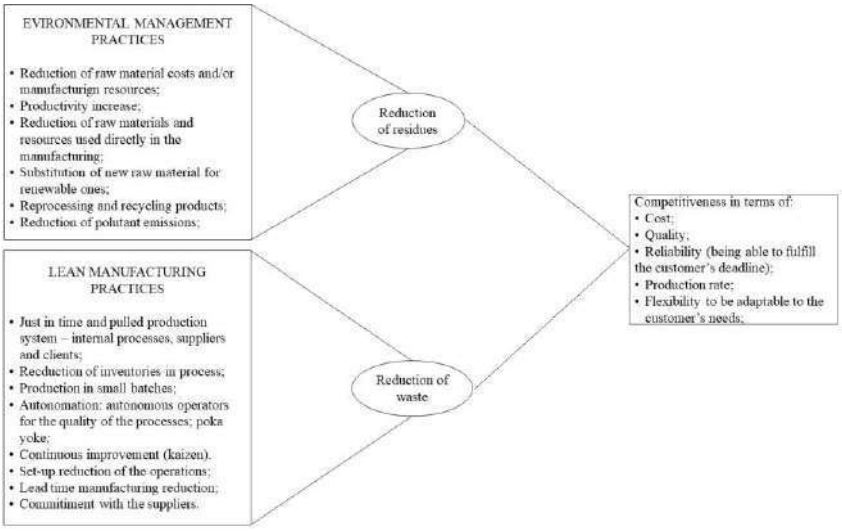

Fig. 1 - Summary of theoretical reference: practices in lean manufacturing, environmental management and competitiveness

Lean manufacturing practices reduce waste and activities that do not add value to processes inside companies. Environmental management practices result in reduced waste and limited use of manufacturing resources. In this context, from the perspective of manufacturing, these two concepts are complementary and lead companies to gains in their competitiveness.

III. METHODOLOGY

The model applied in this work is based on the conceptual construction developed by Rodrigues and Agostinho (2018), which relates the adoption of lean manufacturing practices and practices in environmental management taking into account the manufacturing system to achieve competitiveness in a company's sustainability, as shown in Fig. 2. The model integrates the concepts of lean manufacturing and environmental management and aims to evaluate manufacturing companies as being more competitive from a sustainability perspective, reducing waste and residues in their manufacturing processes.

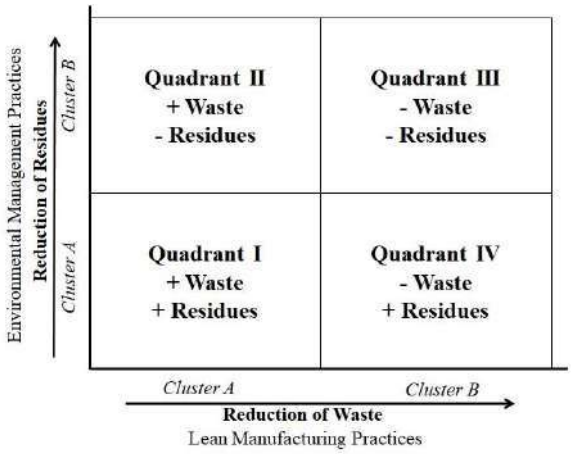

Fig. 2 - Model: environmental management practices and lean manufacturing practices. Critical factors of competitiveness in sustainability. Source: adapted from Rodrigues and Agostinho (2018).

The application of the model agglutinates companies in clusters that conjugate similar practices in lean manufacturing and environmental management.

On the axis of environmental management practices, Fig. 2, the companies grouped into cluster B produce less residues in their manufacturing processes while cluster A companies produce more residues. The same approach is done to the axis of lean manufacturing practices: the waste in the manufacturing processes of the companies

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grouped into cluster A is smaller than it is in the companies grouped into cluster B.

The definition of which companies belong to each cluster is the result of a grouping analysis. In this case, each company was identified as an object. The cluster analysis is an exploratory data analysis, which provides an empirical and objective method to perform object classification and characterization (JR, HAIR, 2005). It aims to organize the data by dividing them into groups, or classes, making the understanding and interpretation of them easier. The variables are the questions that constitute the questionnaire applied to the respondents of the pharmaceutical companies.

In the groupings of pharmaceutical companies, the variables identify the internal practices adopted by the manufacturing system in management of lean manufacturing (two clusters - A and B) and environmental management (two clusters - A and B). For each variable (question) the Likert scale is applied, with values between 1 and 5. This scale requires respondents (interviewed) to indicate their degree of agreement or disagreement with statements to the factors measured.

The technique of non-hierarchical grouping was used for the formation of the clusters, this technique belongs to the multivariate statistics for data grouping analysis field (JOHNSON; WICHERN, 2007). Non-hierarchical grouping techniques are designed for groups of objects in a set of k clusters. The number of clusters, k, can be determined before or during the clustering process. In this model, for the constitution of clusters of pharmaceutical companies we specified the value of k as 2.

The collected data at the interview stage were fed in the statistical software Python in order to perform the grouping of them into clusters.

From the formation of clusters in environmental management (k = 2) and management of lean manufacturing (k = 2), the companies (object) were allocated in the respective quadrant defined in the model. The main goal was to identify which companies were allocated in cluster B for environmental management practices and lean manufacturing (cluster III), cluster A for environmental management practices and lean manufacturing (cluster I), cluster A for lean manufacturing practices and cluster B for environmental management (quadrant II) and finally which companies were cluster B for lean manufacturing practices and cluster A for environmental management practices (quadrant IV).

The results of the exploratory analysis of the features of the companies in environmental management and lean manufacturing into quadrants are presented in section 5 of this paper. Before the results are presented, a presentation of the methodology used in this paper is presented in section 4.

IV. RESEARCH METHODOLOGY

The methodology developed in this paper is important to demonstrate the logical sequence (step by step) of the research development, as shown in Fig. 3. The architecture of the methodology is divided into seven stages:

(i) Elaboration of the applied questionnaire, with questions distributed in the groups of environmental management and lean manufacturing;

(ii) Selection of the companies in the sample;

(iii) Field survey (data collection through questionnaire);

(iv) Clustering the pharmaceutical companies into clusters,

(v) Exploratory analysis of the companies allocated into the quadrants, done by the adopted model, in relation to the implementation of lean manufacturing and environmental management (Fig. 2);

(vi) Results and discussions and

(vii) Conclusions.

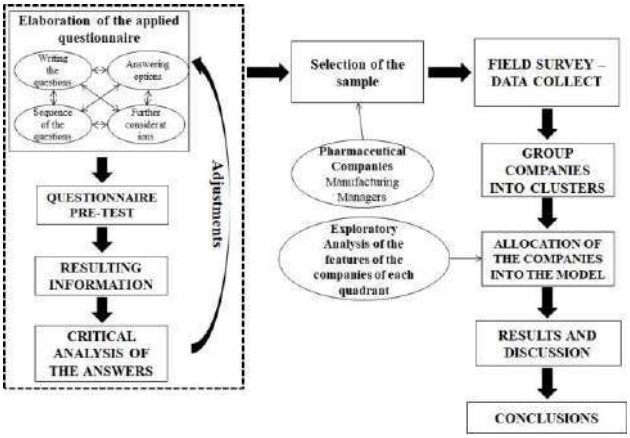

Fig. 3: Step-by-step of the study.

The questions that compose the questionnaire are the variables for the exploratory analysis of the results. The variables and their respective groups are identified in the Chart 1. The variables that characterize the environmental management were named as Environmental Preservation System (EPS), Environmental Strategy (ES), Product Project (PP) and Manufacturing Process (MP). For the management of lean manufacturing the variables were

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named as Customers (C), External Suppliers (ES), Just In Time (JIT) and Autonomation (A).

Chart 1: Variables of the questionnaire – pharmaceutical industries.

	Variable	Code of the Variable	Practices
Environmental Management	Environmental Preservation System - EPS	P7 – P12	- continuous improvement in environmental management; - environmental legislation; - visual management;
	Product Project - PP	P13 – P22	- recycled materials; - raw materials; - consuming of natural resources; - manufacturing lead time; - residues and pollutant emissions;
	Manufacturing Process - MP	P23 – P35	- environmental management and manufacturing process; - manufacturing lead time; - recycled material; - environmental criteria and selection of suppliers;
	Environmental Strategy - ES	P36 – P45	- pollution prevention and competitiveness; - investment; - environmental improvements in the long term; - strategic management;
Lean Manufacturing Management	Just In Time - JIT	P46 – P67	- pulled production system; - kanban management; - family of products; - visual management; - setup; - takt time;
	External Suppliers - ES	P68 – P78	- relationship with suppliers; - pulled production system; - qualifying criteriacritérios;
	Customers - C	P79 – P85	- demand forecasting; - relationship with customers; - just in time; - performance KPIs;
	Autonomation – A	P86 – P93	- assured quality in the process; - poka yoke; - autonomy; - autonomous maintenace;

V. RESULTS – EXPLORATORY DATA ANALYSIS

The data collected from the questionnaire that 32 pharmaceutical companies (object) answered loaded in the Phyton statistical software in order to define cluster A and cluster B for practices in environmental management and lean manufacturing. The clustering results are shown in Fig. 4. The clustering process allowed the allocation of the companies in the quadrants, as defined in the model adopted according to Fig. 5.

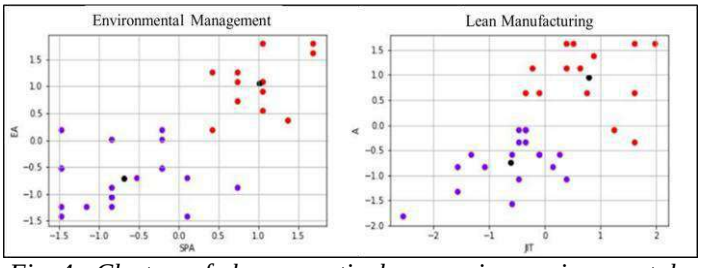

Fig. 4 - Clusters of pharmaceutical companies: environmental management and lean manufacturing practices.

The first and second columns of the Table 1 and Table 2 represent, respectively, the clusters in which the pharmaceutical companies were classified and the numerical identification of each company. The other

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columns of the tables are the variables, which were distributed in:

• Table 1: Environmental Preservation System (EPS), Product Project (PP), Manufacturing Process (MP) and Environmental Strategy (ES).

• Table 2: Just In Time (JIT), External Suppliers (FE), Customers (C) and Autonomation (A).

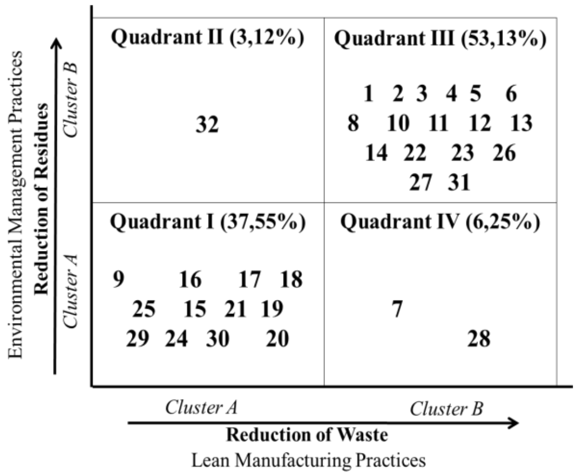

Fig. 5 - Allocation of companies in the quadrants

The frequencies (fashion values) of the answers given by the pharmaceutical companies were analyzed for each set of variables grouped in the clusters. The fashion obtained for each variable, for the sustainability competencies, were plotted on the radar chart shown in Fig. 6. The distribution of the fashion for clusters of environmental management and lean manufacturing allowed the exploratory analysis of data and the characterization of each group of companies in the quadrants I, II, III and IV, as shown in Fig. 5.

The characteristics of the companies in clusters A and B of environmental management are presented in Chart 2. Chart 3 describes the companies of clusters A and B in management of lean manufacturing.

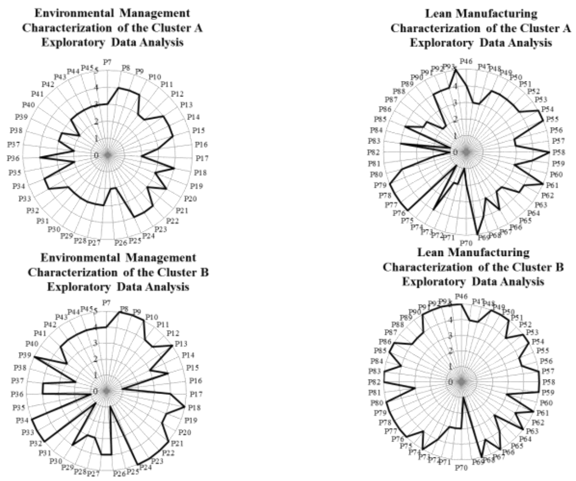

Fig. 6 - Characterization of the clusters for exploratory analysis of the variables

Table 1

Environmental Management																																								
		Variáveis																																						
		EPS						Product Project										Manufacturing Process													Environmental Strategy									
Cluster	Company	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	P26	P27	P28	P29	P30	P31	P32	P33	P34	P35	P36	P37	P38	P39	P40	P41	P42	P43	P44	P45
A	1	4	5	4	5	3	3	4	4	4	4	3	4	4	4	3	4	4	4	3	2	4	4	3	4	5	2	5	5	5	4	2	5	3	3	3	3	2	4	2
A	2	3	4	4	5	3	4	4	4	3	3	1	4	5	4	3	4	4	4	2	3	4	3	2	3	4	2	4	4	5	4	2	4	4	2	3	4	3	3	3
A	3	4	4	5	5	4	4	4	4	4	3	1	3	5	4	4	4	5	4	3	2	3	4	3	4	5	3	5	5	4	3	2	4	3	3	3	3	2	4	3
A	4	2	4	4	4	2	3	3	4	4	2	1	4	5	3	3	4	4	4	2	2	2	4	3	4	4	2	4	5	5	4	2	5	3	1	3	3	3	2	2
A	5	2	4	4	4	2	3	4	4	3	1	2	3	5	4	4	4	4	4	2	3	3	3	2	3	5	3	4	4	5	5	2	4	4	3	3	3	2	3	3
A	6	4	4	4	5	4	3	4	4	3	1	1	4	5	3	4	4	4	4	2	2	2	4	3	4	5	2	4	5	5	4	2	3	2	1	3	3	3	4	2
B	7	3	4	4	4	3	5	5	4	4	3	2	4	5	5	4	4	5	4	3	3	3	4	3	4	4	2	4	5	4	4	2	5	4	3	3	3	3	4	4
A	8	2	4	4	4	2	3	4	4	4	4	3	4	4	4	4	4	4	4	4	4	3	4	3	3	5	4	4	4	3	4	3	5	4	3	3	3	3	3	5
B	9	4	5	5	5	3	3	5	5	4	5	4	4	4	5	5	5	5	5	4	4	4	4	5	4	5	4	5	4	4	5	4	5	5	3	4	4	4	4	4
A	10	3	4	4	4	3	4	4	5	4	5	3	3	3	3	3	4	3	4	3	3	3	3	4	2	4	3	5	2	4	5	3	3	3	2	4	3	3	2	3
A	11	3	4	4	3	3	2	4	4	4	4	2	4	3	4	4	4	4	3	3	2	3	4	3	3	4	4	4	1	3	4	2	2	3	3	3	2	2	3	3
A	12	4	4	4	4	2	3	5	4	5	3	3	4	2	3	4	3	3	4	2	2	2	3	4	2	5	3	4	1	2	3	2	3	4	2	4	3	3	3	2
A	13	4	4	4	4	2	3	4	3	4	4	3	3	3	3	3	4	4	4	3	3	1	4	5	3	3	2	4	2	2	4	2	3	3	1	4	2	3	3	3
A	14	3	4	4	3	3	2	4	4	4	3	2	3	2	4	3	4	5	4	3	2	2	3	3	4	3	3	4	3	1	4	2	4	4	2	4	2	3	4	3
B	15	4	5	5	4	4	4	5	4	4	1	4	5	3	3	3	5	5	4	1	3	3	3	3	3	1	5	5	5	1	5	5	3	5	4	5	4	4	3	4
B	16	4	5	5	4	5	4	4	3	3	1	3	5	3	3	5	3	5	4	1	3	3	3	3	3	1	5	4	5	1	4	5	2	5	4	5	3	4	5	3
B	17	4	5	5	5	4	4	4	3	3	1	3	5	4	4	4	5	5	5	1	4	4	3	4	3	1	5	5	4	1	5	4	2	4	3	3	4	4	5	4
B	18	3	5	5	4	4	4	4	3	3	1	4	5	4	4	3	5	3	4	1	4	4	3	3	4	1	4	5	5	1	5	4	2	4	3	3	3	4	5	3
B	19	4	5	5	4	4	4	5	4	4	1	3	5	3	4	5	4	4	5	1	1	3	3	3	4	1	4	5	5	1	4	5	3	5	4	4	3	3	5	3
B	20	5	4	4	5	5	5	4	3	3	1	3	5	4	4	4	3	5	5	1	2	3	3	3	3	1	4	4	5	1	4	5	2	5	4	4	3	3	4	3
B	21	5	4	4	5	4	5	5	3	4	1	4	5	3	3	5	4	5	5	1	3	3	3	4	4	1	5	4	5	1	4	5	3	4	5	4	4	4	4	4
A	22	3	4	4	4	4	4	4	4	4	3	2	3	4	4	4	4	5	4	2	3	3	3	4	4	3	3	4	4	2	4	4	4	4	2	3	4	3	4	4
A	23	3	4	3	4	3	3	4	3	3	3	2	3	2	3	3	3	3	3	2	2	2	3	3	2	3	3	3	3	2	3	2	3	3	2	3	3	3	3	3
B	24	4	5	4	5	4	4	5	4	4	4	3	3	4	4	4	3	5	4	4	3	4	3	4	4	4	4	4	5	2	4	4	4	5	3	4	4	4	4	5
B	25	4	5	5	5	5	5	5	5	4	4	4	4	4	5	5	5	5	5	4	4	4	4	5	4	4	5	5	5	4	5	4	5	5	3	5	4	4	4	5
A	26	3	4	4	4	3	3	4	4	4	2	2	3	3	3	3	3	4	4	2	3	3	3	3	3	3	3	4	4	2	4	2	3	3	3	3	3	3	3	3
A	27	3	4	4	4	3	3	4	3	3	2	2	3	3	3	3	3	4	4	2	3	2	3	3	3	3	3	4	4	2	4	2	3	3	2	3	3	4	3	3
A	28	3	5	4	5	3	3	4	4	4	3	3	4	3	4	4	4	5	4	3	4	3	4	4	4	4	3	4	4	3	4	4	3	4	2	3	3	3	3	3
B	29	4	5	5	5	4	4	4	5	4	4	3	4	4	4	4	4	5	5	4	4	4	4	4	4	4	4	5	5	3	4	4	4	5	3	4	4	4	4	5
B	30	4	5	5	5	5	5	5	5	4	4	4	5	4	5	5	5	5	5	4	4	4	4	5	4	5	5	5	5	4	5	4	5	5	4	5	4	4	4	5
A	31	3	4	4	4	3	3	4	4	4	4	3	4	3	4	3	4	4	4	3	3	3	3	4	3	4	4	4	4	3	4	3	4	4	2	4	3	4	3	4
A	32	3	5	4	5	5	5	1	3	4	1	4	4	4	5	4	5	4	4	1	4	4	2	2	2	2	2	2	2	2	5	2	3	5	5	5	5	5	5	5

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Table 2

Lean Manufacturing																																																	
		Variables																																															
		Just In Time																						External Suppliers											Customers							Autonomation							
Cluster	Company	P46	P47	P48	P49	P50	P51	P52	P53	P54	P55	P56	P57	P58	P59	P60	P61	P62	P63	P64	P65	P66	P67	P68	P69	P70	P71	P72	P73	P74	P75	P76	P77	P78	P79	P80	P81	P82	P83	P84	P85	P86	P87	P88	P89	P90	P91	P92	P93
A	1	5	4	3	5	4	3	4	3	5	5	3	4	5	4	3	4	5	4	3	3	5	1	4	4	3	1	2	3	4	1	5	5	5	5	4	2	1	5	1	5	3	3	3	2	4	4	5	5
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B	9	5	4	4	5	5	4	4	4	5	5	4	4	5	5	4	5	4	4	4	4	4	4	5	5	4	2	4	4	5	3	5	5	5	5	5	3	1	5	2	5	4	4	2	1	5	5	5	5
A	10	4	4	3	4	4	3	5	5	5	5	3	4	5	4	4	5	3	4	3	3	4	3	5	4	4	1	3	3	4	4	5	5	5	5	5	2	1	3	1	5	3	3	2	3	4	5	4	4
A	11	4	3	3	4	5	2	3	4	5	5	4	2	5	5	4	5	4	3	3	3	4	3	4	5	3	1	3	2	4	1	5	5	5	5	4	1	1	3	1	5	4	4	3	3	4	4	4	5
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A	13	4	4	3	4	4	4	4	3	4	4	3	3	5	4	4	5	5	4	3	2	2	4	3	5	2	1	1	3	4	2	5	5	5	5	3	2	2	4	1	4	2	4	4	3	4	4	4	5
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B	15	2	5	4	5	5	5	5	5	5	5	4	3	3	5	5	5	4	5	5	5	5	4	5	1	3	4	3	1	4	4	4	4	3	2	4	3	5	4	4	4	5	4	4	4	4	4	4	5
B	16	1	4	3	3	4	3	4	4	4	4	4	5	5	4	3	3	4	5	3	4	5	5	4	1	2	3	1	4	5	5	5	5	3	3	4	1	4	5	4	4	4	4	5	5	5	4	4	5
B	17	1	4	1	4	3	3	5	5	5	5	4	3	3	5	5	5	4	5	5	5	5	4	4	1	1	3	3	4	5	5	4	4	3	1	5	3	4	5	3	3	5	5	4	4	4	5	5	4
B	18	2	5	4	5	4	3	5	4	4	4	4	5	5	4	3	3	4	5	3	4	5	5	4	1	3	5	3	3	5	4	5	4	4	2	4	3	4	5	4	4	5	5	5	4	5	5	5	4
B	19	1	5	4	5	5	5	4	4	4	4	4	5	5	4	3	3	4	5	3	4	5	5	4	1	2	3	1	4	5	4	4	3	3	3	4	3	5	5	4	5	4	4	5	5	4	5	5	4
B	20	2	4	3	3	5	5	4	5	4	4	4	5	5	4	3	3	4	5	3	4	5	5	5	1	1	4	3	3	4	5	5	4	4	3	5	1	5	4	5	5	5	4	4	5	5	5	5	5
B	21	2	4	1	4	5	5	4	5	4	4	5	4	4	4	3	3	4	5	2	4	3	4	5	1	3	4	1	3	5	4	4	5	3	2	5	1	5	4	4	4	5	4	4	4	3	4	5	5
A	22	4	3	3	4	4	4	4	4	5	4	4	3	3	5	3	4	4	4	2	3	4	3	4	4	2	1	2	2	4	4	4	4	4	2	4	1	2	4	2	3	3	3	2	2	3	4	3	5
A	23	2	3	3	3	3	3	3	3	5	4	3	2	2	4	2	3	4	3	2	2	4	2	3	2	1	1	2	2	3	3	4	4	4	2	3	1	1	1	1	2	3	3	2	2	3	4	3	4
B	24	3	4	4	5	5	5	5	5	5	4	4	4	3	5	3	5	4	5	3	3	5	3	5	4	3	2	3	4	5	4	5	5	5	3	5	3	2	5	3	5	4	4	4	3	5	5	4	5
B	25	5	4	4	5	5	5	4	5	5	5	4	5	5	4	4	5	4	4	4	5	4	4	5	5	4	2	3	3	5	5	5	5	5	5	4	3	3	5	3	5	5	5	4	4	5	5	5	5
A	26	2	3	2	3	3	3	4	4	4	4	3	3	3	4	3	4	4	4	3	3	4	3	3	3	2	1	1	1	4	4	4	4	5	4	4	1	1	2	2	4	3	3	2	2	4	4	5	5
A	27	3	3	2	3	3	3	4	4	4	4	3	2	3	4	3	4	4	4	3	3	4	3	3	3	2	1	1	2	4	3	4	5	4	4	5	1	1	1	1	4	3	3	2	2	4	4	4	4
A	28	3	4	3	3	4	4	4	4	5	5	3	2	4	5	3	5	5	5	3	4	4	3	3	4	3	2	2	2	4	4	5	5	5	4	4	2	2	2	1	5	4	4	4	3	5	5	4	5
B	29	4	4	3	4	4	4	5	5	5	4	4	4	4	5	4	5	5	4	4	4	4	4	4	5	4	2	3	3	5	4	5	5	5	5	5	2	3	3	4	5	5	4	4	4	5	5	5	5
B	30	5	4	4	5	5	5	4	5	5	5	4	5	4	5	5	5	5	4	4	4	5	5	5	5	4	3	3	3	5	5	5	5	5	5	5	2	3	5	4	5	5	5	4	4	5	5	5	5
A	31	4	3	2	4	4	4	4	4	4	5	4	3	3	4	3	5	4	4	3	3	4	3	4	4	2	1	2	2	4	4	5	5	5	4	5	1	1	3	2	4	4	3	3	2	4	4	4	5
A	32	2	2	4	4	4	4	4	4	5	4	4	3	5	5	4	3	3	5	3	4	3	3	4	5	4	2	2	3	1	1	4	5	4	3	2	2	1	2	1	1	4	4	2	3	5	5	3	5

Chart 2 - Characterization of companies in clusters A and B regarding environmental management.

Environmental Management		
Characteristic	***Cluster* A**	***Cluster* B**
Frequency of implementation of kaizen/circle of quality control for practices of continuous improvement in environmental management.	Moderate	Frequently
Level of information of employees regarding environmental legislation.	Less than 50%	Greater than 80%
Visual management for information on negative environmental effects caused by failures or positive environmental effects caused by improvements in processes.	Being implemented	Being implemented
Development of products with materials (raw materials, components, etc.) that are recyclable or less harmful to the environment.	Being implemented	Currently implemented and leader in the industrial sector
Development of processes to reduce the quantity of materials needed to manufacture products. Environmental management aimed at more efficient use of inputs/raw materials.	Being implemented	Being implemented
Development of products and processes to reduce the consumption of resources such as energy, water, auxiliary products, components, etc.	Implemented	Currently implemented and leader in the industrial sector
Reduction of material flow time in processes by simplifying or removing unnecessary activities in manufacturing operations. Minor lead time.	Planning the implementation	Currently implemented and leader in the industrial sector
Development of products that use recycled materials or materials that cause less damage to the environment	Being implemented	Currently implemented and leader in the industrial sector
Actions aiming at the reduction of electric energy consumption for the manufacturing of products.	Neutral	Agree
Environmental management is predominantly linked to the production processes of the manufacturing system.	Agree	Strongly Agree
The environmental management in manufacturing processes is directed to actions that aim at the reduction of virgin raw materials use.	Not considered	Planning the implementation
The manufacturing system applies environmental criteria in the selection and qualification of suppliers.	Rarely Applies	Frequently Applies
Indicating which degree of pollution prevention is important for the competitive performance of the company.	Important	Important
Percentage of the company's investments destined to the prevention of pollution in the processes of the manufacturing system.	Up to 10% of the Investments	From 25% to 50% of the Investments
Strategic planning that results in a written mission, goals and actions for the implementation of long-term environmental improvements.	The company has an informal environmental planning, which is not very well defined. Meets 25% of the goals.	Strategic environmental planning is formal, defined by the high level managers of the organization and the guidelines are passed on clearly and comprehensibly to all levels of the organization. Meets 50% of goals.
Environmental management as a competitiveness strategy.	The environment is seen as a further constraint on the company's activities. It only complies with the regulations in force.	Environmental management is seen as an element of extra cost competitiveness, with the purpose of prospecting and developing new business opportunities.
Support of the high level managers to ensure the understanding of the whole organization about the commitments to environmental issues.	Neutral	Agree

With the features shown in Charts 2 and 3, it is possible to determine which practices in lean manufacturing and environmental management are adopted by pharmaceutical companies distributed in the quadrants I, II, III and IV, as shown in Fig. 5.

The results indicate that, in the sample of 32 pharmaceutical companies, 53.13% of them adopt practices in lean manufacturing and environmental management aiming to reduce waste and residues, which give them a competitive differential in terms of cost, quality, reliability to meet customer deadlines, speed of production and flexibility in the manufacturing process and products. As a deduction, the other companies, that

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Chart 3 - Characterization of the companies in clusters A and B management regarding lean manufacturing

Lean Manufacturing Management		
Characteristic	**Cluster A**	**Cluster B**
The processes on the shop floor adopt a pulled production system, using kanban.	Some implementation. By 40% of the processes	Advanced implementation and, in some cases, implemented
The suppliers' and customers' processes on the shop floor are located close to each other. Production resources are grouped together to produce product families in a continuous flow of materials.	Advanced implementation	Implemented
Visual management with production, quality and maintenance indicators.	Some implementation. By 40% of the processes	Implemented
The key leadership (directors, managers, supervisors, bosses) of the various departments of the organization work to encourage JIT (Just in time) production.	Strongly Agree	Strongly Agree
The operators of the manufacturing system are trained and adopts techniques to reduce setup time in operations.	Advanced implementation	Implemented
The manufacturing system meets the production schedule and completes the daily production plan.	Neutral	Agree
The manufacturing system adopts takt time, to establish the pace of production.	50% of the processes	100% of the processes
Feedback process to suppliers regarding to the quality of products delivered and their delivery performance.	Advanced implementation	Implemented
Implementation of actions aiming at the commitment of suppliers in the reduction of costs of resources and materials.	Low implementation	Advanced implementation
The manufacturing system of the company adopts the pulled production system with its suppliers, for the supply of raw materials and/or components.	The manufacturing system of the company do not adopt the pulled production system, using kanban, with its suppliers	Yes, between 50% and 70% of the listed suppliers
Ensured quality, reliability of delivery and costs of the inputs are qualifying criteria of the suppliers.	Strongly Agree	Strongly Agree
Customers are actively and directly involved in the supply of current demand and future businesses.	Not involved	Strongly involved
Implementation of Just in Time (JIT) working with the manufacturing system in the customer	No implementation	Advanced implementation
Improvement of product quality, scrap and rework costs indicators	No change in the previous 3 years	Improvement above 20% in the previous 3 years
Productivity of the manufacturing processes.	Increased from 1% to 20%	Increased from 40% to 80%
The crossing time of the materials passing through the manufacturing process (from the raw material to the finished product).	Decreased from 1% to 20%	Decreased from 40% to 60%
The operators of the manufacturing processe are responsible for the quality of the product and they have autonomy to interrupt the process when a problem occurs.	Fom 50% to 70% of the operators	From 70% to 100% of the operators
The machines and/or equipments in the manufacturing processes are provided with "error-proof", or "poka yoke", devices.	From 50% to 75% of the machines and/or equipments have "error-proof" devices installed.	From 75% to 100% of the machines and/or equipments have "error-proof" devices installed.

make up 46.87% of the sample, have to improve their practices in environmental management and/or lean manufacturing management to achieve a more favorable competitive condition. Between the good practices of improvements in environmental management, can be highlighted: the reduction of material flow time along the manufacturing processes, the development of products that use recycled materials or materials that cause less damage to the environment; processes that reduce the emission of pollutants and consume less resources such as electricity, water, raw materials and labour; and establish environmental management as a competitive strategy.

Regarding to the best practices in lean manufacturing, the companies contained in these 46.87% should implement a pulled production system and extend it to their suppliers' and customers' manufacturing systems; reduce setup time; increase the quantity of poka yoke devices; improve quality indicators, as well as reduce scrap and rework; intensify the feedback with suppliers concerning the indicators of quality and reliability of delivery of the resources supplied.

VI. CONCLUSION

Finding a way to improve the performance of manufacturing processes has been a challenge for many manufacturing companies that face a Market which consistely increases its competitiveness.

The manufacturing processes contribute to the company's competitiveness based on the continuous increase of productivity, making the system more efficient.

The main goal of lean manufacturing is to reduce waste, minimizing the environmental impact caused by the manufacturing processes. Therefore, lean manufacturing leads companies to a competitive advantage and environmental management, a differentiated strategy based on the reduction of impacts caused to the environment.

Both the reduction of waste, promoted by the practices in lean manufacturing, and the reduction of residues, with the practices in environmental management, give companies a differentiated competitive ability.

The model proposed in this paper provided adherence to the analysis of companies in the pharmaceutical sector, with the objective of exploring the reduction of waste and residues in their manufacturing processes, supported by the application of lean manufacturing and environmental management practices.

The results pointed out that approximately half of the companies surveyed need to advance in the adoption of practical actions that establish positive outputs in the reduction of wastes and residues in their manufacturing processes, and then they can reach a better competitive

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condition. The results also provided a better understanding about which practices companies need to improve in lean manufacturing and environmental management in order to achieve a more competitive condition in their markets.

The inference of the results refers only to the companies surveyed. It can not be extended to the whole population of pharmaceutical manufacturing companies.

It is suggested to extend the application of this study to other industrial sectors, with the objective of elaborating an analysis of the distribution of the companies between the considered sectors. In this way, comparative exploratory analyzes should be performed between the various segments.

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Application of a Model in the Evaluation of Competitiveness in Sustainability in Factories of the Pharmaceutical Sector

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***Abstract*—** *The competitive scenario for companies has been changing over time, by increasing competitiveness in terms of cost, quality, reliability, agility and, more recently, environmental issues. The aim of this paper is to evaluate the sustainability competitiveness of companies in the pharmaceutical sector by applying a model that relates the adoption of lean manufacturing practices and practices in environmental management in production processes. The model grouped the companies into clusters, distributing them in quadrants according to the quantity of produced waste and residues in their manufacturing processes. It was applied to a sample of 32 pharmaceutical processing industries in Brazil, in the states of São Paulo, Rio Grande do Sul and Paraná. The work is classified as applied, exploratory and qualitative and the survey method was used in order to collect data. The results show that most of the companies surveyed (53.13%) adopt practices for waste and residues reduction in their manufacturing processes, promoting to these companies a competitive differential in reliability of delivery, flexibility, quality and cost of their products. Thus, this research contributes to the pharmaceutical companies, giving them a better understanding of their competitive state in sustainability, from the adoption of practices in lean manufacturing and environmental management in their manufacturing processes.*

***Keywords*— Competitiveness, Environmental management, Lean Manufacturing, Pharmaceutical industry.**

I. INTRODUCTION

The search for improving operational efficiency has been a vital requirement for companies that wishes to stay alive in a competitive market. The performance improvement in production processes has been one of the many strategies applied by companies in order to stay competitive in our increasingly globalized market (ALVES, ALVES, 2015). Furthermore, the pursuit of leadership is often an ambition of most companies in the Market nowadays. In past times, one of the conceptions of business leaders was to have their profit at maximum level, without concerning for other important factors to the final customer. A few years ago, these concepts changed, then for a company to reach the level of leadership, it is necessary to provide other conditions which go beyond profit and cost reduction, such as: increase in the product quality, reliable supply and service, increase the speed of deliveries, and activities related to pre-sale and after-sale (AGOSTINHO, 2014). These new conditions represent great challenges for companies. In this way, manufacturing itself has an important role in this complex and competitive environment. One approach that manufacturing can have, in order to play the leading role in the competitiveness of companies, is to relate and apply projects of lean production and environmental management in their manufacturing processes themselves. Therefore, it is necessary to have a greater sense of sustainability that implies a decrease in waste and residues and provides a better visibility of added value for the market. To overcome these challenges, many manufactures are focused on lean manufacturing. Thus, manufacturing contributes to the competitiveness of companies with the reduction of waste in their manufacturing processes (BHAMU; SANGWAN, 2014). Environmental management is another important issue in this analysis of competitiveness. Environmental protection and improvement are the new key strategies of companies for competitiveness nowadays (JORGE; MADUEÑO; MATINEZ-MARTINEZ; SANCHO, 2015).

In this scenario, this paper aims to present a classification and a competitive evaluation of companies that implemented lean manufacturing and environmental management in their manufacturing processes. The research was performed using a sample of 32 companies in the pharmaceutical industrial sector. According the 2018 annual activity report from Sindusfarma, there are 427 factories producing medicines for human use in Brazil. The logistics chain in the pharmaceutical sector in Brazil consists of suppliers of raw materials,

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manufacturers of medicines (manufacturing industries), distributors, and consumer markets (hospitals, health centers, pharmacy networks, etc.). Then, the research presented in this paper has its outline in medicine manufacturers.

The present work is classified as applied, exploratory and qualitative, and the survey was used in order to collect data through the application of a research questionnaire.

To reach these objectives, this paper initially presents a relevant bibliographical context, addressing aspects related to lean manufacturing, environmental management and competitiveness. The exploratory analysis with the discussion of the results of the research is done through the data resulted from the application of a model that related competitiveness to the adoption of practices in lean manufacturing and practices in environmental management in the production processes (RODRIGUES; AGOSTINHO, 2018). For the classification, the method used in this paper grouped companies into clusters for lean manufacturing and environmental management and attributed a correspondence with competitiveness.

The contribution of this research comes from the assumption that there are not much scientific literature that relates the competitiveness of pharmaceutical companies with adoptions of techniques of lean manufacturing and environmental management in the manufacturing processes.

II. LITERATURE REVIEW

The market is the major driver of internal changes in companies and it plays an important role in terms of external pressure on the innovation process, overcoming organizational inertia, stimulating creative thinking and mitigating management problems.

The starting point is to address the competitiveness of companies within their marketplace and thereby enable companies to expand or keep a sustainable market position on a sustainable basis, with the ability to continually review their competitive strategies(AGOSTINHO; BATOCCHIO; SILVA, 2008). In order to obtain a good competitive performance in its market, a company may reach a good performance internally, reconfiguring its internal and external competences (HART; DOWELL, 2010). Internally, through the determination of their competitive capacities, with the effectiveness of the flow of values throughout the processes of transformation (SILVA and FONSECA, 2010). Companies that adopt the structure of resource productivity, achieve external competitive advantage in cost, product quality, reliability, production rate and flexibility of product and process, aiming to adapt to customer needs (SINGH; GARG; SHARMA; GREWAL, 2010, JABBOUR, JABBOUR, GOVINDAN, TEIXEIRA, FREITAS, 2013, FULLERTON, KENNEDY, WIDENER, 2014, BÜYÜKÖZKAN, KAYAKUTLU, KARAKADILAR, 2015).

Companies implement lean manufacturing in order to keep their competitiveness against their competitors by improving the productivity of their manufacturing systems (ROHANI and ZAHRAEE, 2015). Lean manufacturing is one of the support elements to achieve productivity and then competitiveness (KOVACH; STRINGFELLOW; TURNER; CHO, 2005). The adoption of practices in lean manufacturing by companies, in manufacturing processes, aims to reduce waste and the activities that do not add value (CUA; MC KONE; SCHROEDER, 2001; SHAH; WARD, 2003; LANDER; LIKER, 2007; PIL; FUJIMOTO, 2007; SINGH; GARG; SHARMA; GREWAL, 2010; DÜES; TAN; LIM, 2013; JABBOUR; JABBOUR; GOVINDAN; TEIXEIRA; FREITAS, 2013; WALTER; TUBINO, 2013; ROOSEN; PONS, 2013; ROHANI; ZAHRAEE, 2015). In processes, waste and activities that do not add value to products lead to decreased productivity and increased manufacturing costs (ABILAASH; ARAVINTHKUMAR; SATHISHKUMAR, 2016).

The practices in lean manufacturing that lead to the reduction of waste and the activities that do not add value refer to: (i) just in time and pulled production system (CUA;MC KONE; SCHROEDER, 2001; SHAH; WARD, 2003; HOPP; SPEARMAN, 2004; SHAH; WARD, 2007; DÜES; TAN; LIM, 2013; WALTER; TUBINO, 2013), (ii) reduction of inventories in process (KING; LENOX, 2001; HOPP; SPEARMAN, 2004; DE TREVILLE; ANTONAKIS, 2006; JABBOUR; JABBOUR; GOVINDAN; TEIXEIRA; FREITAS, 2013), (iii) production in small batches (CUA, MC KONE, SCHROEDER, 2001, SHAH, WARD, 2003, DE TREVILLE, ANTONAKIS, 2006), (iv) reduction of the variability in the manufacturing process (HOPP, SPEARMAN, 2004, DE TREVILLE, ANTONAKIS, 2006), (v) autonomation with processes free of errors and defects (KING; LENOX, 2001; DE TREVILLE; ANTONAKIS, 2006; ROTHENBERG; PIL; MAXWELL 2009; WALTER; TUBINO, 2013), (vi) continuous improvement (CUA;MC KONE; SCHROEDER, 2001; SHAH; WARD, 2003; TOWILL, 2007; WALTER; TUBINO, 2013), (vii) reduction of the set-up in the operations (CUA; MC KONE; SCHROEDER, 2001; SHAH; WARD, 2003; SHAH; WARD, 2007; WALTER; TUBINO, 2013) and (viii) reduction of the manufacturing

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lead time (HOPP; SPEARMAN, 2004; SHAH; WARD, 2007; DÜES; TAN; LIM, 2013). These practices are achieved with the application of a variety of tools such as heijunka, six sigma, kanbans, first in first out (FIFO), value streaming mapping (VSM), takt time, single minutes dye exchange (SMED) and five-S principles: these tools are vital components to define the lean culture (ROOSEN; PONS, 2013).

Lean manufacturing provides low-cost production, faster production speed, flexibility and reliability to the manufacturing processes. In this way, manufacturing reaches competitive outputs in cost, quality, reliability, speed of production and flexibility of products and processes in order to be adaptable to the needs of the customer (SINGH; GARG; SHARMA; GREWAL, 2010; JABBOUR; JABBOR; GOVINDAN; TEIXEIRA; FREITAS; 2013, ROOSEN, PONS, 2013, FULLERTON, KENNEDY, WIDENER, 2014, BÜYÜKÖZKAN, KAYAKUTLU, KARAKADILAR, 2015).

According to Dias (2017), "[...] cost, quality of products and services, level of quality control, human capital, technology and capacity for innovation are elements that, when interlinked, dictate the level of competitiveness of companies. Recently, environmental management has been strongly inserted in this context due to the competitive advantages of its application ". In essence, lean manufacturing aims to keep value within companies, maximizing productivity by reducing waste in their manufacturing processes (ROOSEN, PONS, 2013).

Bánkuti and Bánkuti (2014) affirm that environmental management becomes a strategic factor for companies due to the globalization and the care with the environment.

When it comes to strategy in the environmental management, the economy versus ecology struggle should be eliminated as the adoption of environmentally correct practices is not related to the mere increase in costs (PORTER, VAN DER LINDE, 1999 apud BÁNKUTI; BÁNKUTI, 2014, p. 173). There are many benefits that come along with a corporate environmental management, such as cost optimization of the used resources, profit increase due to product innovations and market share increase, improvement of the company's image, product portfolio increase, among others (ORSATO 2002 apud BÁNKUTI; BÁNKUTI 2014).

According to Andrade (1997) apud Bánkuti; Bánkuti (2014) for companies to adapt to the standards of competitiveness, contemplating environmental postures needs, they need to establish three stages of strategies: (i) reactive strategy: taking into account environmental legislation and targeting environmental aspects as costly and without financial return; (ii) offensive strategy: seeking to be ahead of competitors in relation to the optimization of pollution and environmental resources, not only those imposed by law and then obtaining a competitive advantage; (iii) innovation strategy: preventing environmental impacts, seeking environmental excellence, renewing products and processes involving environmental issues and corporate strategy.

According to Medeiros et al. (2015), "... companies that implement the environment as a competitive advantage need to adopt an environmental management model, since the strategy itself cannot ensure competitiveness. When a company adopts a socio-environmental strategy, it establishes a political decision that involves the whole organization, involving its principles and values throughout its manufacturing process, leading to a risk reduction in the production process. This strategy is good when it eliminates the risks exploiting the opportunities and recovering the deficiencies. "

Environmental management allows possibilities of value and competitive advantage through public understanding and cost savings, reducing damages to the environment due to manufacturing processes. Furthermore, it brings benefits when using clean technologies (Porter, 1992 apud MEDEIROS et al., 2015) and generates a differential factor of competitiveness, since with its protection to the environment, that will lead to positive results for future investments (MEDEIROS et al., 2015). Environmental performance has a direct and significant influence on the competitive performance of small and medium-sized enterprises (SMEs), according to studies performed by Jorge; Madueño; Martinez; Sancho (2015). Environmental preservation has been recognized as a competitive advantage by companies (ALVES; ALVES, 2015).

According to Dias (2017), it is possible to mention some competitive advantages that are perceptible when environmental management is applied, such as: (i) the environmental performance and a more effective growth; (ii) the use of environmental requirements in order to develop product design, making it more adaptable to manufacturing process; (iii) reduction of energy generator devices use, resulting in a reduction of the manufacturing costs; (iv) reduction of raw material costs and/or production resources; and (v) the use of renewable materials, reducing the use of energy due to their recycling processes.

Practices in lean manufacturing and environmental management are synergistic when the goals are the

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reduction of waste and inefficiencies. In the manufacturing processes of companies it is possible to develop a management system that involves both principles of lean manufacturing and environmental principles (ALVES, ALVES, 2015). This will lead companies to a better performance in the markets (YANG; HONG; MODI, 2011).

The Fig. 1 illustrates a synthesis of the literature review, which relates the practices in lean manufacturing and environmental management to the competitiveness of companies, taking into account the reduction of waste and residues in manufacturing processes.

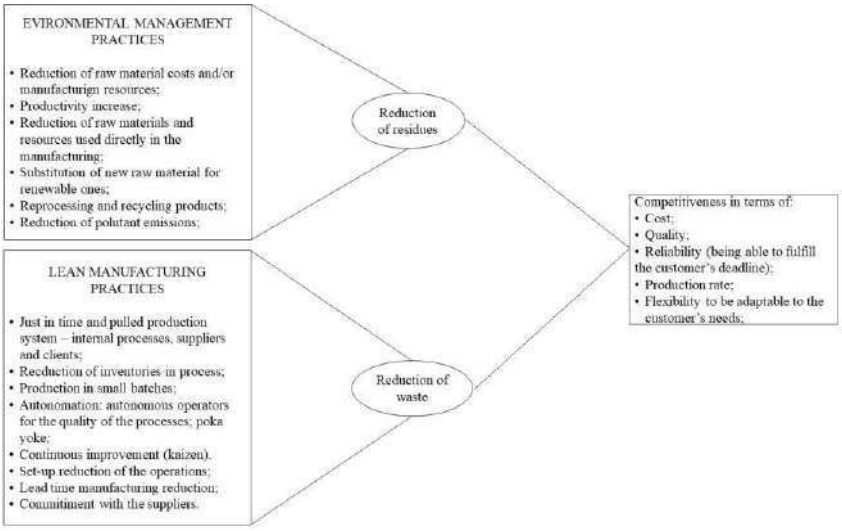

Fig. 1 - Summary of theoretical reference: practices in lean manufacturing, environmental management and competitiveness

Lean manufacturing practices reduce waste and activities that do not add value to processes inside companies. Environmental management practices result in reduced waste and limited use of manufacturing resources. In this context, from the perspective of manufacturing, these two concepts are complementary and lead companies to gains in their competitiveness.

III. METHODOLOGY

The model applied in this work is based on the conceptual construction developed by Rodrigues and Agostinho (2018), which relates the adoption of lean manufacturing practices and practices in environmental management taking into account the manufacturing system to achieve competitiveness in a company's sustainability, as shown in Fig. 2. The model integrates the concepts of lean manufacturing and environmental management and aims to evaluate manufacturing companies as being more competitive from a sustainability perspective, reducing waste and residues in their manufacturing processes.

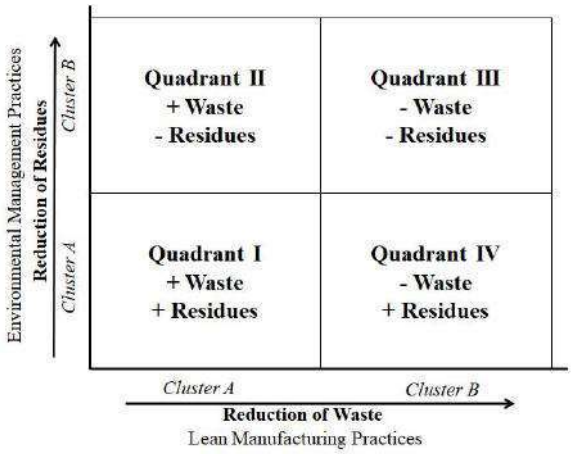

Fig. 2 - Model: environmental management practices and lean manufacturing practices. Critical factors of competitiveness in sustainability. Source: adapted from Rodrigues and Agostinho (2018).

The application of the model agglutinates companies in clusters that conjugate similar practices in lean manufacturing and environmental management.

On the axis of environmental management practices, Fig. 2, the companies grouped into cluster B produce less residues in their manufacturing processes while cluster A companies produce more residues. The same approach is done to the axis of lean manufacturing practices: the waste in the manufacturing processes of the companies

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grouped into cluster A is smaller than it is in the companies grouped into cluster B.

The definition of which companies belong to each cluster is the result of a grouping analysis. In this case, each company was identified as an object. The cluster analysis is an exploratory data analysis, which provides an empirical and objective method to perform object classification and characterization (JR, HAIR, 2005). It aims to organize the data by dividing them into groups, or classes, making the understanding and interpretation of them easier. The variables are the questions that constitute the questionnaire applied to the respondents of the pharmaceutical companies.

In the groupings of pharmaceutical companies, the variables identify the internal practices adopted by the manufacturing system in management of lean manufacturing (two clusters - A and B) and environmental management (two clusters - A and B). For each variable (question) the Likert scale is applied, with values between 1 and 5. This scale requires respondents (interviewed) to indicate their degree of agreement or disagreement with statements to the factors measured.

The technique of non-hierarchical grouping was used for the formation of the clusters, this technique belongs to the multivariate statistics for data grouping analysis field (JOHNSON; WICHERN, 2007). Non-hierarchical grouping techniques are designed for groups of objects in a set of k clusters. The number of clusters, k, can be determined before or during the clustering process. In this model, for the constitution of clusters of pharmaceutical companies we specified the value of k as 2.

The collected data at the interview stage were fed in the statistical software Python in order to perform the grouping of them into clusters.

From the formation of clusters in environmental management (k = 2) and management of lean manufacturing (k = 2), the companies (object) were allocated in the respective quadrant defined in the model. The main goal was to identify which companies were allocated in cluster B for environmental management practices and lean manufacturing (cluster III), cluster A for environmental management practices and lean manufacturing (cluster I), cluster A for lean manufacturing practices and cluster B for environmental management (quadrant II) and finally which companies were cluster B for lean manufacturing practices and cluster A for environmental management practices (quadrant IV).

The results of the exploratory analysis of the features of the companies in environmental management and lean manufacturing into quadrants are presented in section 5 of this paper. Before the results are presented, a presentation of the methodology used in this paper is presented in section 4.

IV. RESEARCH METHODOLOGY

The methodology developed in this paper is important to demonstrate the logical sequence (step by step) of the research development, as shown in Fig. 3. The architecture of the methodology is divided into seven stages:

(i) Elaboration of the applied questionnaire, with questions distributed in the groups of environmental management and lean manufacturing;

(ii) Selection of the companies in the sample;

(iii) Field survey (data collection through questionnaire);

(iv) Clustering the pharmaceutical companies into clusters,

(v) Exploratory analysis of the companies allocated into the quadrants, done by the adopted model, in relation to the implementation of lean manufacturing and environmental management (Fig. 2);

(vi) Results and discussions and

(vii) Conclusions.

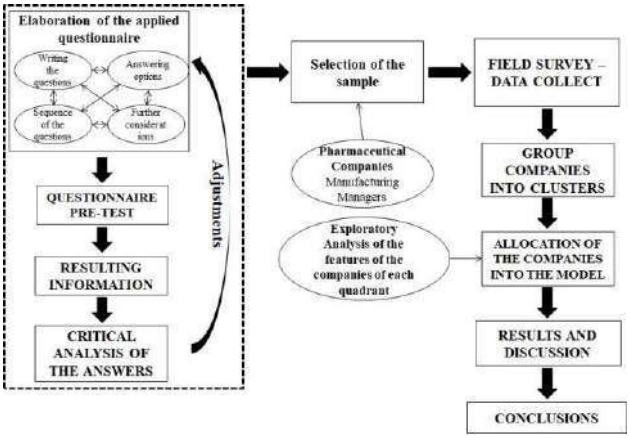

Fig. 3: Step-by-step of the study.

The questions that compose the questionnaire are the variables for the exploratory analysis of the results. The variables and their respective groups are identified in the Chart 1. The variables that characterize the environmental management were named as Environmental Preservation System (EPS), Environmental Strategy (ES), Product Project (PP) and Manufacturing Process (MP). For the management of lean manufacturing the variables were

https://dx.doi.org/10.22161/ijaers.6718 ISSN: 2349-6495(P) | 2456-1908(O)

named as Customers (C), External Suppliers (ES), Just In Time (JIT) and Autonomation (A).

Chart 1: Variables of the questionnaire – pharmaceutical industries.

	Variable	Code of the Variable	Practices
Environmental Management	Environmental Preservation System - EPS	P7 – P12	- continuous improvement in environmental management; - environmental legislation; - visual management;
	Product Project - PP	P13 – P22	- recycled materials; - raw materials; - consuming of natural resources; - manufacturing lead time; - residues and pollutant emissions;
	Manufacturing Process - MP	P23 – P35	- environmental management and manufacturing process; - manufacturing lead time; - recycled material; - environmental criteria and selection of suppliers;
	Environmental Strategy - ES	P36 – P45	- pollution prevention and competitiveness; - investment; - environmental improvements in the long term; - strategic management;
Lean Manufacturing Management	Just In Time - JIT	P46 – P67	- pulled production system; - kanban management; - family of products; - visual management; - setup; - takt time;
	External Suppliers - ES	P68 – P78	- relationship with suppliers; - pulled production system; - qualifying criteriacritérios;
	Customers - C	P79 – P85	- demand forecasting; - relationship with customers; - just in time; - performance KPIs;
	Autonomation – A	P86 – P93	- assured quality in the process; - poka yoke; - autonomy; - autonomous maintenace;

V. RESULTS – EXPLORATORY DATA ANALYSIS

The data collected from the questionnaire that 32 pharmaceutical companies (object) answered loaded in the Phyton statistical software in order to define cluster A and cluster B for practices in environmental management and lean manufacturing. The clustering results are shown in Fig. 4. The clustering process allowed the allocation of the companies in the quadrants, as defined in the model adopted according to Fig. 5.

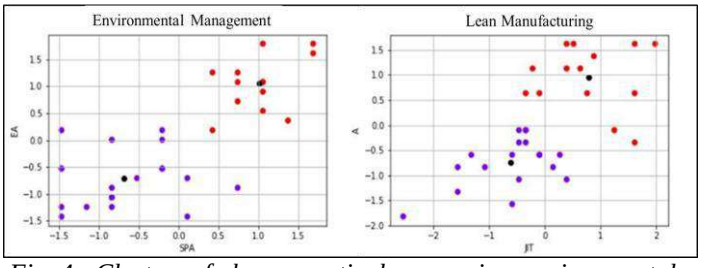

Fig. 4 - Clusters of pharmaceutical companies: environmental management and lean manufacturing practices.

The first and second columns of the Table 1 and Table 2 represent, respectively, the clusters in which the pharmaceutical companies were classified and the numerical identification of each company. The other

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columns of the tables are the variables, which were distributed in:

• Table 1: Environmental Preservation System (EPS), Product Project (PP), Manufacturing Process (MP) and Environmental Strategy (ES).

• Table 2: Just In Time (JIT), External Suppliers (FE), Customers (C) and Autonomation (A).

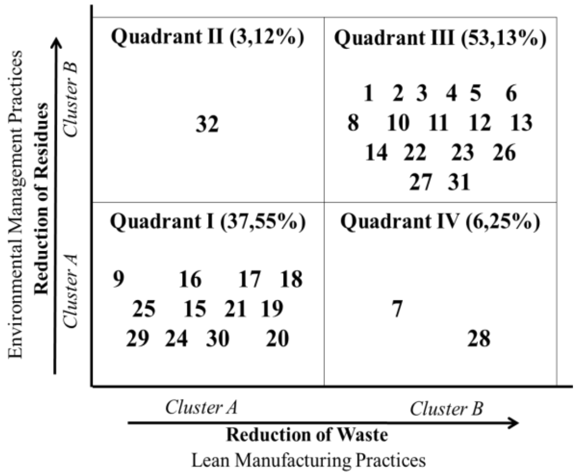

Fig. 5 - Allocation of companies in the quadrants

The frequencies (fashion values) of the answers given by the pharmaceutical companies were analyzed for each set of variables grouped in the clusters. The fashion obtained for each variable, for the sustainability competencies, were plotted on the radar chart shown in Fig. 6. The distribution of the fashion for clusters of environmental management and lean manufacturing allowed the exploratory analysis of data and the characterization of each group of companies in the quadrants I, II, III and IV, as shown in Fig. 5.

The characteristics of the companies in clusters A and B of environmental management are presented in Chart 2. Chart 3 describes the companies of clusters A and B in management of lean manufacturing.

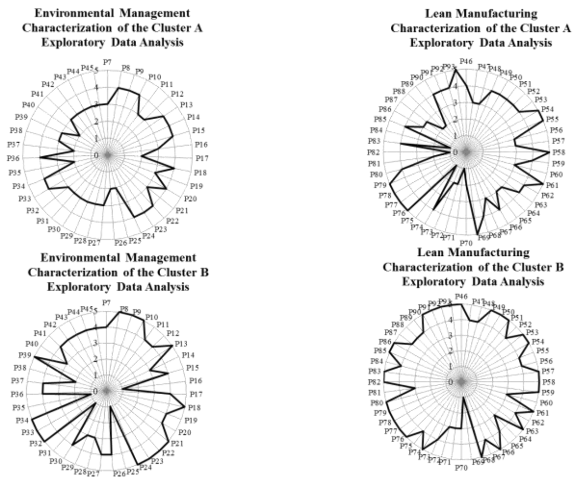

Fig. 6 - Characterization of the clusters for exploratory analysis of the variables

Table 1

Environmental Management																																									
		Variáveis																																							
		EPS						Product Project										Manufacturing Process													Environmental Strategy										
Cluster	Company	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	P26	P27	P28	P29	P30	P31	P32	P33	P34	P35	P36	P37	P38	P39	P40	P41	P42	P43	P44	P45
A	1	4	5	4	5	3	3	4	4	4	4	3	4	4	4	3	4	4	4	3	2	4	4	3	4	5	2	5	5	5	4	2	5	3	3	3	3	2	4	2
A	2	3	4	4	5	3	4	4	4	3	3	1	4	5	4	3	4	4	4	2	3	4	3	2	3	4	2	4	4	5	4	2	4	4	2	3	4	3	3	3
A	3	4	4	5	5	4	4	4	4	4	3	1	3	5	4	4	4	5	4	3	2	3	4	3	4	5	3	5	5	4	3	2	4	3	3	3	3	2	4	3
A	4	2	4	4	4	2	3	3	4	4	2	1	4	5	3	3	4	4	4	2	2	2	4	3	4	4	2	4	5	5	4	2	5	3	1	3	3	3	2	2
A	5	2	4	4	4	2	3	4	4	3	1	2	3	5	4	4	4	4	4	2	3	3	3	2	3	5	3	4	4	5	5	2	4	4	3	3	3	2	3	3
A	6	4	4	4	5	4	3	4	4	3	1	1	4	5	3	4	4	4	4	2	2	2	4	3	4	5	2	4	5	5	4	2	3	2	1	3	3	3	4	2
B	7	3	4	4	4	3	5	5	4	4	3	2	4	5	5	4	4	5	4	3	3	3	4	3	4	4	2	4	5	4	4	2	5	4	3	3	3	3	4	4
A	8	2	4	4	4	2	3	4	4	4	4	3	4	4	4	4	4	4	4	4	4	3	4	3	3	5	4	4	4	3	4	3	5	4	3	3	3	3	3	5
B	9	4	5	5	5	3	3	5	5	4	5	4	4	4	5	5	5	5	5	4	4	4	4	5	4	5	4	5	4	4	5	4	5	5	3	4	4	4	4	4
A	10	3	4	4	4	3	4	4	5	4	5	3	3	3	3	3	4	3	4	3	3	3	3	4	2	4	3	5	2	4	5	3	3	3	2	4	3	3	2	3
A	11	3	4	4	3	3	2	4	4	4	4	2	4	3	4	4	4	4	3	3	2	3	4	3	3	4	4	4	1	3	4	2	2	3	3	3	2	2	3	3
A	12	4	4	4	4	2	3	5	4	5	3	3	4	2	3	4	3	3	4	2	2	2	3	4	2	5	3	4	1	2	3	2	3	4	2	4	3	3	3	2
A	13	4	4	4	4	2	3	4	3	4	4	3	3	3	3	3	4	4	4	3	3	1	4	5	3	3	2	4	2	2	4	2	3	3	1	4	2	3	3	3
A	14	3	4	4	3	3	2	4	4	4	3	2	3	2	4	3	4	5	4	3	2	2	3	3	4	3	3	4	3	1	4	2	4	4	2	4	2	3	4	3
B	15	4	5	5	4	4	4	5	4	4	1	4	5	3	3	3	5	5	4	1	3	3	3	3	3	1	5	5	5	1	5	5	3	5	4	5	4	4	3	4
B	16	4	5	5	4	5	4	4	3	3	1	3	5	3	3	5	3	5	4	1	3	3	3	3	3	1	5	4	5	1	4	5	2	5	4	5	3	4	5	3
B	17	4	5	5	5	4	4	4	3	3	1	3	5	4	4	4	5	5	5	1	4	4	3	4	3	1	5	5	4	1	5	4	2	4	3	3	4	4	5	4
B	18	3	5	5	4	4	4	4	3	3	1	4	5	4	4	3	5	3	4	1	4	4	3	3	4	1	4	5	5	1	5	4	2	4	3	3	3	4	5	3
B	19	4	5	5	4	4	4	5	4	4	1	3	5	3	4	5	4	4	5	1	1	3	3	3	4	1	4	5	5	1	4	5	3	5	4	4	3	3	5	3
B	20	5	4	4	5	5	5	4	3	3	1	3	5	4	4	4	3	5	5	1	2	3	3	3	3	1	4	4	5	1	4	5	2	5	4	4	3	3	4	3
B	21	5	4	4	5	4	5	5	3	4	1	4	5	3	3	5	4	5	5	1	3	3	3	4	4	1	5	4	5	1	4	5	3	4	5	4	4	4	4	4
A	22	3	4	4	4	4	4	4	4	4	3	2	3	4	4	4	4	5	4	2	3	3	3	4	4	3	3	4	4	2	4	4	4	4	2	3	4	3	4	4
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B	24	4	5	4	5	4	4	5	4	4	4	3	3	4	4	4	3	5	4	4	3	4	3	4	4	4	4	4	5	2	4	4	4	5	3	4	4	4	4	5
B	25	4	5	5	5	5	5	5	5	4	4	4	4	4	5	5	5	5	5	4	4	4	4	5	4	4	5	5	5	4	5	4	5	5	3	5	4	4	4	5
A	26	3	4	4	4	3	3	4	4	4	2	2	3	3	3	3	3	4	4	2	3	3	3	3	3	3	3	4	4	2	4	2	3	3	3	3	3	3	3	3
A	27	3	4	4	4	3	3	4	3	3	2	2	3	3	3	3	3	4	4	2	3	2	3	3	3	3	3	4	4	2	4	2	3	3	2	3	3	4	3	3
A	28	3	5	4	5	3	3	4	4	4	3	3	4	3	4	4	4	5	4	3	4	3	4	4	4	4	3	4	4	3	4	4	3	4	2	3	3	3	3	3
B	29	4	5	5	5	4	4	4	5	4	4	3	4	4	4	4	4	5	5	4	4	4	4	4	4	4	4	5	5	3	4	4	4	5	3	4	4	4	4	5
B	30	4	5	5	5	5	5	5	5	4	4	4	5	4	5	5	5	5	5	4	4	4	4	5	4	5	5	5	5	4	5	4	5	5	4	5	4	4	4	5
A	31	3	4	4	4	3	3	4	4	4	4	3	4	3	4	3	4	4	4	3	3	3	3	4	3	4	4	4	4	3	4	3	4	4	2	4	3	4	3	4
A	32	3	5	4	5	5	5	1	3	4	1	4	4	4	5	4	5	4	4	1	4	4	2	2	2	2	2	2	2	2	5	2	3	5	5	5	5	5	5	5

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Table 2

Lean Manufacturing – Variables

Cluster	Company	Just In Time																					
		P46	P47	P48	P49	P50	P51	P52	P53	P54	P55	P56	P57	P58	P59	P60	P61	P62	P63	P64	P65	P66	P67
A	1	5	4	3	5	4	3	4	3	5	5	3	4	5	4	3	4	5	4	3	3	5	1
A	2	5	3	2	4	3	4	5	4	5	4	4	3	5	5	4	4	4	5	2	2	4	2
A	3	5	4	1	5	5	3	4	3	5	5	5	5	5	4	2	4	3	5	1	3	3	2
A	4	4	4	2	5	5	5	4	2	5	5	4	4	5	3	2	5	5	4	3	4	5	4
A	5	5	5	1	5	5	4	4	4	5	5	5	3	5	4	4	5	4	5	1	2	4	3
A	6	5	4	1	5	5	5	5	3	5	5	4	3	5	4	2	4	5	1	2	4	4	3
B	7	5	5	3	5	5	4	5	5	5	5	5	5	5	5	3	5	4	5	3	3	5	4
A	8	4	4	3	4	5	4	3	4	5	4	4	3	4	5	4	5	5	3	3	2	4	3
B	9	5	4	4	5	5	4	4	4	5	5	4	4	5	5	4	5	4	4	4	4	4	4
A	10	4	4	3	4	4	3	5	5	5	5	3	4	5	4	4	5	3	4	3	3	4	3
A	11	4	3	3	4	5	2	3	4	5	5	4	2	5	5	4	5	4	3	3	3	4	3
A	12	4	3	2	3	3	3	3	4	5	5	3	3	4	5	3	4	5	3	2	3	3	2
A	13	4	4	3	4	4	4	4	3	4	4	3	3	5	4	4	5	5	4	3	2	2	4
A	14	4	3	2	4	3	3	4	4	5	4	3	2	4	4	3	5	4	4	2	4	3	3
B	15	2	5	4	5	5	5	5	5	5	5	4	3	3	5	5	5	4	5	5	5	5	4
B	16	1	4	3	3	4	3	4	4	4	4	4	5	5	4	3	3	4	5	3	4	5	5
B	17	1	4	1	4	3	3	5	5	5	5	4	3	3	5	5	5	4	5	5	5	5	4
B	18	2	5	4	5	4	3	5	4	4	4	4	5	5	4	3	3	4	5	3	4	5	5
B	19	1	5	4	5	5	5	4	4	4	4	4	5	5	4	3	3	4	5	3	4	5	5
B	20	2	4	3	3	5	5	4	5	4	4	4	5	5	4	3	3	4	5	3	4	5	5
B	21	2	4	1	4	5	5	4	5	4	4	5	4	4	4	3	3	4	5	2	4	3	4
A	22	4	3	3	4	4	4	4	4	5	4	4	3	3	5	3	4	4	4	2	3	4	3
A	23	2	3	3	3	3	3	3	3	5	4	3	2	2	4	2	3	4	3	2	2	4	2
B	24	3	4	4	5	5	5	5	5	5	4	4	4	3	5	3	5	4	5	3	3	5	3
B	25	5	4	4	5	5	5	4	5	5	5	4	5	5	4	4	5	4	4	4	5	4	4
A	26	2	3	2	3	3	3	4	4	4	4	3	3	3	4	3	4	4	4	3	3	4	3
A	27	3	3	2	3	3	3	4	4	4	4	3	2	3	4	3	4	4	4	3	3	4	3
A	28	3	4	3	3	4	4	4	4	5	5	3	2	4	5	3	5	5	5	3	4	4	3
B	29	4	4	3	4	4	4	5	5	5	4	4	4	4	5	4	5	5	4	4	4	4	4
B	30	5	4	4	5	5	5	4	5	5	5	4	5	4	5	5	5	5	4	4	4	5	5
A	31	4	3	2	4	4	4	4	4	4	5	4	3	3	4	3	5	4	4	3	3	4	3
A	32	2	2	4	4	4	4	4	4	5	4	4	3	5	5	4	3	3	5	3	4	3	3

Cluster	Company	External Suppliers											Customers							Autonomation							
		P68	P69	P70	P71	P72	P73	P74	P75	P76	P77	P78	P79	P80	P81	P82	P83	P84	P85	P86	P87	P88	P89	P90	P91	P92	P93
A	1	4	4	3	1	2	3	4	1	5	5	5	5	4	2	1	5	1	5	3	3	3	2	4	4	5	5
A	2	4	5	2	1	3	4	3	1	5	5	5	4	4	2	2	4	1	3	4	4	1	3	4	5	5	5
A	3	4	5	3	1	1	2	5	1	5	5	5	4	3	3	1	4	2	5	3	3	2	1	4	4	5	5
A	4	5	4	4	1	1	2	4	2	5	5	5	5	4	2	1	5	1	4	3	3	1	2	5	4	4	5
A	5	4	5	3	2	1	3	3	1	5	5	5	4	3	4	1	4	2	4	3	3	3	2	4	5	4	5
A	6	3	5	2	1	3	3	3	1	5	5	5	5	4	2	1	4	1	4	4	4	2	2	4	4	5	5
B	7	5	5	3	1	2	4	4	1	5	5	5	4	5	2	1	5	1	5	2	4	2	2	5	5	5	5
A	8	4	5	3	1	3	3	4	2	5	5	5	5	4	3	2	4	3	4	3	4	3	2	4	4	4	5
B	9	5	5	4	2	4	4	5	3	5	5	5	5	5	3	1	5	2	5	4	4	2	1	5	5	5	5
A	10	5	4	4	1	3	3	4	4	5	5	5	5	5	2	1	3	1	5	3	3	2	3	4	5	4	4
A	11	4	5	3	1	3	2	4	1	5	5	5	5	4	1	1	3	1	5	4	4	3	3	4	4	4	5
A	12	3	5	2	1	2	3	3	1	5	5	5	4	4	1	1	3	2	4	3	4	4	2	3	5	3	5
A	13	3	5	2	1	1	3	4	2	5	5	5	5	3	2	2	4	1	4	2	4	4	3	4	4	4	5
A	14	4	4	3	2	2	2	4	3	5	5	5	5	3	2	2	3	1	4	2	3	3	3	4	4	4	5
B	15	5	1	3	4	3	1	4	4	4	4	3	2	4	3	5	4	4	4	5	4	4	4	4	4	4	5
B	16	4	1	2	3	1	4	5	5	5	5	3	3	4	1	4	5	4	4	4	4	5	5	5	4	4	5
B	17	4	1	1	3	3	4	5	5	4	4	3	1	5	3	4	5	3	3	5	5	4	4	4	5	5	4
B	18	4	1	3	5	3	3	5	4	5	4	4	2	4	3	4	5	4	4	5	5	5	4	5	5	5	4
B	19	4	1	2	3	1	4	5	4	4	3	3	3	4	3	5	5	4	5	4	4	5	5	4	5	5	4
B	20	5	1	1	4	3	3	4	5	5	4	4	3	5	1	5	4	5	5	5	4	4	5	5	5	5	5
B	21	5	1	3	4	1	3	5	4	4	5	3	2	5	1	5	4	4	4	5	4	4	4	3	4	5	5
A	22	4	4	2	1	2	2	4	4	4	4	4	2	4	1	2	4	2	3	3	3	2	2	3	4	3	5
A	23	3	2	1	1	2	2	3	3	4	4	4	2	3	1	1	1	1	2	3	3	2	2	3	4	3	4
B	24	5	4	3	2	3	4	5	4	5	5	5	3	5	3	2	5	3	5	4	4	4	3	5	5	4	5
B	25	5	5	4	2	3	3	5	5	5	5	5	5	4	3	3	5	3	5	5	5	4	4	5	5	5	5
A	26	3	3	2	1	1	1	4	4	4	4	5	4	4	1	1	2	2	4	3	3	2	2	4	4	5	5
A	27	3	3	2	1	1	2	4	3	4	5	4	4	5	1	1	1	1	4	3	3	2	2	4	4	4	4
A	28	3	4	3	2	2	2	4	4	5	5	5	4	4	2	2	2	1	5	4	4	4	3	5	5	4	5
B	29	4	5	4	2	3	3	5	4	5	5	5	5	5	2	3	3	4	5	5	4	4	4	5	5	5	5
B	30	5	5	4	3	3	3	5	5	5	5	5	5	5	2	3	5	4	5	5	5	4	4	5	5	5	5
A	31	4	4	2	1	2	2	4	4	5	5	5	4	5	1	1	3	2	4	4	3	3	2	4	4	4	5
A	32	4	5	4	2	2	3	1	1	4	5	4	3	2	2	1	2	1	1	4	4	2	3	5	5	3	5

Chart 2 - Characterization of companies in clusters A and B regarding environmental management.

Environmental Management		
Characteristic	***Cluster* A**	***Cluster* B**
Frequency of implementation of kaizen/circle of quality control for practices of continuous improvement in environmental management.	Moderate	Frequently
Level of information of employees regarding environmental legislation.	Less than 50%	Greater than 80%
Visual management for information on negative environmental effects caused by failures or positive environmental effects caused by improvements in processes.	Being implemented	Being implemented
Development of products with materials (raw materials, components, etc.) that are recyclable or less harmful to the environment.	Being implemented	Currently implemented and leader in the industrial sector
Development of processes to reduce the quantity of materials needed to manufacture products. Environmental management aimed at more efficient use of inputs/raw materials.	Being implemented	Being implemented
Development of products and processes to reduce the consumption of resources such as energy, water, auxiliary products, components, etc.	Implemented	Currently implemented and leader in the industrial sector
Reduction of material flow time in processes by simplifying or removing unnecessary activities in manufacturing operations. Minor lead time.	Planning the implementation	Currently implemented and leader in the industrial sector
Development of products that use recycled materials or materials that cause less damage to the environment	Being implemented	Currently implemented and leader in the industrial sector
Actions aiming at the reduction of electric energy consumption for the manufacturing of products.	Neutral	Agree
Environmental management is predominantly linked to the production processes of the manufacturing system.	Agree	Strongly Agree
The environmental management in manufacturing processes is directed to actions that aim at the reduction of virgin raw materials use.	Not considered	Planning the implementation
The manufacturing system applies environmental criteria in the selection and qualification of suppliers.	Rarely Applies	Frequently Applies
Indicating which degree of pollution prevention is important for the competitive performance of the company.	Important	Important
Percentage of the company's investments destined to the prevention of pollution in the processes of the manufacturing system.	Up to 10% of the Investments	From 25% to 50% of the Investments
Strategic planning that results in a written mission, goals and actions for the implementation of long-term environmental improvements.	The company has an informal environmental planning, which is not very well defined. Meets 25% of the goals.	Strategic environmental planning is formal, defined by the high level managers of the organization and the guidelines are passed on clearly and comprehensibly to all levels of the organization. Meets 50% of goals.
Environmental management as a competitiveness strategy.	The environment is seen as a further constraint on the company's activities. It only complies with the regulations in force.	Environmental management is seen as an element of extra cost competitiveness, with the purpose of prospecting and developing new business opportunities.
Support of the high level managers to ensure the understanding of the whole organization about the commitments to environmental issues.	Neutral	Agree

With the features shown in Charts 2 and 3, it is possible to determine which practices in lean manufacturing and environmental management are adopted by pharmaceutical companies distributed in the quadrants I, II, III and IV, as shown in Fig. 5.

The results indicate that, in the sample of 32 pharmaceutical companies, 53.13% of them adopt practices in lean manufacturing and environmental management aiming to reduce waste and residues, which give them a competitive differential in terms of cost, quality, reliability to meet customer deadlines, speed of production and flexibility in the manufacturing process and products. As a deduction, the other companies, that

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Chart 3 - Characterization of the companies in clusters A and B management regarding lean manufacturing

Lean Manufacturing Management		
Characteristic	**Cluster A**	**Cluster B**
The processes on the shop floor adopt a pulled production system, using kanban.	Some implementation. By 40% of the processes	Advanced implementation and, in some cases, implemented
The suppliers' and customers' processes on the shop floor are located close to each other. Production resources are grouped together to produce product families in a continuous flow of materials.	Advanced implementation	Implemented
Visual management with production, quality and maintenance indicators.	Some implementation. By 40% of the processes	Implemented
The key leadership (directors, managers, supervisors, bosses) of the various departments of the organization work to encourage JIT (Just in time) production.	Strongly Agree	Strongly Agree
The operators of the manufacturing system are trained and adopts techniques to reduce setup time in operations.	Advanced implementation	Implemented
The manufacturing system meets the production schedule and completes the daily production plan.	Neutral	Agree
The manufacturing system adopts takt time, to establish the pace of production.	50% of the processes	100% of the processes
Feedback process to suppliers regarding to the quality of products delivered and their delivery performance.	Advanced implementation	Implemented
Implementation of actions aiming at the commitment of suppliers in the reduction of costs of resources and materials.	Low implementation	Advanced implementation
The manufacturing system of the company adopts the pulled production system with its suppliers, for the supply of raw materials and/or components.	The manufacturing system of the company do not adopt the pulled production system, using kanban, with its suppliers	Yes, between 50% and 70% of the listed suppliers
Ensured quality, reliability of delivery and costs of the inputs are qualifying criteria of the suppliers.	Strongly Agree	Strongly Agree
Customers are actively and directly involved in the supply of current demand and future businesses.	Not involved	Strongly involved
Implementation of Just in Time (JIT) working with the manufacturing system in the customer	No implementation	Advanced implementation
Improvement of product quality, scrap and rework costs indicators	No change in the previous 3 years	Improvement above 20% in the previous 3 years
Productivity of the manufacturing processes.	Increased from 1% to 20%	Increased from 40% to 80%
The crossing time of the materials passing through the manufacturing process (from the raw material to the finished product).	Decreased from 1% to 20%	Decreased from 40% to 60%
The operators of the manufacturing processe are responsible for the quality of the product and they have autonomy to interrupt the process when a problem occurs.	Fom 50% to 70% of the operators	From 70% to 100% of the operators
The machines and/or equipments in the manufacturing processes are provided with "error-proof", or "poka yoke", devices.	From 50% to 75% of the machines and/or equipments have "error-proof" devices installed.	From 75% to 100% of the machines and/or equipments have "error-proof" devices installed.

make up 46.87% of the sample, have to improve their practices in environmental management and/or lean manufacturing management to achieve a more favorable competitive condition. Between the good practices of improvements in environmental management, can be highlighted: the reduction of material flow time along the manufacturing processes, the development of products that use recycled materials or materials that cause less damage to the environment; processes that reduce the emission of pollutants and consume less resources such as electricity, water, raw materials and labour; and establish environmental management as a competitive strategy.

Regarding to the best practices in lean manufacturing, the companies contained in these 46.87% should implement a pulled production system and extend it to their suppliers' and customers' manufacturing systems; reduce setup time; increase the quantity of poka yoke devices; improve quality indicators, as well as reduce scrap and rework; intensify the feedback with suppliers concerning the indicators of quality and reliability of delivery of the resources supplied.

VI. CONCLUSION

Finding a way to improve the performance of manufacturing processes has been a challenge for many manufacturing companies that face a Market which consistely increases its competitiveness.

The manufacturing processes contribute to the company's competitiveness based on the continuous increase of productivity, making the system more efficient.

The main goal of lean manufacturing is to reduce waste, minimizing the environmental impact caused by the manufacturing processes. Therefore, lean manufacturing leads companies to a competitive advantage and environmental management, a differentiated strategy based on the reduction of impacts caused to the environment.

Both the reduction of waste, promoted by the practices in lean manufacturing, and the reduction of residues, with the practices in environmental management, give companies a differentiated competitive ability.

The model proposed in this paper provided adherence to the analysis of companies in the pharmaceutical sector, with the objective of exploring the reduction of waste and residues in their manufacturing processes, supported by the application of lean manufacturing and environmental management practices.

The results pointed out that approximately half of the companies surveyed need to advance in the adoption of practical actions that establish positive outputs in the reduction of wastes and residues in their manufacturing processes, and then they can reach a better competitive

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condition. The results also provided a better understanding about which practices companies need to improve in lean manufacturing and environmental management in order to achieve a more competitive condition in their markets.

The inference of the results refers only to the companies surveyed. It can not be extended to the whole population of pharmaceutical manufacturing companies.

It is suggested to extend the application of this study to other industrial sectors, with the objective of elaborating an analysis of the distribution of the companies between the considered sectors. In this way, comparative exploratory analyzes should be performed between the various segments.

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Energy Return on Investment (EROI) of Brazilian Coal Production

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Abstract *— The rapid growth in energy demand globally sets the need for studies that evaluate the capacity of a fuel to provide an energy surplus after accounting for all the energy needed to make it available for society. The energy indicator known as energy return on investment (EROI) has been widely used for that purpose, analyzing both renewable and non-renewable fuels ability to provide useful energy. However, there are no study which estimate the EROI for Brazilian fossil fuel production. In this sense, the goal of this study is to calculate the EROI for Brazilian coal production, analyzing how much surplus energy this fuel yield after accounting the energy necessary to its extraction, processing and transportation. The results show that the EROI value highly depends on the data source, with values ranging from 30 to 57 for the Santa Catarina States' coal production and going as high as 115 for the Rio Grande do Sul States' coal production. LCA software SimaPro was also used as a way to estimate the EROI for Brazilian coal production due to its extensive database. Results from both methods are in agreement when considering only the extraction and processing steps, but diverge when the transportation energy costs are added. Differences in the transportation process are the probable cause for the discrepancies in the EROI value. Despite this difference, both methods show that the Brazilian coal is a net energy source.*

Keywords *— **CED, coal, EROI, LCA, net energy analysis.***

I. INTRODUCTION

Coal use worldwide has been growing significantly in the past decades due to its availability, supply stability and low cost [1]. As of 2018, coal remains a major component of global fuel supplies, accounting for 27% of all energy used [2]. It was only in 2015 that the global demand for coal met its first decline since the late 1990's, mainly due the efforts to combat air pollution in China, the decreasing profitability of the industry as a direct cause of coal low prices – the result of over-capacity – and the urge to reduce greenhouse gas emissions [3]. Still, according to the International Energy Agency (IEA), by 2040 the global coal demand is likely to be about 2100 million tonnes of oil equivalent (Mtoe) in the lower case scenario, corresponding to 13% of the world primary energy demand, or higher than 4900 Mtoe in the current policies scenario, which in turn would correspond to 27% of the world primary energy demand [3].

Brazil is not a leading coal producer in the global market, but the southern States of *Santa Catarina* and *Rio Grande do Sul* offer reasonable coal reserves which are used for electricity production and industrial processes [4]. As a result, a growing number of studies have been performed to improve its production process [5], better understand its environmental impacts [6], its chemical properties [7] as well as the possibilities to reduce the coal burning emissions with carbon capture technologies [8]. However, there are no study that aims to investigate how much net energy the Brazilian coal is capable of producing after accounting for all the energy needed to make it available for society. In a increasing energy demand world, knowing the amount of surplus energy a fuel can provide is an important aspect to be taken into account in order to avoid unnecessary financial investment in the energy infrastructure [9].

There are many energy indicators designed to evaluate different aspects of an energy system, including its ability to provide surplus energy. The energy indicator known as energy return on investment (EROI) is probably one of the most used to that purpose. It can be defined as the ratio between the energy delivered to society and the energy spent by society to produce that energy [10,11,12]:

$$EROI = \frac{Energy\ delivered\ to\ society}{Energy\ required\ to\ produce\ that\ energy} \quad (1)$$

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Initial analysis focused in determining the EROI for oil production as it was clear that the so called easy oil have already been exhausted, with new developments needing an ever increasing amount of energy and financial investments to produce the same amount of oil [13]. There is now a widespread concern in the literature that the energy return from oil and gas is declining and likely to continue [14], whereas coal is the only fossil fuel whose EROI hasn't reached a peak yet [15]. Many analysts also raise the issue of the low EROI values of low-carbon energy technologies [14,16,17]. Implications for the declining EROI value of fossil fuels are discussed in many studies, e.g., [12,18,19]. They all tend to show the need for more comprehensive studies about the EROI of different fuels and how its value could impact the future energy policies which need to take place in a transition energy mix.

Reliable sources and readily available data are probably the main cause for the lack in EROI studies [11]. Most processes in the life cycle of a fuel are performed by private companies which makes it difficult to access sensible production information. Analysts tend to rely on financial data to derive energy properties of a system[10], even though some argue that the dependency on market prices removes the EROI ability to measure only physical properties of said system [12]. In recent years, however, there is a growing trend in the number of studies that use the life cycle assessment (LCA) databases as an alternative to perform EROI calculations. Ecoinvent is the most widely applied database in LCA studies and it includes a method for determine the so called cumulative energy demand (CED) indicator. The CED accounts for all use of energy in a product life cycle, tracing back to the natural resource origin and including both energy losses along the way and the energy content in the product [14]. As such, the CED is frequently used to determine or define EROI [14,20].

EROI from PV technologies is calculated by [21] using LCA data and then compared to the EROI from coal and oil electricity production in Europe. In the same way, [22] uses the CED concept to define guidelines for EROI calculation of PV power systems. CED is used by [23] to define and calculate the EROI in a meta-analysis of the electricity production using wind technology. The work by [24] goes a little further and the CED is used as the base for the calculation of many energy indicators, including EROI, from different fuels in a way to analyze the impact that these different indicators have on an energy system evaluation. The use of recycled material had an overall good impact on both CED and EROI for the life cycle assessment of offshore wind technologies as reported by [25]. Lastly, the relationship between the CED and EROI for PV power systems is analyzed by [26], where the results indicate that a low energy demand measured by the CED produces a higher EROI.

Despite the difficulties to estimate the EROI from different fuels, the growth in energy demand sets the need for studies which calculate an energy source capacity to provide surplus energy to meet the society's energy needs. The lack of such studies for the Brazilian fuel production prevents a full analyzes of the country energy options measured by different and important aspects. As such, the goal of this work is to estimate the EROI for Brazilian coal production when considering the coal extraction, beneficiation and transportation to the final user. SimaPro's database was also used to calculate the EROI from Brazilian coal production and the results by the two methods were then compared.

II. METHODOLOGY

2.1 System boundary

As shown in Fig. 1, the system boundary consists of three main stages: (i) mining, (ii) processing and (iii) coal transportation to the final user. Following the boundary definitions by [10], the EROI is then labeled as $EROI_{2,i}$, where "2" indicates the boundary for the energy output, i.e., up to which stage in the coal production the energy flows will be accounted and "i" indicates the

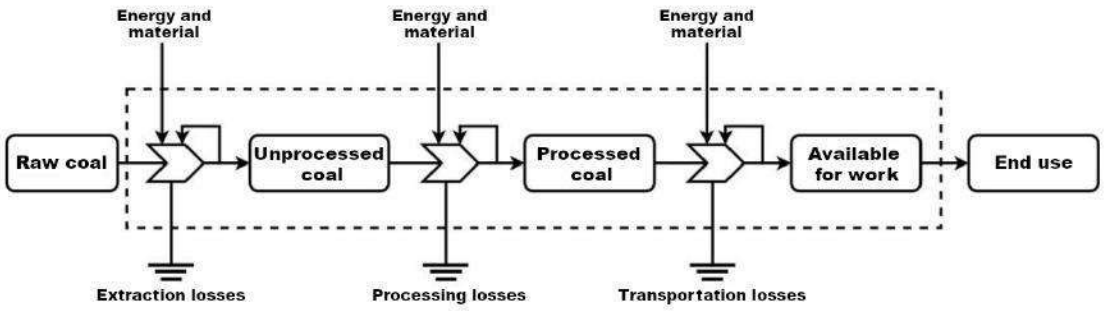

Fig 1: System boundary

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boundary for energy input, meaning that both the direct and indirect energy flows will be accounted as inputs. The precise meaning of direct and indirect flow may vary depending on the study. Here, the direct energy flows represents the energy and material produced and used within the boundary in Fig. 1. Diesel burned in the mining machinery and explosives used in the mining process are examples of direct energy flows. Indirect energy flows are the ones produced outside the limits of the mine and used within its boundary, like electricity. Although it's not the main focus of the study, the $EROI_{STND}$ was also estimated. It's called "standard EROI" as most analysts calculate and compare it among studies. The $EROI_{STND}$ measures the surplus energy a fuel can provide by only accounting the direct and indirect energy inputs and outputs in the extraction stage.

2.2 Data acquisition

Coal production is limited to the Southern Brazilian States of *Santa Catarina* and *Rio Grande do Sul*, thus narrowing the geographic scope for the data acquisition. Data for coal production is often unavailable as its mining, beneficiation and transportation processes are mainly performed by private companies. LCA studies were then used as the main source for data acquisition in the EROI calculation. Information on energy and material flows were taken as given, only being converted to their energy equivalent with the use of the quantities' HHV. As an example, Table 1 shows the energy and material needed to extract and process 1 kg of coal from an underground mine in Santa Catarina State.

Table 1: Inventory for the production of 1 kg of coal in Santa Catarina

Inputs	Amount	Units
ROM coal	2.39	kg
Water	6.99×10^{-3}	m^3
Explosives	1.48×10^{-3}	kg
Diesel	5.42×10^{-2}	MJ
Electricity	4.61×10^{-2}	kWh
Limestone	3.50×10^{-3}	kg

Source: [5]

The HHV was used to convert the material flows to its energy equivalent, as the CED results on SimaPro are given in terms of HHV, thus allowing a consistent comparison between the EROI calculated by the two methods. Data on HHV, densities and other important metrics are usually reported on each study used as source of information. Missing and additional data can be found in the Brazilian Energy Balance, a yearly publication by the *Empresa de Pesquisa Energética* that details the Brazilian energy mix.

2.3 Equations

The EROI here calculated can be defined as shown in (2)

$$EROI = \frac{\sum_{i=1}^{n} \lambda_i E_{OUT,i}}{\sum_{j=1}^{m} \lambda_j E_{IN,j}} \quad (2)$$

The coefficients λ are used to convert each energy flow $E_{OUT,i}$ and $E_{IN,j}$ to its primary energy equivalent, thus making it possible to sum different energy components with different energy qualities. This equation can be used to calculate both the $EROI_{STND}$ and the $EROI_{2,i}$ just by changing the quantities in the denominator. Table 2 shows the primary energy coefficients (λ) used here.

Table 2: Conversion factors for accounting different energy qualities

Product	Conversion factor (λ)
Electricity	1,6
Diesel	1,1
Coal	1

Source: [27]

The energy flows E_{IN} depend on the specificity of each process and may vary based on the data source, but as shown in Table 1, explosives, diesel and electricity can be considered as the main energy and materials required to extract, process and transport the coal, as diesel is usually employed to power the vehicles responsible for the coal transportation. The $EROI_{STND}$ can be then estimated by (3)

$$EROI_{STND} = \frac{\lambda_C \times Q_C \times HHV_C}{(\lambda_{el} \times E_{el}) + (\lambda_D \times Q_D \times HHV_D) + E_{exp}} \quad (3)$$

where λ_C is the primary energy coefficient for the coal Q_C is the amount of the coal produced in kg and HHV_C is its high heating value in MJ/kg. As for the denominator, λ_{el} and λ_D are the primary energy coefficients for the

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electricity and diesel, E_{el} is the electricity measured in MJ, Q_D is the diesel amount in kg and HHV_D its high heating value in MJ/kg. Finally, E_{exp} represents the energy content in the explosives. No primary energy equivalent was used to account for the energy quality of the explosives because no study was found that deals with it. Thus the term E_{exp} can be written as $Q_{exp} \times E_{cont}$, where Q_{exp} is the amount of explosives used to extract the quantity Q C in units of kg and E_{cont} is the energy content of the explosives in MJ/kg.

The $EROI_{2,i}$ can be calculated by adding a term E_T in the denominator of (3). This term represents the energy spent to transport the coal to the final user and it has no definitive form because various fuels can be employed for the coal transportation. Nonetheless, the fuel quantity in kg, its high heating value in MJ/kg and the adequate primary energy equivalent were used to make (3) consistent with the EROI calculation.

2.4 EROI calculation using SimaPro

The life cycle assessment software SimaPro and the cumulative energy indicator were also used to estimate the EROI for the Brazilian coal production and as a mean of comparison with the values calculated using (3). However there are no processes in the software's database that represent the same exact conditions found in the production of this fuel in Brazil, as most of the data is concentrated on the North America and Europe economies. Still, there are processes which are similar enough and can be used for EROI calculation. For the coal extraction the process "Hard coal {RLA}| hard coal mine operation and hard coal preparation" was chosen for two reasons. First, it deals with the extraction and processing of coal in the Latin America and the Caribbean region, stated by the abbreviation RLA (which is the abbreviation used in Ecoinvent for Latin America and the Caribbean). Second, the materials and energy employed in the coal production match those found in Brazil. To account for the transportation stage the process "Hard coal {RLA}| market for" was chosen for the same reasons discussed above.

Data on the coal production for each stage were then loaded in the aforementioned processes on SimaPro for the CED calculation. Fig. 2 shows an example of the CED results obtained on SimaPro for the process "Hard coal {RLA}| hard coal mine operation and hard coal preparation". The CED in this case was 49.9 MJ, as shown in the bottom portion of Fig 2.

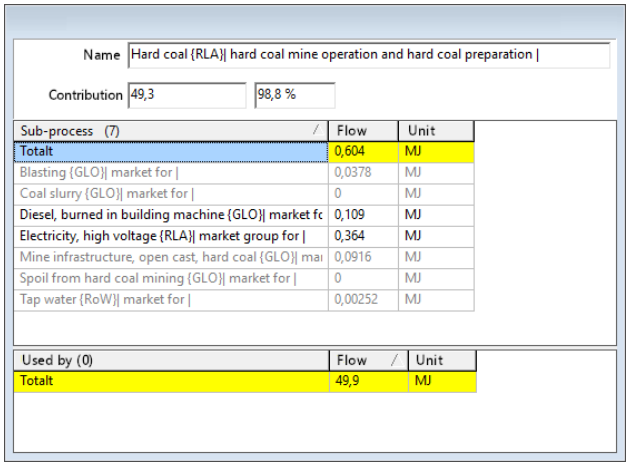

Fig 2: Example of CED results

In order to calculate the EROI using the CED the energy losses and the energy content of the fuel must be subtracted from the CED. As seen in section 1, the CED accounts for all energy in a product life cycle, including energy flows that are not invested by society. Therefore, these quantities must be removed from the CED results and the EROI can then be calculated using (4)

$$EROI = \frac{E_{OUT}}{CED - (E_C + E_L)}, \quad (4)$$

where E_C is the energy content in the fuel and E_L represents the energy losses in the process being analyzed. However, it must be noted that there is no way to ensure the complete removal of all losses accounted in the CED results. Some processes in the SimaPro database explicitly show the energy and material losses in each stage of a product life cycle but implicit losses may also be accounted [14]. As such, the resulting EROI may diverge by some degree from what it would be expected, which do not invalidate the use of SimaPro as a tool to calculate energy indicators.

According to the documentation of the process shown in Fig. 2, the HHV of the coal is 19.1 MJ/kg and it was needed 2.59 kg of coal to produce 1 kg of the fuel. It also states that 0.0002 m³ of methane was emitted as fugitive gas in the coal extraction. Considering a HHV of 39.8 MJ/m³ for the methane and using (4), the EROI of this process is given by

$$EROI = \frac{1 \times 19.1}{49.9 - (2.59 \times 19.1 + 0.0002 \times 39.8)}$$

$$EROI = 28$$

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III. RESULTS AND DISCUSSION

Brazilian coal is deemed volatile and has huge amounts of both ash and sulfur in its composition [4,28]. Nevertheless there is a huge potential in the full exploration of the coal from the *Rio Grande do Sul* State, with the possibility of implementing a thermoelectric power plant with a nominal power of 28.8 GW [29]. However, there are few scientific studies that report in great detail the energy and materials used in the Brazilian coal production. It reflects the fact that coal production is restricted geographically to southern region of the country, as shown in Fig. 3, and economically to few mining companies. LCA studies are often the only reliable source for data acquisition and further EROI calculation which limits the possibility for a more comprehensive study on the surplus energy the Brazilian coal is able to produce. Still, the LCA studies used as data source were enough as a first approach to estimate the EROI from Brazilian coal. The results are presented hereafter.

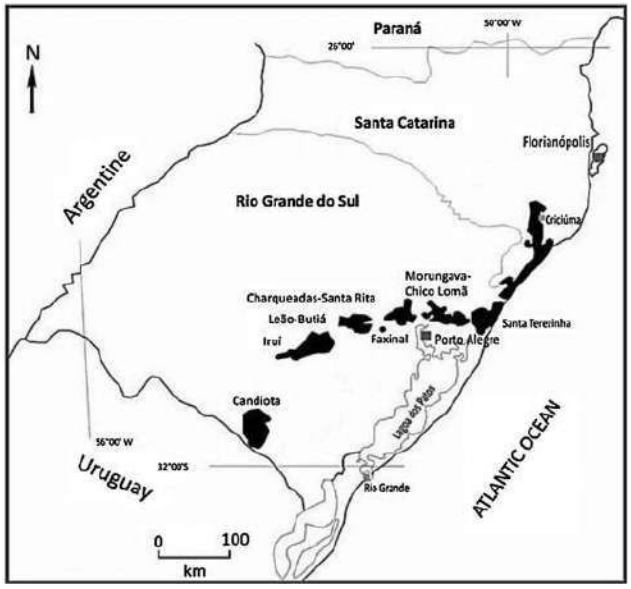

Fig 3: Main coal mining areas in southern Brazilian States. Source: [4]

The LCA study done by [30] provides data for the coal extraction for two different companies in *Santa Catarina* State. Table 3 shows the material and energy reported in said study to extract 1 kg of coal. The ROM coal is the unprocessed coal recently mined and that will be transferred for further processing. There is a considerable difference between the inputs' quantities in Table 3 from each company to produce 1 kg of coal. Company 2 uses more than 50 times more diesel than company 1, probably due to different mining processes and equipment which in turn can greatly influence the EROI results. Coal from both companies is then transported by train to the *Jorge Lacerda* thermoelectric power plant, where 0.05 liters of diesel are used to transport 1 tonne of coal.

Table 3: Energy and material needed to produce 1 kg of coal from Santa Catarina State

Inputs	Amount (company 1)	Amount (company 2)	Units
ROM coal	2.49	2.58	kg
Explosives	1.1×10^{-5}	7.7×10^{-4}	kg
Diesel	2.6×10^{-5}	1.42×10^{-3}	kg
Electricity	3.2×10^{-2}	4.6×10^{-2}	kWh
Limestone	1.43×10^{-4}	1.79×10^{-3}	kg

Source: [30]

Also according to [30], the coal analyzed has approximately 42.9% of ash in its composition. This percentage of ash were assumed as not retrievable and thus removed from the EROI calculations. Using this information, along with data in Table 3 and the fact that this coal has a HHV of 18.83 MJ/kg, the calculated $EROI_{2,i}$ was 57 and 31 for company 1 and 2 respectively. These values reflect how much the coal is reliable and viable in terms of its energy content, even though almost half of it is made of ash. Literature is scarce in terms of $EROI_{2,i}$ values for the coal. Most studies focus in the evaluation of the $EROI_{STND}$ usually for problems in data availability. Table 4 shows a compilation of $EROI_{STND}$ for some countries as well as for the global production as a whole.

Table 4: Compilation of the $EROI_{STND}$ from various studies

Year	Location	$EROI_{STND}$	Reference
1950	United States	80	[31]
2000	United States	80	[18]
2007	United States	60	[18]
1995	China	35	[32]
2010	China	27	[32]
2012	Europe	40 – 80	[21]
1800 – 2012	Global	15 – 75	[15]

In accordance to the study from [30], [4] performs a LCA for the coal in the same region. Their results are shown in Table 1 in section 3.2 and don't differ much from those in Table 3 for the company 2, suggesting that the LCA study was performed in the same location but years apart. The HHV value from coal in [4] is 18.84

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MJ/kg, it has a total of 41.9% of ash in its composition and 0.57 liters of diesel are used to transport 1 tonne of coal by train to the *Jorge Lacerda* thermoelectric plant, the same as in [30]. Using these information the $EROI_{2,i}$ for [4] data is 30, only one unit less when compared to company's EROI founded with [30] data. It once again shows how much surplus energy coal can provide even when accounting for its poor composition. Table 5 shows the $EROI_{2,i}$ for each data source.

Table 5: $EROI_{2,i}$ values for the coal data sources

$EROI_{2,i}$	Data source
57 (company 1)	[30]
31 (company 2)	[30]
30	[4]

$EROI_{STND}$ was also estimated for the coal production and the results are shown in Table 6. When comparing the values on Table 6 with the $EROI_{2,i}$ in Table 5 it is clear to see how little the numbers have changed even though the system boundaries are larger. The energy requirements for the coal transportation are relative small when compared to the mining and processing energy costs. Therefore, adding the transportation costs has little to no effect in changing the $EROI_{2,i}$ when compared to the $EROI_{STND}$. These results suggest that the extraction and processing stages are much more expensive in energy terms than the coal transportation and should thereby be the main target if a measure of energy efficiency were to be applied.

Table 6: $EROI_{STND}$ values for the coal data sources

$EROI_{STND}$	Data source
58 (company 1)	[30]
31 (company 2)	[30]
32	[4]

Even though the processes in SimaPro's database do not accurately represent the reality of Brazilian coal production, the simulated results for the $EROI_{STND}$ using SimaPro are in agreement with the ones presented in Table . This agreement was expected in some extent as the same energy and materials inputs reported in the data sources are presented in the process "hard coal {RLA}| hard coal mine operation and hard coal preparation", used for the $EROI_{STND}$ simulations. Although discrepancies may occur, this result suggest that SimaPro can be a useful tool not only to analyze environmental impacts in a product life cycle, but to also estimate a fuel's capacity to provide useful energy. Table 7 sums up all the results.

However, the simulated values for the $EROI_{2,i}$ are remarkably low when comparing to the ones presented in Table 5. Reasons for this discrepancy are probably due to differences in energy and material flows considered in the SimaPro database for the coal production. In the process "hard coal {RLA}| market for" documentation, the one used here for the $EROI_{2,i}$ simulations, is stated that coal is considered to be transported to harbor or storage. That is clearly not the case for the Brazilian coal which is mainly transferred for few kilometers to a thermoelectric power plant in order to generate electricity. Thus, the energy costs for coal transportation are greater in SimaPro database, which in turn greatly reduces the $EROI_{2,i}$ value.

Table 7: Calculated and simulated EROI results

$EROI_{STND}$	SimaPro ($EROI_{STND}$)	$EROI_{2,i}$	SimaPro ($EROI_{2,i}$)	Source
58	57	57	18	[30] company 1
31	31	31	14	[30] company 2
32	35	30	18	[4]

IV. CONCLUSION

Results indicate that Brazilian coal is a net energy producer with $EROI_{2,i}$ ranging from 30 to 57 depending on the data source. These results mean that for each energy unit invested for society to obtain coal, it yields 30 to 57 more units of energy after accounting for its extraction, processing and transportation. SimaPro simulations reproduced the results for $EROI_{STND}$ but diverged when simulating $EROI_{2,i}$. These differences do not invalidate the use of SimaPro as a tool to evaluate energy indicators of a fuel but it raises the need to correctly choose a process in the software's database that closely portray the actual system boundary being analyzed.

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Basic Education in Brazil, Performance and Indicators about Resources, Management and Projects

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Abstract**—** *This article proposes an analysis for solving problems in a system of continuous change to improve the results, in a typical Brazilian school. As a result of public policies for basic and high school education in Brazil, public schools are increasingly absorbed by the logic of efficiency. Following this guideline managers must work with goals, build partnerships, identify political alignments, seek data, establish a compensation plan and select performance measures for their units. In this way, educational management must implement successful strategies in the medium and long term. This article intends to suggest a promising approach for public education that compose in a process of continuous improvement.*

Keywords**— Public education; Management; Competitiveness; Strategy; Indicators and targets.**

SCHOOL MANAGEMENT IN BRAZIL

From the standpoint of neoliberalism education, public schools are increasingly absorbed by the logic of efficiency. In this logic, managers should clarify goals, build a network of partners, map political alignments, raise data, establish a bonus / retribution plan, and select performance measures. However, for data to be analyzed at the decision-making level, it takes at least three years (Yoder, Freed, Fetters, & Center on Great Teachers and Leaders at American Institutes for Research, 2014).

In this way, educational management must implement successful strategies in the medium and long term. In this direction, a promising approach to public education is the process of "continuous improvement." This term is used in all sectors to describe a process or approach to problem solving in a continuous change system to improve results (Park, Hironata, Penny & Lee, 2013).

In education, continuous improvement can refer to a region, municipality or school, what matters is that there is a continuous commitment of the organization with the improvement of quality. At the classroom level, continuous improvement can be associated with the use of data to inform how it is possible to improve teacher practice. At school or county level, continuous improvement may refer to ongoing efforts to improve operational practices and processes related to teaching effectiveness and efficacy outcomes (Best, Dunlap &McREL International, 2014).

According to Park et al. (2013), educational organizations that adopted the process of continuous improvement were more effective at achieving performance goals, including reducing student failure rates on exams, increasing university enrollments, and using efficient use of financial resources. Therefore, for the authors cited, such results deserve to be considered by education policy makers and education professionals.

According to Park et al. (2013), the implementation of a continuous improvement plan requires four stages: 1) elaborate the plan: at this stage, the continuous improvement team studies the problem that needs to be solved, collects the database about this problem, develops potential solutions to solve the problem and develops a plan of action; 2) do: at this stage, the team implements the action plan, collects data on its intervention and records the development of the plan; 3) study: it is time for the team to measure the success of the intervention by comparing the baseline of the project and the new data, analyzing the results and documenting the lessons learned; finally, 4) law: the team determines what to do with the results. In this way, depending on the success of the intervention, the team can adopt, adapt or abandon the tested solution.

Because the process of continuous improvement is interactive and cyclical, school management teams can work toward many long-term goals. However, it is necessary to focus on few goals at a time. In this sense, ensuring that goals are clear, measurable, and achievable increases the success of the process (Best et al., 2014).

Best et al., (2014) recommend that such managers: investigate current practices in the education system to determine a new and better way to assess the

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effectiveness of the system; analyze the policies related to the number and type of goals to be achieved, the rate of reach and the flexibility related to the objectives; gather information about the training and time dedicated to continuous improvement in the manager's area of work; compile and evaluate information on data collection, data systems, data use and data sharing within and between schools in the manager's area of activity; make sure that there are training measures and intermediaries to help strengthen ongoing improvement efforts; examining policies related to the evaluation of school programs and determining whether they provide ongoing support for improvement efforts; evaluate the current policy to determine what mechanisms are available to promote stakeholder participation in the process of continuous improvement.

To implement educational reforms, the literature indicates that managers take the position of leaders (Robinson, Lloyd, & Rowe, 2008). Leadership is the process of influencing a group to achieve goals. However, not all leaders necessarily possess the skills or competencies of effective managers and vice versa (Mansoor, 2015).

In this way, Gosnell-Lamb, O'Reilly, & Matt, (2013) stress that it is important that school managers also be leaders so that they can make the evaluation of results meaningful for students and teachers, so as to make them understand the real role they play in the learning process in the education system.

In the academic environment, leaders are required to change paradigms and make it possible to increase student performance. If this role was previously restricted to the teacher, in the last decade there has been an expansion to a much larger network, involving principals, supervisors and family members, leaving the educational manager to create an environment of improvement and strengthening of an atmosphere of support for individual learning. and institutional development (Mansoor, 2015).

The presence of leaders in the educational system is important in terms of providing the leaders with a fairer and more egalitarian environment, and also to establish the basis for democratic ideals (Okçu, 2014). By acting in the manner shown, the manager can redesign the school organization to build a culture of collaboration with parents and the community (Steinberg, Regional Educational Laboratory Mid-Atlantic (ED) & ICF International, 2013).

Robinson et al. (2008) concluded that, in the medium term, assuming the leadership position, managers can improve students' performance by 3 to 4 times the average, and this improves the effect of the involvement of teachers in the establishment of curriculum planning, coordination, teaching and assessment.

One of the great challenges to the educational manager, in the role of leader, is raised by Okçu (2014) when he recalls that the effectiveness of educational management requires the manager to be aware of and respect for diversity among employees (gender,) and consider this diversity as wealth. For Okçu (2014) diversity management is one of the approaches necessary to achieve organizational objectives, such as performance, profitability, productivity and efficiency.

On the other hand, Sifakakis, Tsatsaroni, Sarakinioti& Kourou (2016) emphasize that educational managers should seek resources in areas such as economics, market and politics to redefine and systematize pedagogical purposes. For these authors, the global and European discourse of efficient management of education, coming through the changes that were incorporated when adopting NGP and models of educational leadership, is relayed to the point of becoming a "truth regime" for policies public education.

Closing the context of leadership, Matheri, Cheloti, & Mulwa (2015), attest that even with the availability of all the relevant resources required for students to perform well on exams, lack of leadership to motivate teachers and learners would lead to performance. For these authors, no matter how elegant the physical design, since the real innovations go mainly by the support to the employees and other members of the academic community. Thus, to make real improvements, educational managers must develop policies and plans that meet these needs. In parallel, Okçu (2014) recalls that only leaders are able to apply management styles appropriate to environmental conditions.

Brazilian context for municipal public education

In Brazil, educational policy focused on basic education underwent major changes after the 1988 Federal Constitution. Through the constitutional reform, the process of decentralization of responsibilities was encouraged, transferring to the municipalities the basic education network.

In this direction, starting in the 1990s, the Brazilian central government implemented a series of measures to make municipalities more operational in terms of school management, while the central government would assume the role of financier and, at the same time, regulator of quality, implementation of the National Education Plan (PNE) and the IDEB(DaSilva, 2016).

Therefore, knowing its current system of transfers and applications of public funds in education in

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Brazil, becomes a relevant issue for the purposes of this thesis. This is the purpose of this section.

The Brazilian model of performance evaluation of schools

To accompany the results of the decentralization of public education management, in 2005, the central government instituted ProvaBrasil and IDEB, programs designed to provide a detailed diagnosis of Brazilian public education, since it data collection by schools and municipalities from the application of Portuguese Language and Mathematics tests, applied every two years to 5th and 9th grade students (MEC, 2011).

The IDEB adds to the pedagogical focus of the results of the evaluations the possibility of synthetic results on a scale of 0 to 10, calculated based on the methodology of Sanders (2000) and Sanders & Horn (1994), also used by PISA.

The IDEB is, officially, the external quality indicator of Brazilian education at the elementary and secondary levels (basic education). In addition to measuring the quality of each school and each school network in the biennial assessments, it allows the design of educational quality goals for education systems. These targets for each local government are already known by the year 2024, when the proposed national average is 6.0, the average obtained by developed OECD countries(DaSilva, 2016).

The legislation applied to Brazilian municipal public education

Brazil is a country with a large territorial dimension, marked by regional socioeconomic inequalities (Barros, 2011; Souza-Junior & Gasparini, 2006). These disparities make the central government face the challenge of transferring part of its tax revenues to the other federated entities (states and municipalities) in order to reduce possible imbalances between the local collection capacity and the demand for public goods and services (Souza- Junior & Gasparini, 2006).

In this context, the CF of 1988 increased the participation of the state and municipal levels in the use of transfers made mainly through the State Participation Fund (FPE) and the Municipal Participation Fund (FPM) (Souza-Junior & Gasparini, 2006). The FPM is a redistributive transfer, paid by the Union to all municipalities in the country. It is obligatory and its use is unconditional and unparalleled. In small municipalities, FPM accounts for 57.3% of total revenues (Franca & Gonçalves, 2013).

It should also be mentioned that, with the increase of the responsibility assumed by the municipalities in the production of goods and services, in the last decades, the central question of the State reform brought significant changes in the management of resources, previously assigned to the central government (Brunozi, Ferreira, Abrantes &Arantes, 2010).

With this, it falls on the municipality the obligation to manage the resources received better and to give society the best result in terms of the quality of public educational services. Accordingly, Law No. 9,394 / 96, in its article 11, establishes:

Article 11. The Municipalities will be responsible for:

I - organize, maintain and develop the official bodies and institutions of their education systems, integrating them into the educational policies and plans of the Union and of the States;

II - to exercise redistributive action in relation to their schools;

III - to introduce complementary norms for its education system;

IV - to authorize, accredit and supervise the establishments of its educational system;

V - to offer kindergarten and pre-school education and, with priority, elementary education, allowed to work at other levels of education only when the needs of their area of competence are fully met and with resources above the minimum percentage linked by the Federal Constitution for the maintenance and development of education.

VI - assume the school transport of the students of the municipal network

Constitutional Amendments No. 14/1996 and No. 53/2007 created the Fund for Maintenance and Development of Basic Education and Appreciation of Education Professionals (FUNDEB) to materialize the systemic vision of education, since it finances all stages of the basic education (grades 1 to 9) and establish criteria for allocating resources across the country. Therefore, it considers the social and economic development of the regions in relation to the number of students enrolled (MEC, 2011).

Even using autonomy, local managers must follow parameters for the application of public resources in municipal education. These parameters are described in article 70 of Law 9,394 / 96:

Art. 70. The costs incurred in pursuit of the basic objectives of educational institutions at all levels, including those

I - remuneration and improvement of teaching staff and other education professionals;

II - acquisition, maintenance, construction and maintenance of facilities and equipment necessary for teaching;

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III - use and maintenance of goods and services linked to education;

IV - statistical surveys, studies and research aimed at improving the quality and expansion of education;

V - completion of activities-means necessary for the functioning of education systems;

VI - granting scholarships to students from public and private schools;

VII - amortization and costing of credit operations to comply with the provisions of this article;

VIII - acquisition of school-didactic material and maintenance of school transportation programs

For CF the FUNDEB is a special fund, of accounting nature, formed with resources of the Union, states and municipalities as follows:

Article 212 - The Union shall apply annually, never less than eighteen, and the States, the Federal District and the Municipalities shall be responsible for at least twenty-five percent of tax revenue, including transfers, in maintenance and development of teaching.

In order to fulfill the objective of valuing teachers, the Law ensures that at least 60% of FUNDEB's resources are earmarked for the remuneration of basic education professionals, a category that includes teachers and specialists who offer pedagogical support to teaching (art. 22nd, Sole Paragraph, II, of the FUNDEB Law)

In this way, within the municipality it is possible to establish the remuneration of teachers, to create programs of remuneration for performance, to define the administrative structure, among other management actions. Thus, it is underpinned that the policy of the Brazilian central government is to transfer resources to decentralized maintenance of basic education at the level of municipal managers, but not before establishing the IDEB as a performance evaluation model, containing the goals to be pursued by each municipality.

Brazilian public spending in public schools

Official data from the Brazilian government and the International Monetary Fund (IMF) indicate that in the decade 2000-2010, Brazil achieved an average economic growth of 4% per year as measured by GDP, taking the sixth position among the world's largest economies (IPEA - Instituto of Applied Economic Research, Anisio Teixeira, 2010).

However, economic growth indicators do not seem to leverage the social development of Brazilians. For example, in 2010, 14.03% of children up to 14 years of age lived in extreme poverty, with less than US $ 1 a day (IPEA - Anisio Teixeira Institute of Applied Economic Research, 2010).

From this imposed dichotomy, the Brazilian government's Ministry of Finance identified some bottlenecks to sustained growth, such as the lack of skilled labor and the low educational indicators of children and young people (IPEA, 2010). Barros (2011) affirms that the inefficiency of the education of children and young people presents itself as a major economic and social problem in the country's future.

Although the surveys indicate some improvement in the quality of this sector, as can be seen in Bourguignon, Ferreira & Menendez (2007) and Reis & Ramos (2011), such improvements are timid. For example, in PISA, in the comparison between 2003 and 2012, the average performance of Brazilian students jumped from 356 points to 391, an increase of 35 points, making the country continue to occupy position number 58 of 64 countries evaluated (OECD - Organization for Economic Co-operation and Development, 2012).

The OECD (2012, 2002) considers that public expenditure on education in Brazil is small. According to the Organization, to ensure a quality basic education, Brazil should double its spending on primary education (OECD, 2012).

Based on the recommendations of the OECD and the pressures of trade unions and associations concerned, the central government passed Law 13,005 / 2014 approving the PNE and increasing the amount of public spending on education in order to reach at least 7 (seven percent) of Brazil's GDP in the fifth year of its term and at least the equivalent of ten percent (10%) of GDP at the end of ten years.

Following the trend of increases in public spending on education, Law No 13,005, Foreque&Patu (2014) point out that spending on education should go from the current R $ 360 billion in 2013 to R $ 550 billion per year in 10 years, resulting in an increase of R $ 190 billion. As a counterpart to the contribution of this resource, the government set the goal of matching the quality indices of Brazilian education to the average of the OECD countries. However, the aforementioned authors warn that, in proportion to the GDP, Brazil is already investing more than the average value of the OECD countries, estimated at 5.6% of GDP in 2011.

As in Brazil, in the last decade, other developing countries are in the process of increasing spending in public education, looking for an improvement in indicators of educational efficiency, as is the case of China, verified by Hu et al. (2009) and India, as stated by Gourishankar&Lokachari (2012). In this way, it is possible to infer that this seems to be a common decision to the governments of the emerging countries.

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However, international and Brazilian researchers have diverse and conflicting opinions about the effect of the increase in public spending and its relation with the quality of education. In this way, the effectiveness of the increase of public expenditure, in face of the decentralized management of the 5,565 local governments, the interest of the three levels of government and the socioeconomic factors peculiar to each municipality is questioned.

Effect of public expenditure on school performance

At the World Education Forum in Dakar in 2000, the international community committed itself to substantially reducing poverty levels in the developing world through a set of international development goals proposed by the United Nations, Millennium Development Goals (MDGs) for education, more specifically for primary education. In order to achieve the objectives of the proposal, the participants in the forum pointed out, in particular, the need to increase spending on basic education in developing countries (UNESCO - United Nations Educational,).

In this framework, this section aims to compare the positions on the effect of financial resources in public schools. In particular, it addresses the relationship between public expenditure and performance in these schools.

Positions on the effect of expenditure on school quality

Taking into account the context of NGP, which provides for management based on efficiency and effectiveness, governments should only increase expenditures, such as teacher and pedagogical salaries, administrative consumption, educational facilities and research, among others, if the increase the intellectual capital of students. Under this bias, the expected minimum is a positive cost-benefit relationship for society. However, there is great controversy in the literature about the relationship of public expenditure on education and its effects on improving educational performance.

This controversy began with the report on equal educational opportunities of Coleman et al. (1966), which reports that, in the United States, the educational consumption of schools had little or no effect on student performance. From this report, a series of studies begins on the importance of money to improve the quality of public education.

In this direction, the following two subsections demonstrate conflicting opinions about the importance of money to the efficiency of public school education.

Positions contrary to the importance of money in determining the quality of public education.

Hanushek (1986) investigated spending on primary and secondary education in the United States from 1960 to 1983 when enrollment in public schools declined by 10 percent, teacher enrollment increased by 7 percent, and student expenditures of 135 %.

In this new scenario, it was expected an improvement in indicators of educational quality. However, students 'performance as measured by the Scholastic Aptitude Test (SAT) showed that during the study period there was a sharp drop in students' performance in English language and mathematics.

Hanushek (1986) also found that teachers sought to raise their qualifications with master's and doctorate degrees to improve their salaries. In this way, it was observed that the average salaries of teachers increased significantly during the 1960s and remained fairly constant in the following years.

The results of Hanushek's (1986) research show that there is no strong correlation between the quality of education and teacher-student ratios; or with the teacher's training or, also, with the time of the teacher's experience.

Thus, Hanushek (1986) goes to meet Coleman et al. (1966), indicating that there seems to be no strong or systematic relationship between school expenses and student performance. Thus, Hanushek (1986) concludes that educational success can be derived from the individual experiences of students and teachers, the student's family environment, and the policies adopted by decision-makers in education.

In the same vein, in New Jersey, USA, Coate&VanderHoff (1999) investigated the effect of expenditures on the performance of students in basic education, under the legal organization of financing public education, based on the constitutional decision to allocate more public resources to districts in an attempt to make them more efficient.

The purpose of this research was to analyze the effects of legal protocols on increasing educational expenditures. The data used were collected from the New Jersey Department of Education from 1988 to 1995 and compared with municipal finance numbers and student expenditures. As a result, Coate&VanderHoff (1999) argue that the legal provision that allocated more resources to schools in poor regions did not have any effect, as they found no evidence of the positive effect of student spending and performance.

In the period between 1980 and 1994, Rapp (2000) observed that, in the United States, nominal expenditure on education increased by 283%, while student proficiency fell by 3%. For Rapp (2000) this has caused disquiet among parents and education authorities, forcing the US government to create mechanisms of

https://dx.doi.org/10.22161/ijaers.6720 ISSN: 2349-6495(P) | 2456-1908(O)

competition between school districts and between public and private schools. The competition came mainly because the US government created a voucher mechanism that allowed public school students to study in private schools.

Rapp (2000), based on agency theory, says that competition has led parents to transfer their children to better-rated schools, including other local governments or school districts. Thus, in 1995, 11.1% of American parents chose to pay private schools to educate their children. As a synthesis of the conclusions, Rapp (2000) affirms that only the laws or policies of public spending determined by the public power are not sufficientfor the improvement of the educational quality. Therefore, it is necessary the involvement of parents and the local community to know and interfere in school actions.

In order to assess whether the differences in resources allocated to education can explain the performance among the countries mentioned in the Dakar 2000 Forum, Al-Samarrai (2006) carried out a study with the following research question: would the increase in resources available for education in developing countries makes them closer to achieving quality indicators in education? To address this issue, Al-Samarrai (2006) used repetition and dropout rates in primary schools and made a combination of these two indicators. In conclusion, the cross-country regression analysis described in the study showed that the ratio of public expenditure on primary education to school outcomes, as measured by a number of indicators, is weak. Al-Samarrai (2006) points out that the absence of a strong relationship between public expenditure and school performance makes it unlikely that decisions on public spending on education will be made on the basis of this useless and insignificant relationship. However, this author emphasizes that this does not imply that resources are unnecessary, but that increasing resources alone is unlikely to be sufficient.

Positions favoring the importance of money in determining the quality of public education.

Challenged by the issues described in the previous section, Hedges, Laine & Greenwald (1994) investigated the production function of education to try to model the relationship between resource inflows and school outcomes.

The proposal of the work of Hedges et al. (1994) was to reanalyze Hanushek's (1979; 1986) data into a meta-analysis that shows the relationship between resource inflows and school outcomes. Statistical analysis used combined tests of significance and estimation methods for variables: a) teachers' experience; b) teacher training; c) salary of teachers; d) teacher-student relationship; e) administrative consumption and; f) installations.

Once the analyzes have been reported, Hedges et al. (1994) argue that, unlike Hanushek's (1979, 1986) conclusions, overall resource inflows, student expenditures, and teacher experience have a substantially positive influence on student performance. The research also points out that only the teacher-student relationship did not present consistency in the results. In view of the conclusion presented, Hedges et al. (1994) recommend that educational managers observe local circumstances to determine the levels of resource inputs so that they obtain the best results for students.

In the same perspective, Krueger (2003) examined the effect of class size on student performance, considering that the decrease in the teacher-student ratio causes an increase in overall expenses. The results of the research suggest that the size of the class, when reduced from 22 to 15 students, causes an increase in the internal rate of student performance of about 6%. Therefore, the view put forward by Krueger (2003) is that increased spending improves the educational quality of students.

Parcel &Dufur's (2001) research is based on the management of public resources earmarked for the maintenance of basic education in Pakistan in order to discover the relationship between the use of school resources and the academic performance of students. Parcel &Dufur (2001) conclude that the cause of the poor quality of education is fundamentally the insufficiency of resources allocated to schools, combined with maldistribution. For the authors, the political implication of the study is that if resources were properly allocated and used at the ideal level, student performance could be improved to more effective levels. Therefore, the problem encountered is resource management and not just lack of money.

In the same vein, Heyneman& Loxley (1983) used data from 29 countries to estimate individualized regression models. To do so, they used school and non-school variables in order to explain the educational quality of the students. These authors observed that, when comparing the results among countries, the proportion of explained variance with school expenses is higher in countries with lower per capita wealth than in countries with higher per capita income.

In sum, Heyneman& Loxley (1983) conclude that in countries with lower income per capita, eg Uganda, Egypt, Paraguay, and Colombia, the predominant influence on student learning falls on school consumption and teachers. Therefore, in poor countries public spending is determinant for school quality. On the other hand, in countries with higher income per capita, for

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example: Germany, North America and Japan, these authors conclude that the students' results are more related to non-school variables.

Along the same lines, Harris (2007) investigated educational expenditures and the effect on the quality of student performance from data from 32 countries. This author empirically addresses the variable (decreasing) marginal return to spending on education in relation to student performance. Harris (2007) concludes that, although the effects of education spending are positively related to quality, this correlation is small.

However, Harris (2007) observes that this result is consistent with evidences observed in developed nations, especially in the USA, where he found evidence that the variation of student performance is mainly explained by the family (non-school variables) in school expenses.

Like Heyneman& Loxley (1983), when it comes to developed nations, the conclusions of Harris (2007) are in accordance with the investigations of Coleman et al. (1966) and Hanushek (1979, 1986). However, in developing countries, school expenditures are highly correlated with improving educational quality. For the author, this is possibly because students enter schools with little or no prospect, but in it they achieve a high rate of added value.

With the advancement of research, Hanushek, Link &Woessmann (2013) moderate their arguments and suggest that educational policy lessons in developed countries do not directly translate into advice for developing countries.

The results of the studies that examine whether policies that put more money up the quality of teaching and student performance are at best ambiguous (De Witte, Geys& Solondz, 2014).

As just exposed, there is a clear dichotomy about the effect of public money on improving educational quality. In this way, the following section explores this issue better and advances to identify other variables that potentially affect school performance.

Recent studies on determinants of school performance

This section aims to record what is currently being produced in the field under study of this thesis through an analysis of recent studies.

The set of recent studies that follows is composed of 30 investigations, namely: 15 at the international level, in the databases made available to the University of Aveiro, under the criteria of search of determinants of performance in basic and basic level public schools , in the period 2010-2014, among the most relevant.

With the same specifications, the other 15 investigations are of Brazilian researchers, mainly published in the Scientific Periodicals Electronic Library (SPELL) database, which concentrates Brazilian scientific production in the areas of Administration, Accounting, Economics and Tourism.

DESCRIPTION OF RECENT STUDIES

In this first subsection, the empirical investigations are listed under the order of year of publication, specifying the purpose, the method and, in short, the conclusions.

Chakrabort (2010) analyzed the effectiveness of public education with the value parameter added to the public school quality indexes in the Kansas district from 2003-2005. With a sample of 304 schools, the author applied a Tobit regression model, to eliminate negative added values, and then submitted to the DEA. The empirical application indicates an average inefficiency of 5.9%. This amounts to a misallocation of $ 802 million in schools that were supposed to operate at the efficiency frontier in 2003-2005. The study found that in Kansas, the majority of school consumption has low or no influence on student achievement. However, socioeconomic factors of the students had a significant influence on their income.

Crabtree & France (2010) investigated the management effectiveness of primary schools in the rural Waikato-New Zealand region and thus verify if the trends identified in national surveys confirm that schools are underfunded in 2008. To do so, they interviewed school principals to capture financial and non-financial data, such as indicators of the socioeconomic status of the local community. The data were submitted to Pearson's statistical correlation. The findings of the study suggest that schools should seek more government resources to improve educational efficiency, but recognizes that improvements in management can increase the effectiveness of these institutions.

Mihaiu (2010) in a multivariate analysis based on Ordinary Least Squares (OLS), Stochastic Frontier Analysis (SFA) and Data Analisys Envelopment (DEA), evaluated the efficiency of public expenditure for education in Romania compared to European Union in 2010. The author made a comparative analysis of standardized indicators. The conclusion of the study indicates that the resources were not used properly enough to produce the expected results. For the author, it would be reckless to suggest an increase in resources for education, when the analysis carried out shows that the volume of funding is not the problem, but rather the management.

https://dx.doi.org/10.22161/ijaers.6720 ISSN: 2349-6495(P) | 2456-1908(O)

Agasist (2011) compared the efficiency of spending on education in 20 European countries during the period 2006-2009, using variable return returns to scale (VRS). The results of the school sample indicate that the average score of the efficiency indicator is quite high, however the volume of resources applied is too high or should raise the average score of the quality indicator by 20%. In addition, the model indicates that schools are not efficient from a purely managerial point of view.

Almeida & Gasparini (2011) analyzed public spending on basic education in 179 municipalities in the State of Paraíba, using the DEA-VRS with data from 2007. The results indicate that the smaller municipalities are those with the lowest efficiency indexes educational services and that the large centers appear to positively influence the performance of neighbors.

Cadaval& Monteiro (2011) identified the determinants of the quality of education in Brazil, using micro data from the National System for the Evaluation of Basic Education (SAEB), from a sample of 237 schools in a panel for the years 2001, 2003 and 2005. Based on the data analysis, it was possible to conclude that the factor that most strongly influences students 'performance is their parents' schooling, although the other characteristics have also been significant in part of the analysis.

Dahar and Dahar (2011) investigated the effects of public spending on quality of education in Pakistani schools in the years 2006 and 2008. The sample consisted of 288 schools, 2880 teachers and 5760 secondary school students in 36 municipalities in the district of Punjab. The authors applied questionnaires and submitted them to Pearson's correlation. It has been found that school resource inflows are poorly distributed and managed inefficiently, leading to considerable waste of money. For the authors, if resource inflows were properly allocated, they would be sufficient for effective education outcomes.

Di Gropello& Marshall (2011) analyzed the effectiveness of the Honduran community education program, from a sample of 120 rural schools in 15 states. Based on multiple linear regression, the research indicates the need to implement in school management concepts based on business literature to identify mechanisms for local community involvement, given its importance in improving educational outcomes.

In Brazil, Diniz&Corrar (2011) evaluated the efficiency in allocating public expenditures in elementary education, as a function of the budget structure of 183 municipalities in Paraíba, with data submitted to the DEA in two stages: the first with controllable consumption by the manager and the second including local socioeconomic variables. The research results showed that efficient municipalities have, on average, higher operating budgets, as well as a positive relationship between administrative operating expenses and student performance. It was also verified that the expenses with the teaching profession are not significant for the students' performance. According to the authors, these results have important implications in Brazilian educational management, specifically in the financing of education, school politics and taxation.

Lewis &Pattinasarany (2011) investigated the utility of increasing public spending to improve the quality of primary schools in 408 Indonesian districts, with data collected for the year 2005. The authors used a multiple regression OLS translog. The analysis of the results shows that money really matters for the achievement of primary education goals in the country, but it is not a sine qua non for improving this performance. For the authors, empirical evidence suggests that better management in schools is sufficient to achieve significant improvements while simultaneously reducing overall government spending.

Perelman and Santin (2011), in order to present an empirical application of a model to measure educational efficiency, used Spanish PISA data implemented by the OECD for 2440 students in 185 schools in the year 2000. The authors applied a translog elasticity function with SFA. The results identify the different aspects of the technology underlying the educational quality and suggest that when controlled the endogeneity of school consumption, no other factor differentiates public and private schools. Therefore, research indicates that a model with educational variables is sufficient to measure educational efficiency.

Raposo, Soares, Maia & Menezes (2011) proposed a methodology based on DEA and Tobit to evaluate the efficiency of 862 4th grade public schools in the Northeast Region of Brazil, with data from 2006 and 2007. The results showed that after controlling for students 'socioeconomic variables and teacher effects on learning, the estimated efficiency has become much more homogeneous across schools, which means that school performance seems to depend on the social conditions of the students and the teachers' ability.

Zoghbi, Mattos, Rocha &Arvate (2011) aimed to create indicators of efficiency in education and reinforce the need for accountability in basic education in 15 municipalities in the State of São Paulo in 2005. Using the DEA, the authors analyzed the results in function of the IDEB and concluded that Barretos is the most efficient municipality, and Presidente Prudente, the second most efficient. On the other hand, Ribeirão Preto was the most inefficient. The analysis of quartiles based on GDP per capita shows that the second quartile was the

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most efficient in the IDEB and the fourth quartile (of richer municipalities) was the least efficient.

Batare (2012) investigated the indicators that determine the efficiency of public spending on education and identified the problems related to the evaluation of such efficiency by comparing education funding in the European Union (EU) countries. The author characterized public spending on education in Latvia from the analysis of correlation and multiple regressions. It was concluded that there are a number of indicators that determine the efficiency of education. Therefore, there is no unified approach to its assessment and it should be borne in mind that efficiency indicators are continuously influenced by environmental factors. The author also emphasizes that the value of the financing per student allows to evaluate the efficiency of the public expenses.

Kirjavainen (2012) used panel data models to estimate the stochastic frontier function in the education output of Finnish secondary schools. The results indicate that the data models in panel of random effects and fixed have very divergent results. In this case, the number of years of study by the students was shown to negatively affect the students' performance.

Macedo, Starosky_Filho&Rodrigues_Junior (2012) analyzed the efficiency of public resources directed to education in 285 municipalities in the State of Santa Catarina, from 2005 to 2009. From the DEA-VRS, results indicated that 12% of municipalities in Santa Catarina are efficient in their spending on education and that those of smaller populations tend to be the most efficient.

Sarrico et al. (2012), complementing previous parametric research, conducted semi-structured interviews with influential people in school management to, using the NVivo program, explore the understanding of school self-assessment. As a contribution, research shows that the incorporation of measures of performance in school management is incipient in Portuguese secondary schools. Most interviewees recognize the difficulty of measuring results and few can demonstrate that improvement actions are consequences of self-evaluation. For the authors, there seems to be a consensus that the external evaluation of schools leads to self-evaluation.

Franca & Gonçalves (2013) analyzed the factors that affect the efficiency of educational management in 4350 Brazilian municipalities in the year 2005. Using the DEA-RSV, the authors concluded that the demographic, political and resource impacts on the educational management among the different groups of Brazilian municipalities. For the authors, the increase of public resources, in general, increases the efficiency of municipal school management.

Hanushek et al. (2013) analyzed issues involving the effect of school management autonomy in 42 countries evaluated by PISA in the period 2000-2009. Using panel data with fixed effects, the results suggest that management decentralization negatively affects student performance in countries with low socioeconomic performance. However, it positively affects such performance when it comes to developed countries.

Macedo, Scarpin, Starosky_Filho&Rodrigues_Junior (2013) analyzed the efficiency of public resources directed to education in the years 2005-2009, with a sample of 485 municipalities of the State of Rio Grande do Sul, from the DEA Fixed Returns to Scale (FRA) and RSV. The results indicate that 24.95% of the analyzed cities were efficient in their spending of resources with education. According to the authors, it is noticed that the management of these resources has proved more efficient in the smaller municipalities, with up to 30 thousand inhabitants. Among these, Pelotas occupies the first position.

Poker, Nunes & Nunes (2013) evaluated the quality of spending on education in 5,504 Brazilian municipalities, in order to provide subsidies to guide public policy both in terms of total allocation and the distribution of spending in the Federation. Data submitted to multiple regression indicate that the variation of the Human Development Index (HDI), education dimension, between 2000 and 2010 can be explained by public expenditure on education.

Rodrigues_Júnior, Felipe, Bezerra, Mendonça& Mol (2013) analyzed educational development in the metropolitan region of Natal through the IDEB, with panel data fixed and random effects for 9 municipalities in the years 2005, 2007 and 2009. The authors concluded that spending on education is related to the IDEB, that greater investment in education presupposes an improvement in the quality of the services offered, which can result in better results in the learning process of students attending public schools, with positive repercussions for society.

Savian&Bezerra (2013) analyzed the efficiency of public spending on basic education for 381 municipalities in the State of Paraná, in 2005 and 2009, using DEA-VRS. The results suggest that, in most of the municipalities of Paraná, public spending on education has proved to be inefficient, which demonstrates the need for a review by the public administration of the means of resource allocation.

Silva, Benedicto, Carvalho & Santos (2013) investigated the efficiency of 853 municipalities in the allocation of public resources for the provision of basic education in the year 2010. From the DEA-VRS, the

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results present an average of the technical efficiencies of 61% and reveals that 84% of municipalities can be considered as having a strong or moderate degree of inefficiency and less than 2% are efficient. For the authors, it is evident the need for improvements in the management of resources destined to education.

Wilbert &D'Abreu (2013) evaluated the efficiency of public expenditures with basic education in 94 municipalities in Alagoas to identify the most and least efficient in the period 2007-2011. From the DEA, research indicates that efficient municipalities were those with the worst starting conditions, in terms of average wealth and educational level, and that spent little per enrolled student. On the other hand, the least efficient municipalities were those with the best starting condition in terms of GDP per capita and that had high expenditures per student, but which reached the worst performance in the 2011 IDEB.

Almeida & Almeida (2014) analyzed the relative efficiency of government spending on the provision of basic education services to 157 municipalities in the state of Pernambuco in 2009-2011. From the DEA-VRS, the results indicate that many municipalities performed below the potential they had, given the magnitude of the inputs used. Therefore, they provide the population with an unsatisfactory educational service both in terms of the students' level of learning and the level of expenses incurred.

Blackburn, Brennan & Ruggiero (2014) estimated the efficiency of 1,650 primary schools and 400 secondary schools in the State of New South Wales (NSW), Australia. With DEA-VRS, the results suggest that Australian schools increase efficiency when socioeconomic conditions are more favorable. In addition, efficiency is higher in schools with more students.

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Analysis of stress - strain State of the Local Bearing area caused by a Prestressed Cable Anchor in Reinforced Concrete beams according to the Nonlinear Model

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Abstract— *The paper presents the results of stress and strain state of the local bearing area caused by a prestressed cable anchor in reinforced concrete beams. Ansys software was used to model and analyze the structure. The analysis process was carried out in 3 types: linear elastic analysis, nonlinear elastic analysis, and nonlinear analysis considering the destruction of concrete. The results of the analyses were also compared with each other.*

Keywords— ***Prestressed, reinforced concrete beams, nonlinear analysis, crack.***

I. INTRODUCTION

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

The reinforced concrete structures have been used very popular in construction and transportation works. The reasonable design for reinforced concrete components (RC) is essential to ensure the economic and technical requirements for the works [1],[2]. To achieve that, design engineers need to analyze and evaluate the behavior of load-bearing structural components [3]. According to the currently popular methods, the structural analysis is usually divided into two cases: general analysis and local analysis (or detailed analysis). The general analysis examines the overall working of the structural system with the concern of interaction behavior between structural components together. In contrast, a local analysis focused on the behavior of some small areas considered to be disadvantageous in the structure for the purpose of evaluating results or instructing to design or find solutions to limit or overcome the disadvantage of the structural parts. When analyzing the overall demand in the transport sector, there are many assumptions used to simplify and thereby reduce the amount and time of calculation. Therefore, the general analysis has been done quite completely and comprehensively in current designs. Meanwhile, the analysis and design of structures for local bearing areas faces many difficulties, especially for reinforced concrete structures although it is a very important step that affects the safety of construction parts. According to statistics of many countries around the world, damage in reinforced concrete structures usually starts from local bearing areas, connecting areas, etc [4],[5]. So, local analysis is based on adequate and consistent consideration in suitable areas in concrete structures is a great concern today. For this purpose, the study focused on solving the problem of analyzing and calculating the local bearing area caused by a prestressed cable anchor in concrete beams according to the nonlinear model.

II. STRUCTURE MODELING

Consider the local bearing area caused by a prestressed cable anchor in reinforced concrete beams under the effect of prestressing cable load as shown in Figure 1. Local bearing area (anchor head area) includes a prestressed cable, anchor, concrete reinforced area.

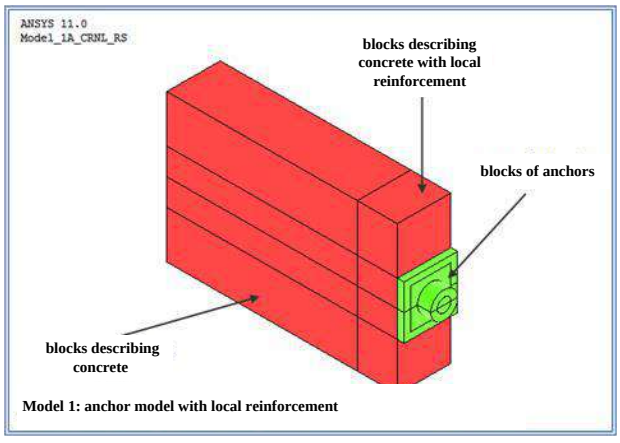

Fig.1: Geometric model

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III. TYPES OF ELEMENTS USED IN THE MODEL

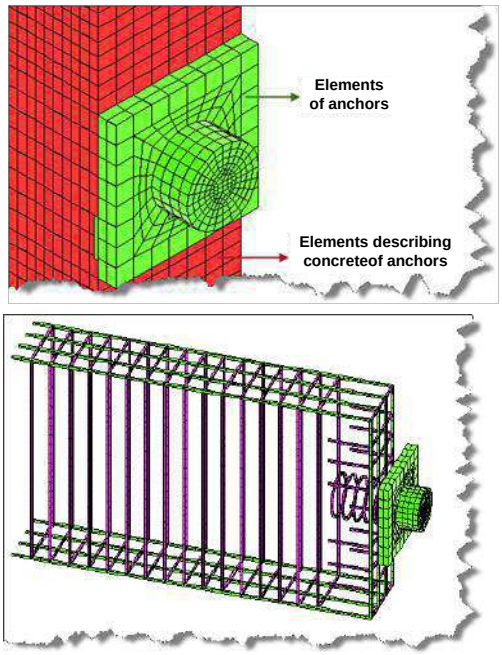

Fig.2: Elements describing concrete, anchor, reinforcement

Types of elements used in the model.

Types of elements	Purpose
Solid65	For concrete elements
Solid45	For block elements that describe anchors
Link8	For reinforcing elements

IV. LINKS AND LOADS

Links: nodes at the end of the anchor area will be assigned links to control the displacements in three directions.

Loads: the load of the prestressed cable is transferred to the concentrated load at the anchor nodes. According to the given data, the load is divided into 5 levels and organized according to 5 data files of the corresponding load file.

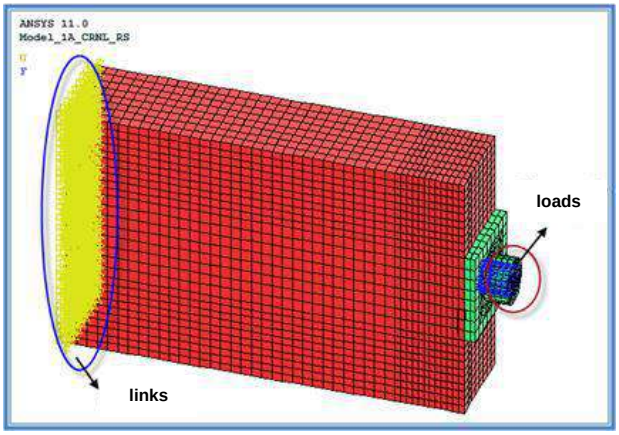

Fig.3: Load and link

V. USING ANSYS IN MODELING AND ANALYZING LOCAL BEARING AREAS IN REINFORCED CONCRETE STRUCTURES

After the finite element model of the structure is stablished, the structural analysis will be performed. This work includes:

- Building element equations (element stiffness matrix, element load vector);
- Assembling the elements based on compatible models to create the structure stiffness matrix;
- Set up general equations;
- Solve general equations;
- Calculate the necessary results from the solutions of the general equation.

The form of general equations:

$$[K]\{u\} = \{P\}$$

Where: [K] is the structure stiffness matrix; {u} are the system node displacements; {P}- the general load vector.

In the case of structural behavior in linear elastic state, element stiffness matrices are constant and therefore [K] is also constant. Therefore, just one step of solving the general equation is needed to find the node displacement vector {u}. However, the behavior of concrete materials is nonlinear, the stiffness of the material depends on the deformation itself and thus the matrix [K] will change according to the displacement vector {u}. Then the general equation system will become a nonlinear system of displacement vector {u}. the Newton - Raphson iteration method was used to solve the nonlinear equations.

VI. NUMERICAL RESULTS AND DISCUSSION

6.1. Input data

Geometric data

The anchor head area of the prestressed cable is shown as the figure 4. Each prestressed steel bundle contains 14 strands of 13 mm diameter (1/2 in).

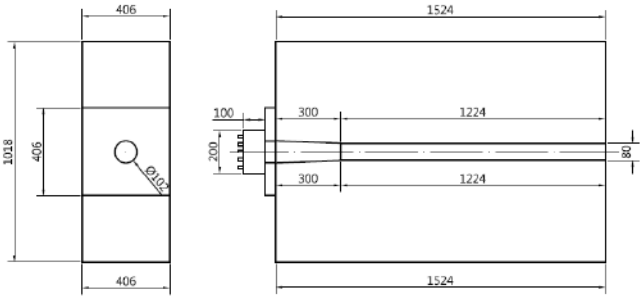

Fig.4: The general layout of the cable anchorage area

Material

Reinforcement: using steel with elastic modulus E = 2.1 10^{11} N/m^2, flow intensity f_y = 4.14 10^8 N/m^2, Poisson's coefficient μ = 0.3.

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Anchor: using steel with elastic modulus E = $2{,}1.10^{11}$ N/m^2, flow intensity f_y = 4.14 10^8 N/m^2, Poisson's coefficient μ = 0.3.

Cable: using steel with low self-slackness and maximum strength fu = 1860 MPa.

Concrete: has an initial elastic module E = 3.10^{10} N/m2, compressive strength at the time of pullin f'c = 34,5 MPa = $3{,}45.10^7$ N/m2, tensile strengt fcr = 0,95 MPa = $9{,}5.10^5$ N/m2, Poisson's coefficient μ = 0.2.

Strain-stress curve of concrete with specific data is presented as table and figure below:

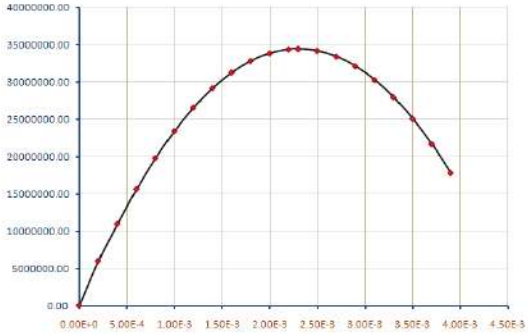

Fig.6: Stress - strain curve of concrete

6.2. Analysis results

Comparison between linear elastic analysis, elastic nonlinear analysis and cracked nonlinear analysis.

Stress distribution: When the load is low, the stress distribution is relatively similar. With a higher load, when the concrete is cracked, the stress distribution in the cracked nonlinear analysis is different from the results of the two remaining analyzes.

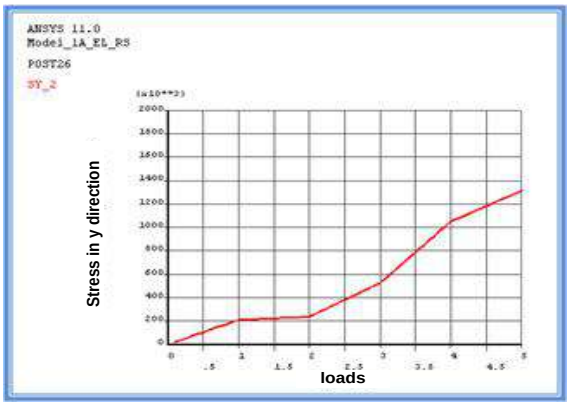

Fig.8: Stress in the Y-direction when linear elastic analysis (node 13334)

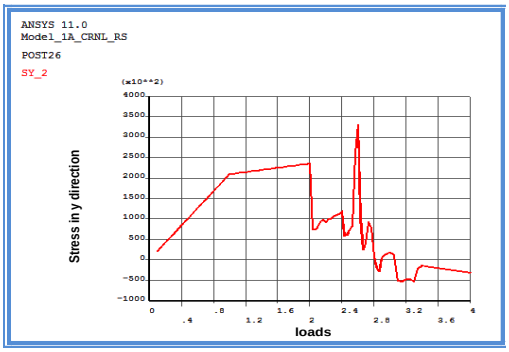

Fig.9: Stress in Y - direction with cracked nonlinear analysis (node 13334)

Strain distribution: Similar to stress distribution: in low load stage, strain distribution of nonlinear crack analysis like elastic analysis; but when the load level increases, the difference in the two analysis results is clearly.

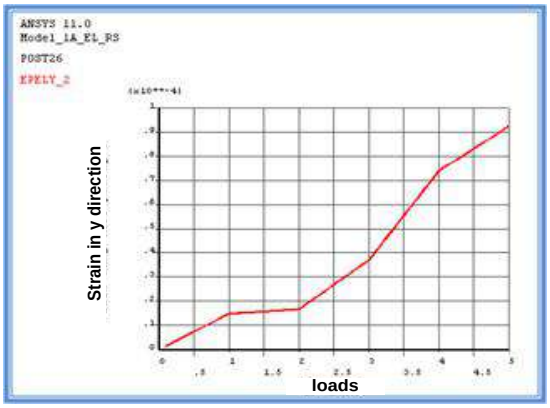

Fig.10: Strain in Y - direction with linear elastic analysis (node 13334)

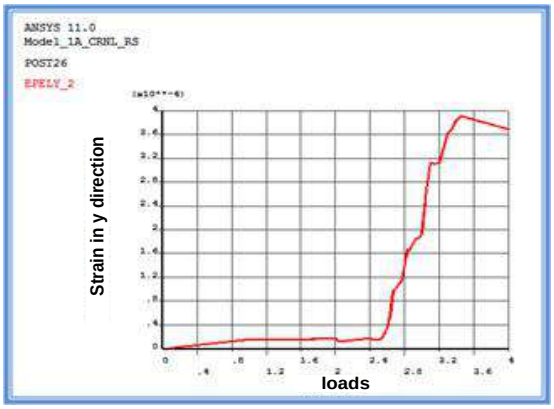

Fig.11: strain in the Y direction with cracked nonlinear analysis (node 13334)

Cracking formation in stages: The first crack appears at load level 1 - step 7 load at the area behind the anchor. After that, the number of cracks increases gradually in this area according to the loading steps.

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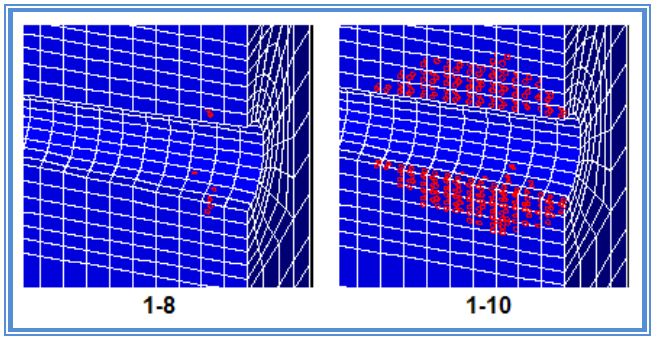

Fig.12: Cracking development in phase 1-8 and 1- 10

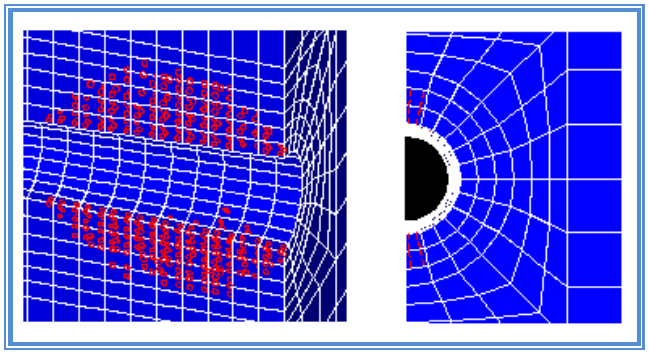

Fig.13: Cracks at phase 2-10

As the load continues to increase, cracks spread to the breaking zone and start appearing on the outside of the concrete.

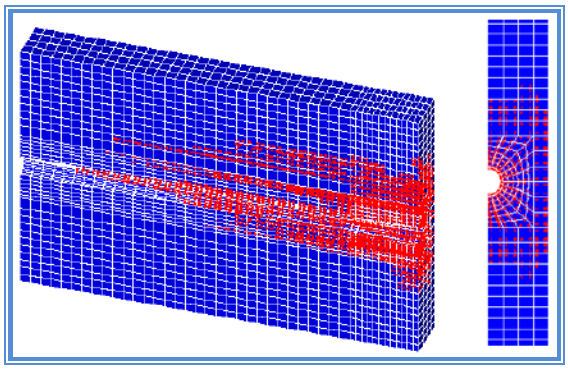

Fig.14: Development of sprung cracks at phase 3-30

Differences in stress and strain distribution in each type of analysis show: to analyze the anchor area with the cable tension load to $0.75f_u$, it cannot be based on elastic analysis and must consider the effect of local vandalism in concrete. Investigation of crack formation according to the stages shows: Splitting cracks will spread to the concrete surface at the adjacent area between the overall and local areas. Cracking damage has occurred since the small load. The earliest cracks occur in the concrete area behind the anchor and around the genotype. The arrangement of twisted steel to control concrete must be calculated on the basis of these cracks.

VII. CONCLUSIONS

At the local bearing areas, the stress state is usually the multi-axial stress state and there is a large and sudden change in distribution. There, concentrated stress is very large while concrete is a material that only works linearly when stress is small (concrete begins to work nonlinearly at stresses of about 40% intensity). In addition, concrete is an anisotropic material (totally different compressive and tensile behavior) and cracks in the structure can appear at the time of fabrication as well as when the load is first started. Another difficulty is that reinforced concrete is a composite material consisting of two components, concrete and reinforced with work. In the general analysis, with simple stress state and small stress values, due to the co-deformation of concrete and reinforcement as well as limiting cracking problems, it can be simplified by considering reinforced concrete is a homogeneous material (through the calculation between concrete and reinforcement). For locally stressed areas, due to the complex stress state as well as the great concentration stress, the deformation between concrete and reinforcement is not guaranteed, especially when the concrete has been cracked. So describing the work of concrete and reinforcement is not easy. In this study, the authors used nonlinear theory and finite element method with the support of Ansys software to fully and comprehensively consider the behavior of the local bearing area in phases with different load segments of post-tensioning cable anchors. The results are the initial foundation for the authors to develop other local bearing areas in reinforced concrete structures such as the position of the bearing of the abutment or local bearing area of other structural materials such as composite materials.

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Main Sources of Electricity Generation in Brazil

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Abstract*— *Brazil is one of the largest producers of electricity by means of hydroelectric plants; however, this generation process depends on large volumes of water directly affected by climate changes that, consequently, affect the production of electricity. Thus, the predominant production of electric energy, through hydroelectric plants in Brazil, is increasingly complemented by thermal plants to cope with the rapid growth of demand, the greater the amount of electricity generated by thermal plants, the more expensive is the cost of production and greater is the environmental impact due to the burning of fossil fuels. To combat this alternative, new renewable sources should be used in large scale. The three main sources of renewable energy for electricity generation in Brazil are: hydroelectric, wind and biomass of sugarcane, in specific the sugarcane bagasse. The aim of this study is to present how these renewable sources concentrate in a way regional, with the purpose of presenting how these sources can be complementary in the energy supply, according to the characteristics of seasonality of the same ones.

Keywords*— *Energy, Hydroelectric, Renewable, Sugarcane, Wind.

I. INTRODUCTION

The Hydroelectric plants are still the backbone of Brazil's electricity generation sector. The use of this resource is advantageous in terms of greenhouse gas emissions, flood dampening, navigation and low cost in the generation of electric energy, however, climate changes directly affect its energy production and in times of drought; the country is forced to use thermoelectric plants that burn fossil fuels that generate more expensive and polluting energy. The severe droughts of recent years have exposed the country's huge dependence on hydroelectricity. Brazil's electricity supply system is vulnerable and has required a significant revision to meet its challenges. Renewable energy sources are not continuous as they depend on geographic location as well as climatic conditions and also require large proportions of land for their installation. Factors such as efficiency, operational facilities for power generation, infrastructure and distribution the guide public policies, so that a satisfactory reform in the sector can be achieved, as well as the social and environmental considerations that have been given priority in Brazilian energy planning [1][2].

The National Energy Balance of 2018 base 2017, developed by the Energy Research Company - EPE and the Ministry of Mines and Energy - MME, shows that the generation of electric energy in Brazil is of the order of 587,962 GWh, in the composition of this figure should be highlighted renewable sources, which represent 76.8% of electricity generation in the country, among which are: water sources, wind and biomass sources, in particular sugarcane bagasse. The representation of these renewable sources for electricity generation is of the order of: 63% Hydroelectric, 7.20% Wind and 6.06% by sugarcane bagasse [3].

Brazil is an independent economy. In this way, the expansion of the generation of energy from renewable sources would not only increase the country's economic growth, but also reduce the environmental impact and create an opportunity for an international leadership role. In this context, it should be noted that one of the objectives of the Ministry of Environment - MMA, through the Secretariat of Climate Change and Environmental Quality - SMCQ, is to "contribute to the development of a low carbon economy through encourage energy efficiency and environmentally sound energy alternatives ".

The problem to be addressed in this article is to present the concentration of these renewable energy sources per region of the federation and the amount of electric energy generated, with the purpose of presenting how the integration of these sources can be carried out, promoting the energy supply and the socioeconomic balance of the Country. The composition of the data will be through analysis of articles and documents of the national energy sector, will also be used the software QGIS® version 3.4.5 for the compilation of these data and consequently the production of maps referencing the amount of energy generated per region, for a geographic evaluation of this energy generation source.

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II. LITERAURE REVIEW

In this item will be presented the basic concepts of the three main sources of renewable energy in Brazil, used for electricity generation.

2.1 Hydropower

The contribution of hydropower to the country's economic development has been expressive in attendance the diverse demands of the economy or of society itself, representing an improvement in the comfort of dwellings and the quality of life of people, also plays an important role in the integration and in the development of regions distant from large urban and industrial centers. Hydroelectricity has historically been the main generation source of the Brazilian electricity system, accounting for about 63% of installed capacity in Brazil.

This significant participation in the electric matrix is due to the great hydroelectric potential of the country and the various advantages that this source of electricity generation presents in relation to the others. It is a source of renewable generation, economically competitive, and has great flexibility of operation, capable of responding to demand fluctuations almost instantaneously. Hydropower reservoirs can provide a range of non-energy services such as flood control, irrigation, water supply for human consumption, recreation and navigation services. On the other hand, it should be mentioned that the multiple uses of water can be conflicting. The main variables used in the classification of a hydroelectric plant are: height of waterfall, flow, capacity or installed power, type of turbine used, location, type of dam and reservoir. All are interdependent factors. Thus, the height of the waterfall and the flow will determine the construction site and determine the installed capacity, which in turn determines the type of turbine, dam and reservoir.

There are two types of reservoirs: accumulation and run-of-the-river. The former, usually located at the head of the rivers, in places of high waterfalls, given their large size allow the accumulation of large amount of water and function as stocks to be used in periods of drought. In addition, because they are located upstream of other hydroelectric plants, they regulate the flow of water that will flow to them, in order to allow the integrated operation of the set of plants. The run-of-the-river units generate energy with the flow of water from the river, that is, by the flow with minimal or no accumulation of the water resource.

The installed power determines whether the plant is large or medium-sized or a Small Hydroelectric Plant (SHP). The National Electric Energy Agency (Aneel) has adopted three classifications: Hydroelectric Generating Centers (CGH) (with up to 1 MW of installed capacity), Small Hydroelectric Plants (between 1.1 MW and 30 MW of installed capacity) and Hydroelectric Power Plant (HPP, with more than 30 MW). The size of the plant also determines the size of the transmission network that will be needed to bring energy to the center of consumption.

The larger the plant, the farther it tends to be from the large centers. Thus, it requires the construction of large transmission lines in high and extra-high voltages that often cross the territory of several States. The SHPs and CGHs, installed alongside small waterfalls, generally supply small consumer centers, including industrial and commercial units, and do not require such sophisticated facilities to transport energy.

The use of hydraulic energy for electric power generation is done through the use of hydraulic turbines, properly coupled to a generator. With an efficiency that can reach 90%, hydraulic turbines are currently the most efficient forms of converting primary energy into secondary energy. Hydraulic turbines come in a variety of shapes and sizes. The most widely used model is Francis, as it adapts to both low-fall and high-fall sites. As it works totally submerged, its axis can be horizontal or vertical. Among other models of hydraulic turbines, Kaplan stands out, suitable in places of low fall (10 m to 70 m), and Pelton, more appropriate to places of high fall (200 m to 1,500 m) [4].

The construction of hydroelectric dams is clearly associated with a series of positive and negative environmental impacts. Some of them may represent real constraints to the installation of such structures, while others may act as a sustainable path to local development. Since energy is widely needed for almost all human activities, it is necessary to balance the pros and cons related to the generation of energy by a hydroelectric plant. No universal recipe can be established here, since regional peculiarities will play a significant role in the decision-making process. In the case of Brazil, the government, civil society, water users and the scientific community have for many years been deeply involved in this relevant discussion. From a broad point of view, it can be assumed that the advantages usually prevail over the limitations and a solid trend of additional power generation through the installation of dams can be identified in the country [5].

2.2 Wind energy

Wind energy is the kinetic energy contained in the moving air masses (wind). Its utilization occurs through the conversion of the kinetic energy of translation into kinetic energy of rotation, using wind turbines, for the generation of electricity, or through mills, for mechanical

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works such as water pumping. For the generation of electricity, the first attempts appeared in the late nineteenth century, in 1970 with the international oil crisis arises the interest and investments to enable the development and application of equipment on a commercial scale.

The evaluation of wind potential in a region requires systematic data collection and analysis on wind speed and regime. In order for wind energy to be considered technically feasible, its density must be greater than or equal to 500 W / m2, at a height of 50 m, which requires a minimum wind velocity of 7 to 8 m / s, however, according to the World Meteorological Organization, only 13% of the earth's surface presents this characteristic.

In Brazil, although there are still divergences between specialists and institutions in the estimation of Brazilian wind potential, several studies indicate extremely considerable values. Until a few years, the estimates were of the order of 20,000 MW. Today most studies indicate values greater than 60,000 MW. These divergences are mainly due to the lack of information (surface data) and the different methodologies used. Regarding the design of turbines, it can be said that at the beginning of the use of wind energy, turbines of various types arose; the wind turbine design was consolidated with the following characteristics: horizontal rotation axis, three blades, active alignment, induction generator and non-flexible structure, however, some characteristics of this project still generate controversy, such as the use or not of the control of the pitch angle of the propeller blades to limit the maximum power generated. Regarding the generation capacity in 1997, 1 MW and 1.5 MW wind turbines were introduced commercially, starting the generation of large machines. In 1999 the first wind turbines of 2MW appeared and today there are prototypes of 3.6MW and 4.5MW being tested in Spain and Germany. The average capacity of wind turbines installed in Germany in 2002 was 1.4MW and in Spain 850kW. Currently there are more than 1,000 wind turbines with a rated power of more than 1 MW in operation in the world. In recent years, the biggest technological innovations have been the use of direct drive (without gear multiplier), with synchronous generators and new control systems that allow turbines to operate at variable speed with any type of generator. As for the application, the turbines can be connected to the electrical network or intended for the supply of electricity to communities in isolated systems. Regarding the location, the installation can be done on land or offshore.

An important factor that should be highlighted in Brazil is the possibility of complementarity between hydroelectric generation and wind generation, since the greatest wind potential in the Northeast region occurs during the period of lower water availability [4]. In the Brazilian scenario, wind energy is advantageous for complementary use with hydraulic energy, source with higher generation rate in the Brazilian matrix. In addition, this complementary generation could be established in different regions of the country [6] [7] [8].

Due to this characteristic, studies have examined the possibility of installing wind turbines in reservoirs of large hydropower plants or even around small power plants[6]. The potential for generating employment due to wind energy in Brazil is 13.5 people / year for each MW between component manufacturing and the first year of the plant. The total potential is 24.5 people / year for each MW during the lifetime of the wind farm [6] [9].

Wind has become an important source of energy in Brazil, since it is the second largest renewable source in the Brazilian energy matrix. In recent years, exponential growth has been observed. The growth of this source is extremely important for the construction of a diversified, clean structure and a renewable energy matrix.

2.3 Biomass – Sugarcane bagasse

Sugarcane has been used as a raw material for large-scale ethanol production in Brazil for over three decades, where most sugarcane mills produce sugar, ethanol and electricity. A typical plant has processes common to the ethanol distillery and to the sugar factory composed of the following processes: reception of sugarcane, preparation of sugarcane and extraction of juice. All the energy (steam and electricity) required in this process is produced by the sugarcane bagasse as fuel in the boilers, this residue is generated in the process of extracting the juice. In many plants, the surplus energy generated is marketed to distributors [10]. Sugarcane mills currently use a co-generation system based on the Rankine cycle, the sugarcane bagasse is burned in the boiler, producing steam that is expanded in turbines coupled to electric generators, exhaust steam from the turbines is used as a source of thermal energy in the sugar and ethanol production process. This cogeneration system is installed in most of the sugar and alcohol plants in Brazil, however the steam demand in the plant is a limiting factor for the cogeneration system, that is, not all the available bagasse is often consumed [11].

Until the late 1990s, the cogeneration systems used in the mills were designed only for the thermal energy needs of the sugar and ethanol production process, burning all

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the bagasse available and producing little or no electricity surplus. However, in the same period, with the elimination of certain rules and regulations of the energy sector in Brazil, conditions were created for power plants and other electricity producers to market this surplus electricity to the distributors, which enabled a modernization of cogeneration facilities existing [12]. Modern plants have replaced low pressure / low efficiency boilers with medium and high pressure boilers (42 to 90 bar) [13]. The systems with condensation-extraction steam turbines allow the maximization of the production of electricity, since the amount of steam produced does not have to correspond to that necessary to provide thermal energy for the process, since the excess steam can be condensed [10]. Approximately 25% of processed cane is processed into bagasse. According to the National Energy Balance [3], during the 2017/2018 harvest, 165.6 million tons of wet bagasse were produced. Currently, most of the sugarcane bagasse is destined to the burning of the boiler as fuel for cogeneration of energy (Steam and Electricity). The sugarcane bagasse, lignocellulosic biomass, is composed of a complex structure, composed mainly of three fractions denominated cellulose, hemicellulose and lignin. These fractions have a high energy content, being composed of cellulose (40 to 45%), hemicellulose (30 to 35%) and lignin (20 to 30%) [14]. The generation of electricity through sugarcane bagasse is a strategic source for the Brazilian electricity system due to the complementary time between the sugarcane harvest period and the period in which the reservoirs of the sugarcane plants have their lowest levels. Currently, due to the low price of electric energy in biomass energy auctions (regulated market), the investments of the sugar and ethanol sector have postponed their investments in new projects of electricity generation (bioelectricity). Another factor that is influencing the postponement of investments in bioelectricity is the latest advances in the economic-financial viability of second generation ethanol, which competes with bioelectricity using the same raw material: sugarcane bagasse [15].

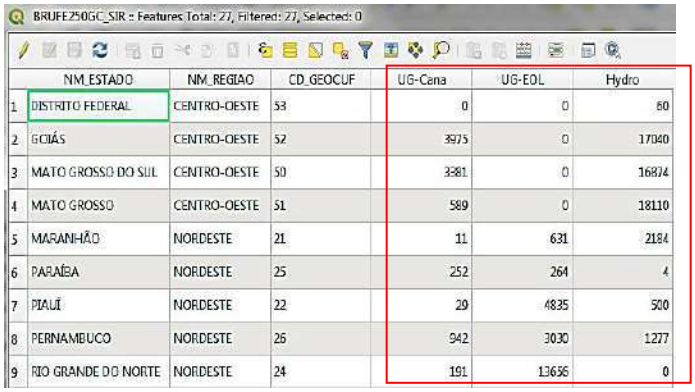
III. APPLICATION DEVELOPED

For the answer to the problem addressed in this article, the first step was to verify the generation of electricity in Brazil by source, in this way was used data available in the National Energy Balance 2018 [3], which specifies the amount of electric energy generated by source in each unit of the federation. After data collection, the second step was to allocate this amount of electric energy generated in a map for verification and visualization of the energy generating region by source, to carry out this stage of the study the following steps were followed:

a) Obtaining the map of Brazil, detailed in units of the federation: This file is available on the IBGE website [16], the map "Brazil - Units of the 2017 Federation" was chosen, where it is possible to download the file "BRUFE250GC_SIR" with the extensions; shx; shp; prj; dbf and cpg, for further work on QGIS® software.

b) Obtaining the software "QGIS Desktop 3.4.5": QGIS® is a licensed open source Geographic Information System (GIS). QGIS operates on a variety of operating systems and supports vectors, rasters, and databases. The use of QGIS® is necessary for the inclusion of data obtained from electric power generation by source in each geographic region [17], in this study, by region of the federation;

c) With the data obtained and the software available for use, in the file "BRUFE250GC SIR" the table of attributes was changed including three columns referring to the generation of electricity by source, hydroelectric (Hydro); wind (UG-EOL) and biomass - Sugarcane bagasse (UG-Cana), with data values in Gigawatt (GWh), as shown in Figure 1;


BRUFE250GC_SIR :: Features Total: 27, Filtered: 27, Selected: 0

	NM_ESTADO	NM_REGIAO	CD_GEOCUF	UG-Cana	UG-EOL	Hydro
1	DISTRITO FEDERAL	CENTRO-OESTE	53	0	0	60
2	GOIÁS	CENTRO-OESTE	52	3975	0	17040
3	MATO GROSSO DO SUL	CENTRO-OESTE	50	3381	0	16874
4	MATO GROSSO	CENTRO-OESTE	51	589	0	18110
5	MARANHÃO	NORDESTE	21	11	631	2184
6	PARAÍBA	NORDESTE	25	252	264	4
7	PIAUÍ	NORDESTE	22	29	4835	500
8	PERNAMBUCO	NORDESTE	26	942	3030	1277
9	RIO GRANDE DO NORTE	NORDESTE	24	191	13656	0

Fig.1: Attribute table

d) With the inclusion of the data in the attribute table, it was possible to create three different files, for each electric power source and using the layer properties function, it was possible to identify the amount of energy generated by each region in the federation, as shown in Figure 2.

https://dx.doi.org/10.22161/ijaers.6722 *ISSN: 2349-6495(P) | 2456-1908(O)*

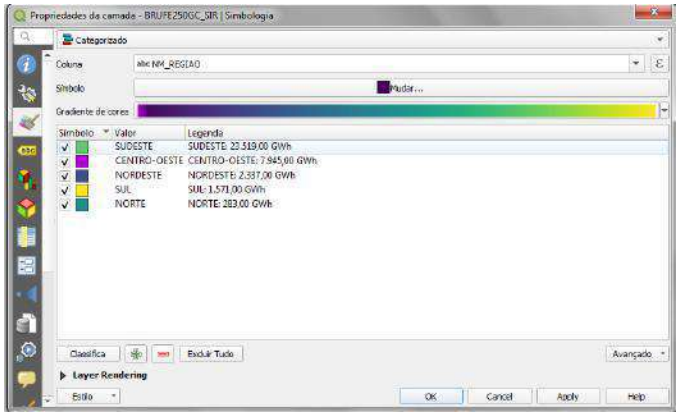


Fig.2: Layer property setting

IV. DISCUSSION OF RESULTS

The results presented objectively describe the concentration of these renewable energy sources and the generation of electricity through these sources per unit of the federation in Brazil.

4.1 Hydroelectric

Table 1 shows the generation of electric energy for each region in Brazil, through hydroelectric plants.

Table 1: Electricity generated in Brazil - Hydroelectric

Region	Electric power generation- GWh
South	127.530,00
Southeast	87.003,00
North	86.364,00
Midwest	52.084,00
Northeast	17.927,00

Within these regions the states of Paraná, São Paulo, Pará, Minas Gerais and Rondônia stand out. The generation of electricity in Brazil generated by hydroelectric dams is carried out through two large integrated structural systems: the South-Southeast-Mid-West system and the North-Northeast system, which correspond respectively to 70% and 25% of the hydroelectric power in Brazil. Figure 3 shows the generation of electric power, through hydroelectric plants per region of the federation.

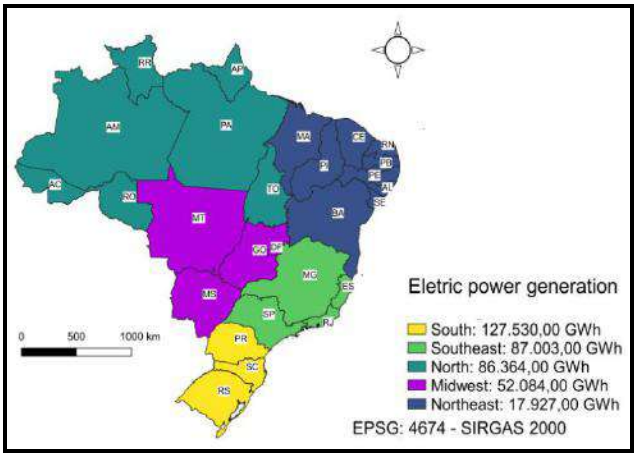


Fig. 3: Generation of electric energy by region – Hydroelectric

4.2 Wind energy

Table 2 shows the generation of electricity for each region in Brazil, through wind power plants.

Table 2: Electricity generated in Brazil – Wind energy

Region	Eletric power generation- GWh
Northeast	36.188,00
South	6.108,00
Southeast	78,00
Midwest	0,00
North	0,00

Within these regions stands out the states of the northeast region with the greatest amount of electric energy generated, such as Rio Grande do Norte; Bahia and Ceará, in the South region the state of Rio Grande do Sul stands out, these states are concentrated in coastal regions with a higher incidence of winds. Figure 4 shows the generation of electric power, through wind power plants per region of the federation.

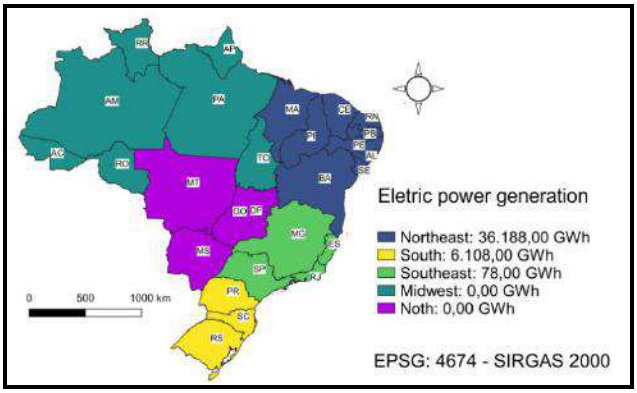


Fig. 4: Generation of electric energy by region – Wind energy

4.3 Biomass – Sugarcane bagasse

Table 3 shows the generation of electric energy for each region in Brazil, through sugar and ethanol plants, using sugarcane bagasse in the cogeneration process.

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Table 3: Electricity generated in Brazil – Sugarcane bagasse

Region	Electric power generation- GWh
Southeast	23.519,00
Midwest	7.945,00
Northeast	2.337,00
South	1.571,00
North	283,00

Within these regions the states of the Central South region, which are located in the Southeast and Midwest regions, stand out. The country's sugar and ethanol plants are concentrated in the Zona da Mata, in the Northeast, and in the states of São Paulo; Minas Gerais and Mato Grosso do Sul, in the Center South region (Southeast and Center West). It stands out the state of São Paulo, which produces about 52% of all the sugarcane produced in the country. Another point that stands out refers to sugarcane bagasse, sugar cane bagasse is used for power generation and there is no demand for fossil fuels in the industrial phase of sugar and ethanol production, these plants are self-sufficient. Sugarcane bagasse, the residue of the milling process, is used to produce heat and the electricity needed to produce ethanol and sugar in production plants, and in cases of excess electricity production, this becomes another item to be marketed in favor of producers. The use of sugarcane bagasse for energy cogeneration is the reason why the energy balance of ethanol production from sugarcane is highly positive, since no fossil fuel is used, except for those that are included in the production of fertilizers and pesticides, and the diesel oil used in agricultural equipment and in the transportation of sugarcane to supply the production plants.

As a result, there is a strong benefit not only in the energy balance, but also in the greenhouse gas emissions associated with sugar and ethanol production. Figure 5 shows the generation of electric energy, through sugar and ethanol plants, using sugarcane bagasse, per region of the federation.

Based on the amount of electricity generated by the three main renewable sources of energy generation in Brazil, an analysis of how these sources are to be addressed and addressed is necessary. Currently experts are beginning to question about new investments in large hydroelectric dams, considering that the development of hydroelectric dams is a global phenomenon that is affecting the most important watersheds in the world, including the Amazon, the Congo and the Mekong, creating huge disruptions, in these ecologically important regions.

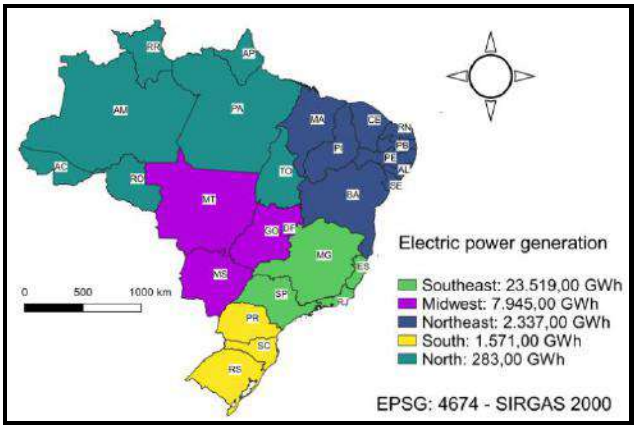

Fig. 5: Generation of electric energy by region – Sugarcane bagasse.

The financial costs of the dams are immense, and many believe that the benefits do not outweigh the costs. The hydrological consequences of large-scale dams and reservoirs are extensive; sharp declines in available fresh water due to dam construction cause seasonal changes in river flow, as well as loss of freshwater habitat downstream, floodplains and even coastal erosion and salinity changes. In the Tucuruí dam region of the Brazilian Amazon, fish catching declined by almost 60%, and more than 100,000 people living downstream were affected by loss of fishing, recession agriculture and other natural resources. The Jirau dam and the Santo Antônio dam on the Madeira River in the Brazilian Amazon, completed only 5 years ago, are expected to produce only a fraction of the 3 GW each that are designed to produce due to climate change and small storage capacity. However, it should be noted that this same author advocates the creation of small power plants, due to the lower socio-environmental impact and benefits to the community involved [18].

The bioelectricity potential of biomass through sugarcane is estimated at 62-93TW / h, which can be improved through a more adequate use of biomass from the sugar and alcohol industry, in order to balance the availability of biomass, hydroelectric power [1].

With a view to the near future, when the sugar and alcohol plants start to produce much larger surpluses of electricity, especially with more developed technology for burning straw in conjunction with sugarcane bagasse, average surplus energy values will increase substantially [13]. In relation to wind farms, Brazil has an immense coastal area with the capacity to absorb more wind farms, coinciding with the areas of greater consumption at the extreme of the transmission lines, enabling the expansion of the sector in an attractive way, [7] in particular , the peculiarities of the coastal region of the Brazilian

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Northeast (NE) allow a strong penetration of wind energy, which should generate 57% of the electricity supply of the Northeast until 2020. As precipitation in the Northeast is susceptible to climate change, it is predicted that wind power may replace lost hydropower availability [1].

V. CONCLUSION

In this article, the current condition of the electric power generation sector in Brazil is transparent, the most used source in the country is the hydroelectric plant, the share of electricity generated by projects created on the basis of renewable sources is growing; wind, biomass-sugarcane bagasse and small hydroelectric plants, with the objective of increasing energy security, reducing greenhouse gas emissions, regionalizing production, introducing new technologies, modernizing the national industrial park and valuing the respective localities. Considering the various renewable sources available, the country shows potential for integration between renewable energy sources, which would lead to an energy matrix for more distributed electricity generation, presenting socio-economic gains, technological and providing local industrial development, with a view to the power of technology absorption and learning from local industries. For the success of this integration between renewable sources, it is necessary to consider the seasonality of energy sources and that the use of these sources should be planned and functioning positively and complementing each other, it is also necessary to improve government programs to encourage the generation of electricity, in particular, the smart grid, which allows the connection of small photovoltaic and wind systems to consumers of low voltage (commerce and residences), besides allowing the perfect functioning of these systems in tune with the whole electrical system, favoring the generation of electric energy . In this context, it should be clear that there is room for other forms of generation by clean sources, such as solar energy, but these investments should always focus on the integration of generation processes, always seeking the growth of the country.

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Recognition of Key Drivers to the Improvement of Competitiveness Strategies in Brazilian Coffee

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Abstract— *The adequacy of the coffee properties and the production systems for the certification has allowed the improvement in the management and the sustainability of the companies raising the degree of their participation in the international markets. The agricultural management about productive assets and human capital is the real challenge for the recognition of the key drivers that are associated with competitiveness. The changes that segment is expressed in the development of relations and interactivity among the stakeholders of the value chain, suggesting that, training and knowledge are a guide to the new productive and competitive of producers. The need for management for coffee quality, improvement of management techniques, and training of social capital presented as potential tools to increase competitiveness in coffee production.*

Keywords— ***interactivity, Knowledge, management, social capital, value chain.***

I. INTRODUCTION

Brazilian coffee industry has been working to increase opportunities for market participants and the possibilities for improvement that presented in the innovations and social-environmental technologies applied to management.

As a result, the average yield of Brazilian coffee production in the period from 2006 to 2016 increased by approximately 23% and the area harvested decreased by approximately 12%. These indicators point out that the continuous improvements applied to coffee production have allowed market expansion and positive results for rural owners, without the dependence of new productive areas.

The emphasis on the adequacy of rural farms and production systems for certification has allowed the improvement in the management and sustainability of agricultural coffee enterprises in general, as well as increasing their participation in international markets.

In parallel, a global movement of the coffee segment to the main focuses of collective interventions in the coffee value chain, increasing the agricultural extension, technical assistance, training and training of the producers, preparing them for access to available to small and medium-sized producers.

Some studies by BUAINAIN et al. (2014) allow us to infer that the family farmer in Brazil, mainly the cooperative and or associates, differentially enjoy technical assistance, private-public partnerships for the market, diffusion of technologies and knowledge for certifications and good agricultural practices, which reflect in continuous improvement , cost reduction and efficiency in rural production.

However, it is not only the cooperative with its philosophical principles that attract farmers to the association but the economic advantages that this may mean, since for the current coffee market competition is no longer at low cost and scale production, but mainly in the quality of the product, keeping the costs low (production by positioning).

The reorganization of rural management about productive assets and human capital become challenges for the recognition of *key drivers* that can improve competitiveness.

In this way, the primary objective of this project was to recognize the changes that are beginning to characterize the Brazilian coffee segment, when expressing themselves in the development of relations and interactivity among the stakeholders of the value chain (*key drivers*), suggesting that, training and knowledge are a new productive and competitive reality of rural producers.

Focusing specifically on knowledge and skills in environmental management and management for small and medium-sized coffee-producing farmers and exploring the potential of value chain partnerships, authors such as STEENSMA, 1996; SCHMITZ, 2005; UTTING, 2009; SAES et al., 2014, recognize and admit indicators (actions) that improve the insertion of rural organizations in the market.

It is essential to progress in recognition of assets and capital, which specifically concern the creation of differentials in opportunities for the agricultural company

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to participate in the market and its adaptation to the production standards for sustainability.

II. LITERATURE REVIEW

It is a consensus in coffee cultivation that the property management process has paradigms to be worked. It observed in interviews and data collection, in line with the literature reviewed here (PINHEIRO, 1996; KASSAL, 1997), that rural owners often make production decisions based on feelings and without planning.

In this way, it suggested that for the rural owner to adapt to the context of current competitiveness, his management efforts should be related to production planning, production quality, innovation, and technology.

The synergy between the links in the value chain makes it possible to recognize influences and adaptations in management, education, quality, training and training of producer organizations; as well as what are the opportunities for partnering.

A synergistic capability is considered the set of strategically understood business processes that add value. This synergistic capacity is still little thought of as a long-term strategy (PORTER, 1980: 1989: 1991, PRAHALAD, 2009 and 2010).

Porter (1980, 1991) introduced the idea of collective analysis (different from the neoclassical idea), where the determination of the behavior of agents in the industrial structure is the main responsible for organizational failure or competitive success. The term essential competency gained importance in management from Prahalad and Hamel (1990) and Prahalad (2009), arguing that "in the long term, the systematic development of learning and innovation in organizations can model the capture of values that generate competitiveness and operational productivity. "

By definition, core competency designates the strategic, unique and distinctive competencies of an organization. The concept presents competence from the skills that companies must develop to compete for participation in market opportunities and not for market share.

Some authors (Porter, 1989; Reeves and Bédar, 1994; DUNCAN, 1988; CASTRO JUNIOR and REIS, 1998 and 2003) have suggested the potential strengthening of organizations in the quest for product quality and the management and information flow processes are indicators that allow us to analyze and compare the challenges to achieve efficiency in continuous improvement.

As well as good agricultural practices (GAP) permeated the value chain and the generation of competitive opportunities, analyzes were developed for the recognition of key drivers (DUNCAN, 1988 and NELSON, G. C. et al., 2005).

The influencing agents or drivers of change (DUNCAN, 1988) are elements of reality that directly influence the strategic environment, investments, P & D activities or knowledge.

Change drivers (guiding forces) are real indicators that impact the environment of influence, are elements that can cause changes according to the strategies, chosen for the management of organizations (NELSON, G. C. et al., 2005). Drivers, as considered in the present work, are indicators resulting from the management process applied in the coffee production cycle, which can cause significant changes in rural properties, considering the knowledge and the available training and the possibility of changes and improvement.

Certification, introducing the improved quality of rural properties, can be seen as a result of synergistic dialogue and general technical assistance among all stakeholders in the value chain. In this way being cooperated has been considered as a critical strategy to reach the highest quality of specialty and gourmet coffee for the markets (MAPA, 2017).

In processes of certification and adoption of good agricultural practices, management, social capital, and environmental compliance are tools of analysis to understand the influence of training and knowledge of the actors involved in productive activities.

Utting (2009) in the analysis of social capital management and environmental impact on coffee in Nicaragua, considered the use of analysis techniques to recognize the influence of knowledge and management on human, social and physical capital based on income and productivity of farms.

Technically, BUREAU / UFLA (2016) recognizes the management of farms when analyzing the knowledge and management of social and human capital and identifies contributions and limitations of partnerships or certifications regarding the strengthening and preparation of the farmer and its property to the market.

The results of the approaches and analyzes of the partnerships that can potentially strengthen organizations and producers, for Barret, 2008 and Markelova et al., 2009 are in recognition of the technological improvements of the productive assets and the social and human capital of the organizations.

In the same way, other authors (Porter, 1985: 89, BOWMAN, C & J.SWART, 2007; BOJNEC, S. & FERTÖ, I., 2009; MARKELOVA et al., 2009; PRAHALAD, 2009: 2010; LATRUFFE, (GARDEN et

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al., 2011), with an approach on the technical knowledge and the applied management in the supply chain value of specialty coffee, that is, its relation to the continuous potential flow of dialogue among value chain agents.

III. MATERIALS AND METHODS

3.1 Characterization of the Study Area: Meso-region, Microregion, and Cities

The identification of chain actors for the analyzes explores changes in welfare systems and patterns for sustainable development, identifies potential conflicts of interest and compromise solutions between different local actors and potential evidence of innovation and continuous improvement in agricultural holdings and its surroundings.

The low and middle Mogiana Paulista, the reference in this research, is located in the Campinas Meso-region; which is into two micro-regions, the first being the Micro-region of São João da Boa Vista, composed of the municipalities of Espirito Santo do Pinhal, São João da Boa Vista, Divinolândia. The second Amparo Micro-region formed by the municipalities of Amparo, Serra Negra, and Socorro, with a total of four cooperatives and production for the year 2014: 2015 of 31,972 tons (IBGE, 2018).

Middle and low Mogiana Paulista is the third largest national producer, and second in overall quality in the production of Arabica coffee. The characteristics of the grains appear with a pronounced aroma, medium body (full bodied) and balanced acidity.

In the Mogiana Region, the most traditional denomination in the State of São Paulo, coffee introduced almost 200 years ago. The planting is in sandy soil, at an average altitude of 900 to 1,000 meters.

Is economically located in the lower and middle Mogiana Paulista Region, being a research reference to Meso-region Campinas with its central municipalities and micro-regions, and the production in tons for the harvest of 2015/2016, is 25,514 production tons significant, that is, 22,850 / scs.

Approximately 97% of the production of municipalities with representation by IBGE / WEBCART, 2018. The cooperatives and associations identified for these two micro-regions are COOPINHAL, COOXUPE, APROD, ACECAP *, COOCASER * and SPECIALITY COFFEE *, (* non-existent physically).

The South Meso-region of Minas was into two micro-regions: the Alfenas micro-region, formed by the rural coffee-producing properties of the municipalities of Alfenas, Machado and Poço Fundo and the micro-region of Poços de Caldas, formed by the farms of the municipalities of Andradas, Ouro Fino and Poços de Caldas.

In each micro-region, a total of 15 farms searched. The South Minas grouping comprised of eight coffee cooperatives; its properties were responsible for a total of 80,432 tons of Arabica coffee in the 2015/2016 harvest, that is, 140,500 scs.

It is representing 20% of the production of the meso-region, except for the surrounding municipalities and the influence of the Cooperative of Guaxupé - COOXUPÉ.

These municipalities excluded so that there was no distortion in the results, the fact that COOXUPÉ, corresponds to 95% of agents in Brazil. The South of Minas Gerais produces coffee with a sweet and mild flavor, sharp aroma, balanced body, and citric acidity.

Currently, it corresponds to 70% of the income of the rural properties of the South of Minas. The average altitude of the planting is approximately 950 meters.

3.2. Interviews and Variables Used to Recognize Key Drivers

The indicators (51) used to construct the questionnaire, the basis for collecting the information and analyses, preserve the shared characteristics between the different codes and norms. Consequently, its construction took into account differences in social, environmental and political aspects; and in the institutional context of each area of application, as well as the distinct nature of resources and the number and different actors involved.

The productive groups analyzed were recognized according to the concepts of Malhotra (2006), to characterize the groups and their performance in terms of socioeconomic variables, about management and administration conformities in the farmer has studied.

In order to gather the necessary information for the stakeholder characterization analyzes, a questionnaire was on the leading standards, codes of conduct of certification programs and laws in force in the country and the world, in GAP.

The application and construction of the questions started from the premise that the indicators vary according to nature and the management system applied in the rural properties, and include a characteristic of each meso-region, micro-region, and surroundings, relevant in the proposed recognition.

Thus, the indicators are grouped to meet the three dimensions that are the focus of the research: Environmental Management with 30 indicators; Economic Management with 12 indicators and Social Capital Management with nine indicators. In its modeling, the questionnaire combines economic, social and environmental indicators, to allow the recognition of

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the specificities of influencing competitiveness, helping in the suggestion of actions to take advantage of market growth opportunities and product quality.

The answer to the questions provided a four-point scale for the arguments: "yes," "partially," "no" and "not applicable" (dummy). By maximizing comparable similarities between properties, the questionnaire gathers production data, as well as qualitative and contextual data from properties, cooperatives, and due to certification bodies or market (value chain/stakeholders).

It is important to emphasize that when quantitative indicators (binary forms) and qualitative (often subjective) indicators used, for each analyzed dimension, one or more indicators of influence can be in the opportunities for improvements to competitiveness.

A sum of approaches to quantitative and qualitative research has been used to adequately qualify the information of the different stakeholders and their expertise in the productive processes.

3.3.1 Environmental Management

The first investigative set of recognition for environmental management consists of 30 indicators divided into 06 indicators for analysis of machine management and benefactors, being they:

- ✓ Number of tractors: quantitative; for knowledge of applied technology and mechanization;
- ✓ Harvester: quantitative for knowledge of applied technology and mechanization;
- ✓ Benefit Machine: dummy for knowledge of applied technology and characteristics of harvested coffee;
- ✓ Granary: dummy for knowledge of applied technology and characteristics of coffee;
- ✓ Terrace: dummy yard for knowledge of applied technology, coffee quality ratio;
- ✓ Irrigation: quantitative for knowledge of applied technology, interference in cost.

The second division for environmental management and opportunity recognition in a production environment, composed of 14 indicators:

- ✓ Erosion: qualitative; control compliance with GAP standards;
- ✓ Chemical fertilization/tons: quantitative; correlation with production costs;
- ✓ Organic fertilization/tons: quantitative; correlation with production costs;
- ✓ Does organic fertilization buy waste? Quantitative; related to management costs and opportunities;
- ✓ Applies insecticide: quantitative; disease prevention and productivity, related to management costs and opportunities;
- ✓ Applies fungicide: quantitative; disease prevention and productivity, relative to manage costs and opportunities;
- ✓ Manually harvested area (ha): quantitative; disease prevention and productivity, related to management costs and opportunities;
- ✓ Mechanically harvested area (ha): quantitative; related to management costs, opportunities and productivity;
- ✓ It has technical guidance in the property: qualitative; related to management costs and opportunities, related to management costs;
- ✓ It controls costs of production: quantitative; productivity, relative management costs, and opportunities;
- ✓ The number of plots: quantitative; related to management costs, opportunities, and productivity;
- ✓ The number of economic tables: quantitative; productivity, relative to manage costs and opportunities;
- ✓ Descartes of packaging: quantitative; adequacy of GAP;
- ✓ Disposal of waste: quantitative; relative to manage costs and opportunities productivity and GAP adjustments.

The third division for Environmental Management for recognition of opportunities in management and production, consisting of 11 indicators, being their:

- ✓ It has enough terrace: quantitative; related to the quality of production;
- ✓ Complies with the standards APP's, RL: qualitative; adjustments to GAP;
- ✓ Preservation of energy resources, firewood, water: quantitative, adequacies for GAP;
- ✓ Performs annual soil analysis: quantitative; opportunities to reduce costs and risks in production;
- ✓ It performs organic fertilization with the bark of the coffee: quantitative; opportunities to reduce costs for production;
- ✓ It records the operations in the field: quantitative; opportunities to reduce costs for production;
- ✓ It carries out selective harvesting: quantitative; opportunity for production quality;

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- ✓ Separates the harvested coffee (cloth and machine): dummy; sweeping opportunities for production quality;
- ✓ Sparing and gathering according to technical recommendations: dummy; opportunities for production quality;
- ✓ Monitors moisture in the process of drying and storage: dummy; opportunities for production quality;
- ✓ Controls environmental impacts: dummy; GAP adjustments;

3.3.2 Economic Management

It evaluates the size of the administration and management of the property, formed by 12 indicators, and it involves information on specifics for the efficiency. In this dimension, indicators on the income of the establishment, the diversity of sources and the distribution of income among those involved in the productive processes and data on the quality of housing considered.

- ✓ Type producer: analyzes the production systems used being conventional (commodities) or certificates;
- ✓ Area of the property (ha): quantitative variable for characterization of the productive project and its management;
- ✓ Planted area (ha): quantitative variable for characterization of the productive project and its management;
- ✓ Total Production coffee (sacks): variable for calculating productivity, the profitability of properties;
- ✓ Quantitative productivity (ha): informed by the owner;
- ✓ Cost/sack (R$): quantitative; informed by the owner;
- ✓ Cost/ha (R$): quantitative; informed by the owner;
- ✓ Qualitative certification highlights the loyalty of the producer and its synergy to the collective;
- ✓ Percentage of production receives by quality: quantitative differentiated value, analyzes business risk and generation of other incomes;
- ✓ Quantity harvested: quantitative; indicative of productivity;
- ✓ Exchange inputs by coffee: analyzes the producer's knowledge regarding opportunities for risk and cost sharing;
- ✓ Estimates production: quantitative; use of technology and management in the properties;
- ✓ Quantitative fixed employees: determination of a type of labor;

3.3.3 Social Capital

The term Capital refers to relational networks based on trust, cooperation, and innovation (individuals inside and outside the organization) facilitating access to information and knowledge. In this study the networks are informal, involving horizontal (between peers) and diagonal (between employees of different areas and stakeholders) (PRAHALAD, 2004).

Buyers and consumers have demanded products with differentiated quality, regarding the environment and social responsibility, which requires an effort of the producers to maintain their improvements continuously.

It also includes considerations about the quality of life of the residents of the property, including access to education, essential services, consumption patterns, employment characteristics such as quality and benefits; occupational health and Safety; and job opportunity in a qualified location.

The third set of 09 social capital management indicators includes verification of the consolidation of integration mechanisms among the actors in the chain for continuous improvement.

- ✓ Offers to a house; Accommodation; Access drinking water; Offers protection equipment: are variables dummy for GAP Adequacies and legal compliance;
- ✓ Portfolio registration: dummy; GAP adjustments and legal compliance;
- ✓ Social security: dummy; GAP adequacies and legal compliance;
- ✓ Training and qualification of labor: dummy; opportunities for improvement in production and management;
- ✓ Heirs provide continuity in the activity: dummy; adherence and opportunity for fixation in the field;
- ✓ Children of employees remain in the activity: dummy; adherence and opportunity for fixation in the field.

IV. RESULTS AND DISCUSSIONS

The results presented in the analyzes accurately represent the answers given by the rural owners. The interviewers, even though they understood the impossibility of the constant attainment of the presented performances, abstained from directing the answers.

The emphasis on the adequacy of rural properties and production systems for certification has allowed the improvement in the management and sustainability of agricultural coffee enterprises in general, as well as increasing their participation in international markets. In

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parallel, a global movement of the coffee segment to the main focuses of collective interventions in the coffee value chain, increasing the agricultural extension, technical assistance, training of the producers, preparing them for access to available to small and medium-sized producers.

The better understanding of the productive system as the need to improve the management of coffee quality, the management techniques, training of social capital, are presented as potential tools to increase competitiveness in coffee activity in a general and collective manner, in the two Meso-regions. In general, the results of this work contribute to the rural owners, recognize and interact with opportunities for improvements in knowledge and training in the management of their properties; in order to take advantage of the continuous flow of dialogue with the value chain of coffee production.

4.1 Characterization of Meso-regions.

This characterization of the Southern Meso - regions of Minas and Campinas / SP, was made in such a way as to individualize each municipality and researched property. The analyzes express information obtained through the application of the guiding questionnaire, from 2015 to 2017.

All 30 answers were given by the interviewees without the researcher's guidance, even in cases of data that diverged from the bibliographies consulted mainly.

In the "Table 1" average economic outlook of the surveyed properties for the Southern Meso-region of Minas and Meso-region Campinas / SP.

Table 1: Economic management indicators average panorama of 30 properties

Indicators	**Average Campinas/SP**	**Average South of Minas**
Production Area/ ha	93,6	22
Planted Area / ha	70	21
Production/ scs	1.408	659
Productivity/ha avarage	22	31
Custs/scs	R$ 396,00	R$ 386,00
Custs/ha	R$ 11.705,00	R$ 10.789,00
Sale with Added Value above 80 points	60 %	68 %

4.2 Meso-region of the South of Minas Gerais

In this study, the Southern Meso-region of Minas is of the micro-regions: Poços de Caldas and Alfenas. The questionnaire was composed of 51 variables divided into Economic, Environmental and Social Management. The results extracted by adapted analyzes of the key driver's concept found in the study by DUNCAN (1988).

The influencers with emphasis on training and knowledge improvement focused on improving the management analyzed in the 30 researched farms and according to the owners' responses without suggested induction. Even when the reported data diverged from the bibliography referenced in other analyzes or data collection, stand out in key drivers for Economic Management: Where the response rate of the variables was 85% among the properties. The rationale for this adherence lies in the predominance of family labor, property area of up to 20 ha and exclusive dedication to coffee production.

Key drivers with the possibility of improvement in Economic Management:

- ✓ 43% of the properties are not certified;
- ✓ 33% of the properties sell less than 70% of their coffee production with a quality or special recognition;
- ✓ 46% of the properties are unaware of or are not interested in switching from future production to production inputs.

Key drivers for Environmental Management (Machinery and Equipment, Production, Environment and Management).

In this case, the adhesion index of the properties was 61%. Justifications for low adherence is in the fact that mechanization and irrigation not used in coffee production due to the terrain and altitude of the crops.

Key drivers with the possibility of improvement in Machines and Processing:

- ✓ 27% of the properties are not self-sufficient in residues for organic fertilization;
- ✓ 6% of the properties do not control the cost of production and does not make estimates.

Key drivers with the possibility of improvement in Production and Management:

- ✓ 16% of the properties have an insufficient terrace, but the answers note that this insufficiency reflects in loss of quality in the production;
- ✓ 23% of the properties do not make soil analysis annually;
- ✓ 46% of properties do not record field operations;
- ✓ 26% of the properties carry out a selective harvest of production.

For Indicators with the possibility of improvement in Social Capital, adherence in 90%, it is noted that there is no future vision among heirs of properties; however, this fact repeated in the Meso-region Campinas; which may

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indicate lack of suitability of the heirs and new career paths.

4.3 Mogiana Paulista Region (lower and middle)/ Meso-region Campinas.

The municipalities that form the meso-region are in the middle Saw of Mantiqueira.

In this study, the Mogiana Paulista region geographically formed by the Meso-region Campinas and two of its micro-regions: Amparo and São João da Boa Vista.

The questionnaire was composed of 51 variables divided into Economic, Environmental and Social Management. The results extracted by adapted analyzes of the tool of key drivers found in the studies of DUNCAN (1988).

Influencers with emphasis on training and knowledge improvement, focused on improving the management analyzed in the 30 research in according to the owners' responses without suggested induction, even when the reported data diverged from the bibliography referenced in other analyzes or data collection, stand out in key drivers for Economic Management.

Where the index of adherence to the variables was 80% among the properties surveyed, the rationale for this grip is in the predominance of other sources of income from production in properties, 70% of properties sell production below the level of 80 points.

Is noted in the responses and structures of the properties that the commercialization of the production of coffee with gourmet quality and or, is in own and individual way, either in export sales or through coffee shops.

Key drivers with a possibility of improvement in Economic Management:

- ✓ 43% of the properties are unaware of or do not exchange future production for productive input;
- ✓ 26% of the farms do not estimate production costs.

Key drivers for Environmental Management (Machinery and Equipment, Production and Production Environment and Management):

In this case, the adhesion index of the properties was 87%. The rationale for this adherence lies in the fact that the farms are self-sufficient in residue for organic fertilization, and only two do not control production costs.

Key drivers with the possibility of improvement in Machines and Processing:

- ✓ There were no variables with significant prominence; all properties showed a balance of adherence with the variables studied.

Key drivers with the possibility of improvement in Production and Management:

- ✓ 30% of the properties do not perform soil analysis annually in their production;
- ✓ 23% of farms do not record field operations.

The indicators with the possibility of improvement in Social Capital, adherence of 90%, we can see that there is no vision of the future among the heirs of the properties, however, this fact is in the Southern Meso-region of Minas too; which may indicate lack of suitability of the heirs and new career paths.

In the comparison of the two meso-regions studied it is evident that the producers that have a synergic and shared information line have better conditions for differentiation in their performance as a rural company.

This information, knowledge, and skills evidenced the higher the grouping approaches a certification or cooperative. In the comparisons carried out, the Southern Meso-region of Minas Gerais is the grouping of greater synergy between the essential competencies of the actors in the production chain.

The South of Minas Gerais is a typical case of the configuration of a competitive region to produce coffee. Its productive potential is justified by the concentration of various technical and regulatory systems, to make coffee production and logistics efficiency.

The Meso-region consists of many infrastructures, institutional, and strategic-operational that give competitiveness to the productive space circuit of the coffee and, consequently, to its leading economic agents (FREDERICO, 2004).

On the other hand, the properties surveyed in the Meso-region of Campinas favor the quality of the beverage, as it enters its producers in the globalized market, with differentiated certifications and denomination of origin.

Among the most evident transformations in the Mogiana Paulista region is the development of new practices in the field related to agricultural technical systems, endowed with science and information and new field-city relations (components, people, news).

Meso-region of Campinas presents excellent infrastructure and easy access to technology, skilled labor, and good highways to transport production, thus explaining the ease of properties in producing thinner coffees in a less synergistic way (less exploitation of essential collective skills) concerning the Southern Meso-region of Minas Gerais.

In the Amparo micro-region, unlike the other micro-regions surveyed, both in São Paulo and in the South of Minas, the presence of associations and cooperatives is

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practically nil; not being able to find the physical headquarters of COOCASER, SPECIALITY COFFEE, and ACECAP.

No property claimed is associated with these entities and what was detected was the presence and partnership with the production of each municipality, playing the role of cooperative and seeking to accompany and develop the rural owners in their initiatives.

V. CONCLUSIONS

Certifications require a high standard of synergistic quality, for excellence in management, reflecting the exploration of the essential competencies, access to information, knowledge, and training in the production cycle.

The Southern Meso-region of Minas Gerais explores in better conditions the essential competencies of the value chain. The Fairtrade certification in the Southern Minas brings improvements to social capital on the properties and is confirmed by the strengthening of the productive capacities of the small producers, offering technical support and training as was verified in the interviews made with the cooperatives in general, although they present opportunities in relation to the labor force employed in production.

Another relevant fact is that the cooperatives of Minas Gerais consider and comply with the requirements required by law; this may suggest a process of empowerment, in which the people or groups act to reach their defined goals, through the mobilization of resources, becoming more connected to the networks.

The Southern Meso-region of Minas Gerais is the most synergistic grouping in the essential competencies of the actors in the production chain. It is essential to highlight the organizational infrastructure of joint production and the continuous flow of dialogue among the agents of the chain, perceived in professionalism, in the qualification of the coffee grower and of the workforce, in the expressive organization of properties in cooperatives and the diffusion of technology and technical assistance for sustainability.

Regarding the Mogiana Paulista Meso-region, the producers favor the quality management of the beverage, with a focus on the insertion in the globalized market of its production. Differentiated certifications and designation of origin are handled individually by the landowners. Several significant properties do not just produce coffee in the area. The Meso-region has excellent infrastructure availability, easy access to technology, skilled labor, and right roads to transport its production.

The better understanding of the productive system as the need to improve the management of coffee quality, improvement of management techniques, training of social capital, are presented as potential tools to increase competitiveness in coffee activity in a general and collective manner, in the two Meso-regions.

In general, the results of this work contribute to the owners, recognize and interact with opportunities for improvements in knowledge and training in the management of their farms; in order to take advantage of the continuous flow of dialogue with the value chain of coffee production.

In terms of economic management, owners are advised to practice "diseconomy of scale" for the commercialization of production; to work synergistically with cooperatives and associations to alleviate difficulties in the market access for small quality lots and to improve tools for maximizing intangible property revenues (quality, GAP, and environmental legal compliance).

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Proposed Integration of the Technical Regulations of Systems of Management of Operational Safety and Structural Integrity of Facilities, defined by the ANP of Brazil

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Abstract *— This article aims to analyze and integrate the main requirements of the Technical Regulations of the Operational Safety Management Systems (RTSGSO), Structural Integrity of Facilities (RTSGI), Terrestrial Pipelines (RTDT), Submarine Systems (RTSGSS) and Wells (RTSGIP) Producers and Injectors, defined by the National Petroleum Agency (ANP), to simplify implementation and integration with other Integrated Management Systems (SGI), such as Quality, Environment, Safety and Health at Work (QMS&ST) in the management of concessionaires and/or operators of oil and natural gas producing fields in Brazil. The methodology used was an exploratory and descriptive research, through a bibliographical review and documentary. As a result, the main requirements of the 5 (five) technical regulations of the operational safety and structural integrity management systems of the facilities, ground pipelines, subsea and well systems were integrated into a structured correspondence matrix model with 17 (seventeen) Management Programs of the RTSGSO, for implementation in the global management of concessionaires and/or operators of oil and natural gas producing fields. This way it was concluded that the matrix with the integration and correspondence of the ANP's technical regulations will simplify the implementation and integration with other management systems such as QMS&ST (SGI) in the global management of the concessionaire company or operator of oil and natural gas producing fields, and will also contribute to the development of data collection tools such as: checklists, to periodically perform diagnoses and/or performance evaluation of implementation and/or maintenance of the management systems applied in the exploration and production of oil and natural gas.*

Keywords *—* ***Exploration and Production of Petroleum. Management Systems. Operational Safety. Integrity of Facilities. National Petroleum Agency.***

I. INTRODUCTION

In the oil industry the process of exploration and production of oil and natural gas onshore and offshore is structured with activities and tasks of high risk for the safety of processes, operational and occupational, workforce, environment and heritage, which may characterize incidents and accidents such as fires, explosions, large oil, gas or high-salinity water leaks, with possibilities for deviations in quality, damage to employees' health, impacts on the environment, fauna , flora, with changes in the quality of water, soil and air, and heritage.

In this context, to ensure operational safety, facility integrity (reliability), environmental preservation and health of the workforce, the National Oil, Natural Gas and Biofuel Agency (ANP), the Brazilian oil industry regulatory body, has developed and issued resolutions and annexes with technical regulations for operational safety and facility integrity management systems to regulate, supervise and perform external audits on Brazilian concessionaires and / or operators of oil and natural gas producing fields.

The main Technical Regulations (RT) defined by the ANP are: Operational Safety Management System (RTSGSO); System Structural Integrity Management System (RTSGI); Terrestrial Pipelines (RTDT); Subsea Systems (RTSGSS) and Well Integrity Management System (RTSGIP).

In this way, this article aims to analyze and integrate the main requirements of the Technical Regulations of the Operational Safety Management Systems (RTSGSO), Structural Integrity of Facilities (RTSGI), Terrestrial

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Pipelines (RTDT), Subsea Systems (RTSGSS) and Wells (RTSGIP) Producers and Injectors, defined by the National Petroleum Agency (ANP), to simplify implementation and integration with other Integrated Management Systems (SGI), such as Quality, Environment, Safety and Health at Work (QMS & ST) in global management of concession companies and / or operators of oil and natural gas producing fields in Brazil.

II. LITERATURE REVIEW

2.1 Exploration and Production of Oil and Natural Gas in Brazil

The exploration and production of oil and natural gas (upstream) is one of the stages of the productive chain of the petroleum sector, with high added value, high risk, great economic impact and technological innovation in Brazil and a higher rate of return on investments (SOUZA, 2006 and SCHIAVI, 2016).

The Exploration and Production Operating Units in Brazil are structured with oil and natural gas fields onshore and offshore, some of these characterized as mature fields, because it has more than thirty years in operation, with can pose a risk of accidents and fluid leaks, with impacts on the safety and health of employees, the environment and quality.

For Thomas (2004), oil and natural gas exploration involves onshore and offshore exploration, drilling and exploration for oilfield / reservoir discoveries.

The production process is characterized by the activities of extraction of oil reserves through the processes of elevation, flow, collection, separation, treatment, storage and transfer of oil, treatment and injection of water, gas handling and processing (THOMAS, 2004 and MANÇÚ, 2018).

In order to minimize risks and regulate exploration and production activities in oil and natural gas fields, offshore and onshore in Brazil, the ANP defined as mandatory the implementation of the requirements of the Technical Regulations for Management of Operational Safety and Integrity of Facilities (RTSGSO, RTSGI, RTDT, RTSGSS and RTSGIP).

2.2 ANP Technical Regulations for the Exploration and Production of Petroleum and Natural Gas in Brazil

The ANP has as one of the main attributions to the promotion of bids for the concession of oil and natural gas blocks, as well as the activities of management, regulation, control of the contracts signed with the concessionary companies and the Union and definition of blocks for bidding, and in 2005 Law No. 11,097 expanded the ANP duties in regulating, regulating and supervising the activities of production, storage, distribution and resale of biodiesel, fuel of vegetable or animal origin, to be added to diesel.

The Technical Regulations RTSGSO, RTSGI, RTSGSS, RTSGSS and RTSGIP Technical Regulations aim to establish requirements and guidelines for implementation and operation, aiming at the operational safety and structural integrity of facilities, pipelines, subsea systems and wells producing and injecting, in the exploration and oil and natural gas production, as well as the protection of human life, the environment, the integrity of the Union's assets, third parties and the Contract Operator (ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 and ANP, 2016).

2.2.1 Technical Regulation of the Operational Safety Management System (RTSGSO), published in 2007

The RTSGSO of the Oil and Natural Gas Offshore Drilling and Production Facilities is structured with 17 (seventeen) Management Practices (PGs), distributed between Chapters 2, 3 and 4, and Chapter 2 - Leadership, Personnel and Management structured with 9 (nine) PG; in Chapter 3 - Facilities and Technology with 5 (five) PGs, and in Chapter 4 - Operational Practices with 3 (three) PGs and requirements (Figure 1), which should be applied by the Concession Organizations (OCs) operating in Brazil.

The objective of RTSGSO is to establish requirements and guidelines for the implementation and operation of an Operational Safety Management System (OSMS), aiming at the operational safety of offshore drilling and oil and natural gas production facilities, with the objective of protecting human life and the environment (ANP, 2007).

2.2.2 Technical Regulation of the Structural Integrity Management System of Facilities (RTSGI), published in 2010

The Technical Regulation of the Facilities Integrity Management System (RTSGI) is structured in 03 (three) Chapters, where it presents in Chapter 1 the description of the general provisions, Chapter 2 the organization and operational safety and in Chapter 3 the guarantee of integrity of the installations (Figure 1). The RTSGI defines that the Concessionaire Organization (OC) of an onshore oil and natural gas field must guarantee Structural Integrity of Facilities and Operational Safety, from the design, installation, operation and maintenance of static equipment, pipelines and dynamic equipment, through the best practices of the oil industry, regulations, applicable standards and continuous improvement actions, to ensure the effectiveness of the activities and tasks under their responsibility (ANP, 2010).

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2.2.3 Terrestrial Pipeline Technical Regulation (RTDT), published in 2011

Technical Regulation of Terrestrial Ducts (RTDT) is to guarantee the Integrity and Operational Safety of Terrestrial Pipelines (Pipelines and Gas Pipelines) throughout the life cycle (ANP, 2011). To meet this objective of the regulation, the OCs that operate in Brazil must comply with all the requirements defined in Chapters II to X (Figure 1), from the design phase, construction, assembly, operation, inspection, maintenance structural integrity, emergency response and decommissioning, and pipelines already in operation, requirements should be applied in operation, inspection, maintenance of physical integrity, emergency response and decommissioning the operational safety of the Terrestrial Pipelines (Pipelines and Pipelines).

2.2.4 Technical Regulation of the Submarine System Management System (RTSGSS), published in 2015

The Technical Regulation of the Subsea System Management System (RTSGSS) is structured in the categories of management from 5 to 26 (*Fig. 1*), with their respective requirements of mandatory application and has the objective of managing the operational safety of Submarine Systems, as an essential factor for the reliability of the supply of petroleum, by-products and natural gas in the national market, as well as for the prevention or mitigation of possible accidents that can cause damages to people, facilities / processes and the environment, through the awareness of employees , with standardization of methods, mechanical integrity of equipment and teamwork, to perform a safe, incident-free operation (ANP, 2015).

2.2.5 Technical Regulation of Well Integrity Management System (RTSGIP), published in 2016

Meanwhile, the Technical Regulation of the Well Integrity Management System (SGIP) aims to guarantee the integrity of the wells by defining the responsibilities of oil and natural gas exploration and production companies and establishing operational safety and preservation requirements of the environment for drilling, completion, evaluation, intervention, production and abandonment of oil and natural gas wells (ANP, 2016).

The RTSGIP is structured in two Chapters, with Chapter 1 being the general provisions, divided into six topics, and Chapter 2 presents the 17 (seventeen) Management Practices (PG), mandatory application by the Brazilian Concession Organizations. The Technical Regulations of the ANP were approved by Resolutions: No. 43/2007 (RTSGSO); No. 02/2010 (RTSGI); No. 06/2011 (RTDT); (RTSGSS) and No. 46/2016 (RTSGIP), and are structured according to Figure 1.

ANP RESOLUTION No. 43/2007	**ANP RESOLUTION No. 02/2010**	**ANP RESOLUTION No. 06/2011**	**ANP RESOLUTION No. 43/2015**	**ANP RESOLUTION No. 46/2016**
Technical Regulation of the Operational Safety Management System (**RTSGSO**), of the Maritime Facilities of Perf. and Petroleum Production and Natural Gas	Technical Regulation of the Integrity Management System (**RTSGI**) Structural of Terrestrial Petroleum and Natural Gas Production Facilities	Technical Regulation of Terrestrial Ducts (**RTDT**) for Petroleum, Derivatives and Natural Gas Handling	Technical Regulation of the Subsea Systems Operational Safety Management System (**RTSGSS**)	Technical Regulation of the Integrity Management System of the Terrestrial and Marine Well Production Facilities (**RTSGIP**) for Oil and Natural Gas
CORRELATION OF THE REQUIREMENTS OF ANP TECHNICAL REGULATIONS				
RTSGSO	**RTSGI**	**RTDT**	**RTSGSS**	**RTSGIP**
1. Purpose	1. Introduction	1. Introduction	1. Introduction	1. Introduction
2. Definitions	3. Definitions	4. Definitions	2. Definitions	3. Definitions
3. Scope	4. Scope	6. Scope	3. Scope	4. Scope
		3. Scope		
4. Structure of Management Practices (PG)				
5. Operational Safety Documentation (DSO)	10. Documentation of Operational Safety (DSO)		4. Registration of Submarine Systems	
	5. Normative and Legal References	5. Normative and Legal References		
		2. Protocol of Responsibilities	5. Protocol of Responsibilities	
PG 1. Culture of Safety, Commitment and Managerial Responsibility	6. Organizational Structure, Qualification and Training	31. Organizational Structure	6. Culture of Safety, Commitment and Managerial Responsibility	Management Practice (PG) 1. Culture of Safety, Commitment and Managerial Responsibility
		32. Availability and Resource Planning		
PG 2. Staff Involvement		33. Employee Involvement	7. Involvement of the Work Force	PG 2. Involvement of the Work Force

CONTINUATION				
RTSGSO	**RTSGI**	**RTDT**	**RTSGSS**	**RTSGIP**
PG 3. Qualification, Training and Performance of Personnel	6. Organizational Structure, Qualification and Training	34. Identification of Critical Tasks	8. Qualification, Training and Performance of Work Force	PG 3. Competency Management
		35. Qualification Training		
PG 4. Work Environment and Human Factors			9. Working Environment and Human Factors	PG 4. Human Factors
PG 5. Selection, Control and Management of Contractors	6. Organizational Structure, Qualification and Training	36. Contratadas	10. Selection, Control and Management of Companies	PG 5. Selection, Control and Management of Companies

https://dx.doi.org/10.22161/ijaers.6724 *ISSN: 2349-6495(P) | 2456-1908(O)*

CONTINUATION				
RTSGSO	**RTSGI**	**RTDT**	**RTSGSS**	**RTSGIP**
6. Monitoring and Continuous Improvement of Performance			11. Monitoring and Continuous Improvement of Performance	Management Practice # 6: Monitoring and Continuous Improvement of Performance
PG 7. Audits			12. Internal Audit	PG 7. Audits
PG 8. Information and Documentation Management	7. Information and Documentation		13. Information and Documentation Management	PG 8. Information and Documentation Management
PG 9. Incident Investigation	9. Emergency Plan		14. Incident Investigation	PG 9. Incidents
PG 10. Design, Construction, Installation and Deactivation	12. Installation Design	8. Project Documentation	20. Project	PG 10. Well Life Cycle Steps
	13. Installation Construction and Assembly	11. Construction and Assembly	21. Manufacturing and Installation	
		12. "As Built"	24. Reuse	
		13. Commissioning	25. Length of life	
	18. Deactivating the Installation	50. Temporary Deactivation	26. Decommissioning and Deactivation	
		51. Permanent Deactivation		
PG 11. Critical Operational Safety Elements	14. Critical Elements of Operational Safety	15. Operation	15. Critical Elements of Operational Safety	PG 11. Critical Elements of Well Integrity
PG 12. Identification and Risk Analysis	8. Identification and Risk Analysis	9. Risk Assessment	16. Risk Analysis	PG 12. Risk Analysis
PG 13. Mechanical Integrity	15. Inspeção de Equipamentos e Tubulações	16. Inspection	23. Integrity Management	PG 13. Well Integrity
	16. Equipment and Pipe Maintenance	17. Maintenance		
		25. Corrosion Control		
		26. External Corrosion Control		
		27. Internal Corrosion Control		
		28. Control of Atmospheric Corrosion		

CONTINUATION				
RTSGSO	**RTSGI**	**RTDT**	**RTSGSS**	**RTSGIP**
PG 13. Mechanical Integrity	16. Equipment and Pipe Maintenance	29. Time limits	23. Integrity Management	PG 13. Well Integrity
		38. Integrity Management Program		
PG 14. Planning and Management of Major Emergencies	9. Emergency Plan	41. Emergency Identification	18. Emergency Planning and Management	PG 14. Well Control Emergency Planning and Management
		42. Emergency Response Plan		
		43. Pipelines		
		44. Gas pipelines		
		45. Management of Response Resources		
		46. Communication of the Incident		
		47. Incident Investigation		
		48. Management of the Emergency Response Plan		
PG 15. Operational Procedures	17. Operation and Process	15. Operation	22. Operation	PG 15. Procedures
PG 16. Change Management		19. Change Management System	17. Change Management	PG 16. Change Management
PG 17. Safe Work Practices and Control Procedure in Special Activities		15. Operation	19. Safe Work Practices and Control Procedures in Special Activities	PG 17. Environmental Preservation
		8. Duct History Log		
		20. Signaling of Pipeline Ranges		
		22. Public awareness		
		23. Prevention of Third Party Damages		
		39. Basic Processes of PGI		

Fig. 1 - Matrix of Correspondence of the mandatory requirements of the Technical Regulations of the ANP

Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 and ANP, 2016.

The technical regulations defined by ANP correspond to their mandatory application requirements for integration and structuring in a single management system, with the objective of rationalizing resources, reducing bureaucracies and simplifying the process of unification with other management systems of the organization.

III. METHODOLOGY

The methodology used was an exploratory and descriptive research, through a bibliographical review and documentary research. According to Gil (2016) and Lacerda (2016), the exploratory research aims to develop, explain and modify concepts and ideas for the formulation of later approaches.

For Martins (2016), the bibliographic research is characterized by a survey of all the information related to the subject to be researched in academic articles and recognized books, being this practice common to almost all scientific works.

The documentary research seeks to research unedited material, such as letters, memoranda, written reports, formal studies, administrative documents, procedures, regulations, policies and organizational guidelines and others, increasingly available on the Internet. Documents can be evaluated in workplaces, internet sources, and archives and libraries (OLSEN, 2015).

IV. RESULTS AND DISCUSSION

An analysis and integration of the requirements of the 5 (five) Technical Regulations of the Management Systems of Operational Safety and Structural Integrity of the Facilities, Terrestrial Pipelines, Submarine and Well Systems (RTSGSO; RTSGI; RTDT; RTSGSS and RTSGIP) of ANP , using the structure and reference the Management Practices (PG's) 1 to 17 and other requirements of the RTSGSO.

The results of the integration of the main requirements of the ANP technical regulations are defined in the Figures 2 a 19. And this starts with the following items: integrated objective, definitions, systems comprehensiveness, inclusion obligation, updating of pipeline information in the submarine system registry, safety documentation (DSO), and procedure of the protocol of responsibilities, for the companies that operate a same duct.

The introductory phase of the ANP technical regulations (*Fig. 2*) is characterized by the obligation to

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comply with normative and legal references and the elaboration of technical documents (DSO), focusing on the safety and integrity of the facilities.

ANP RESOLUTION No. 43/2007 (RTSGSO); No. 02/2010 (RTSGI); No. 06/2011 (RTDT); 41/2015 (RTSGSS) AND No. 46/2016 (RTSGIP), DEFINED BY THE NATIONAL PETROLEUM, NATURAL GAS AND BIOFUELS (ANP) AGENCY IN BRAZIL		
TECHNICAL REGULATION (RT)	**REQUIREMENTS WITH REFERENCE TO RTSGSO**	**MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL**
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	1. Purpose	Implement a system for managing the safety and structural integrity of facilities, pipelines, submarine system and wells, maritime and terrestrial concession.
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	2. Definitions	Know the definition of terms of operational safety and integrity of facilities, pipelines, submarine system and wells, maritime and terrestrial concession.
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	3. Scope	Apply the technical regulations in the Exploration and Production facilities, pipelines, submarine systems and wells in land and sea.
RTSGSO	4. Structure of Management Practices (PG)	Implement RTSGSO's 17 Management Practices (PG) in the organization's global management and RTSGI, RTDT, RTSGSS and RTSGIP requirements.
RTSGSS	5. Subsea Systems Registry	The concessionaire or operator must include and update the information contained in existing and new pipelines in the Cadastre of Submarine Systems of ANP.
RTSGSO / RTSGI	6. Operational Safety Documentation (DSO)	The Concessionaire must submit to the ANP the Operational Safety (DSO) documentation for offshore and onshore concessions: 1-Correlation Matrix (MC); 2-Description of the Maritime Unit (DUM) and Terrestrial Unit (DUT); 3-Concessionaire Information Report (RIC) "sea"; 4-General arrangement of the installation; 5 - Installation Process Flowchart; 6-Electric classification of areas; and 7-List of Critical Elements of Operational Safety.
RTSGI / RTDT	7. Normative and Legal References	Comply with a list of standards, codes and good engineering practices.
RTDT / RTSGSS	8. Protocol of Responsibilities (PR)	Elaborate the PR when two or more companies are involved in the operation of pipelines or pipeline system with definition of responsibilities.

Fig. 2 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices
Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

The Management Practics (PG) 1 is characterized by a culture of security, commitment and managerial responsibilities through the definition of values and politics, organizational structure, responsibilities, qualifications and attributions of the workforce, communication system with the workforce and availability of resources to ensure operational safety (*Fig. 3*).

With the implementation of PG 1, the organization defines its course based on normative, legal and engineering best practices references, with attributions and responsibilities for the workforce, from the definition of values, political, objectives, goals, indicators performance, plan of action and availability of the resources needed to achieve them.

TECHNICAL REGULATION (RT)	**PG 1 - CULTURE OF SAFETY, COMMITMENT AND MANAGEMENT RESPONSIBILITY**	**MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL**
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	1.1 Objective	Define the values, the security Politics; organizational structure; responsibilities and attributions; process of communication and availability of resources.
	1.2 Values and Security Politics	The Installation Operator shall establish and disclose the values and the Safety Politics for the personnel involved in the Installation activities.
	1.3 Organizational Structure and Management Responsibility	Establish the organizational structure for the management of the Installation with regard to Operational Safety.
		Implement an organizational structure with responsibilities, qualifications and assignments, so that the Workforce.
		Ensure the effective participation of Installation Managers in activities related to Operational Safety.
		Define the assignments and responsibilities of the entire workforce in Operational Safety, including the management of the Facility and other employees.
	1.4 Communication System	Inform the workforce about the Politics, values, goals and plans to achieve the established performance for the operational safety of the facility.
		Establish reciprocal and continuous communication mechanisms between the Facility Management and the workforce in order to improve operational safety.
	1.5 Availability and Resource Planning	Plan and provide the necessary resources for the implementation and operation of the management systems and fulfill the other established requirements.

Fig. 3 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices
Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

The implementation of PG 2 (*Fig. 4*) aims to promote the involvement and participation of the workforce, with awareness activities, related information and conditions for the development, implementation and periodic review of procedures and / or safety management systems.

TECHNICAL REGULATION (RT)	**PG 2 - INVOLVEMENT OF PEOPLE**	**MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL**
RTSGSO / RTDT / RTSGSS / RTSGIP	2.1 Objective	Promote the involvement, awareness and participation of the workforce in the application of the SGSO.
	2.2 Participation of People	Establish conditions for the participation of the workforce in the development, implementation and periodic review of the SGSO.
		Promote awareness and information activities related to the SGSO.
RTSGI	2.3 Organizational Structure, Qualification and Training	Provide conditions for the participation of the Labor Force in the development, implementation and periodic review of procedures, work instructions and other documents.

Fig. 4 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices
Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

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For the organization to achieve the planned results, it becomes strategic to develop work environments, focused on team analysis and decision making, based on risk studies, incident and accident investigation, and lessons learned, as well as education, awareness and participation workforce, to provide greater commitment and operational discipline.

The definition of qualification, training and personnel performance, according to PG 3 (*Fig. 5*), is one of the most relevant programs to meet the goals and objectives of an organization, because it is concerned with the education and training of the workforce, to comply with the operational procedures critical and non-critical in a safe and efficacious manner.

TECHNICAL REGULATION (RT)	PG 3 - QUALIFICATION, TRAINING AND PERFORMANCE OF PEOPLE	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS	3.1 Objective	Ensure that the workforce performs its functions safely.
	3.2 Organizational Structure	Define the organizational structure of the facility, establishing the classification of functions and tasks related to the position held.
		Identify the levels of training, competence, skill and knowledge specific to the role.
	3.3 Training / Critical Tasks	Establish the training requirements so that your employees are able to perform the tasks related to the position held.
		Scale the training program according to the classification of duties and the tasks to be performed.
		Ensure that contractors establish the training requirements.
		Establish the qualification and training necessary to carry out the activities provided for in the operational procedures.
		Consideration should be given to: Awareness Training (workforce and visitors), General Training and Specialized Training.
		Maintain evidence that the workforce has received appropriate training to perform its functions and evaluate effectiveness.
RTSGIP	3.4 Competency Management	Establish, document and implement the workforce's responsibilities and responsibilities for Well Integrity Management.
		Identify and ensure academic training, levels of training, experience, skill and knowledge specific to each function of the Workforce.
		Establish, implement and document mechanisms to periodically evaluate the ability and competence of the Workforce.
	3.5 Training Logging and Verification	Establish, document and implement methodology for monitoring and recording Workforce training.
		Keep up to date the workforce's functional register in order to ensure traceability, validity of training and technical qualification.

Fig. 5 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices
Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

For the training of the workforce, proficiency analysis by function and activities is recommended, with the structuring of a training matrix of compulsory legal compliance courses and others defined by the organization.

In PG 4 (*Fig. 6*), the organization must implement resources that promote a good work environment, with mapping and analysis of the aspects considering the human factors, with awareness activities for the possible risks that can characterize an incident or an accident.

REGULAMENTO TECNICO (RT)	PG 4 - WORK ENVIRONMENT AND HUMAN FACTORS	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGSS / RTSGIP	4.1 Objective	Promote an adequate working environment and consider human factors throughout the Installation lifecycle.
	4.2 Working Environment and Human Factors	Analyze aspects of the work environment by considering human factors in all phases of the Installation lifecycle.
		In the design, construction, installation and deactivation phases, codes and standards of aspects of work environment and human factors should be identified.
		In the operational phase, awareness of the workforce should be promoted in situations and conditions that may cause incidents.

Fig. 6 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices
Source: Prepared by the author of ANP, 2007; ANP, 2015 e ANP, 2016.

The work environment and human factors have a direct influence on the work pace and productivity of the workforce, based on their abilities, effort, working conditions, aspects of activities, stress levels and process stability.

For the process of selection, control and management of contractors defined in PG 5 (*Fig. 7*), the organization shall establish the criteria in a documented operational procedure, including the obligation to map training, conduct, evaluate effectiveness and control training records and awareness of the contracted workforce, as well as indicators for evaluating the performance of critical activities and tasks.

TECHNICAL REGULATION (RT)	PG 5 SELECTION, CONTROL AND MANAGEMENT OF CONTRACTORS	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	5.1 Objective	Establish criteria for selection and evaluation of contractors, considering aspects of operational safety in the activities covered by this Technical Regulation.
	5.2 Selection and Evaluation of Contractors	Establish criteria for selection and evaluation of performance of contractors, according to the risk of the activities to be carried out, that consider aspects of operational safety.
	5.3 Responsibilities of the Installation Operator	Establish the responsibilities of contractors related to Operational Safety.
		Ensure trained, educated employees about hazards and responsibilities regarding PRE / PEL and to report hazards identified at the facility.
	5.4 Training of Contractors	Evidence should be maintained that the contractor's employees have received adequate training in the performance of their duties in a safe manner.

Fig. 7 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices

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Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

Organizations that outsource their activities purposes or means should elaborate procedures with contracted company responsibilities, selection criteria, indicators, evaluation of performance of critical activities, quality control and actions of improvements, with data storage and traceability.

In PG 6 (*Fig. 8*), the process of monitoring and continuous improvement of the performance of the organization, where it is necessary to establish the operational safety objectives, with goals and performance indicators, period and critical analysis, with preventive and corrective actions and regular performance reviews.

TECHNICAL REGULATION (RT)	PG 6. MONITORING AND IMPROVEMENT OF PERFORMANCE	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGSS / RTSGIP	6.1 Objective	Establish performance indicators and targets that assess the effectiveness of management systems and promote continuous improvement in safety.
	6.2 Safety Performance Indicators and Targets	Establish objectives and evaluate Operational Safety performance.
		Establish proactive and reactive Operational Safety performance indicators and regular performance reviews.
		Establish a system of corrective and preventive actions when there is insufficient performance.
	6.3 Monitoring	Establish and maintain documented procedures to regularly monitor and measure operations and activities that may cause incidents.
		Procedures should include recording information to track performance, operational controls, and compliance with targets.
		Establish means for periodic assessment of compliance with relevant safety legislation and regulations.

Fig. 8 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices

Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

The organization should systematize the monitoring and monitoring of the results with trained people, application of data collection instrument and update of performance indicators, with actions to ensure the effectiveness of management systems.

The internal and external audit process defined in PG 7 (*Fig. 9*) should be planned, conducted objectively and impartially. This is a process of evaluation of the effectiveness of implementation and operation of management systems, so for continuous improvement.

TECHNICAL REGULATION (RT)	PG 7. AUDIT	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGSS / RTSGIP	7.1 Objective	The objective of this management practice is to evaluate the effectiveness of the implementation and operation of the ANP's technical regulations through audits.
		The audit may be internal or third party, considering all requirements of the regulations and performed in an objective and impartial manner.
	7.2 Audit Planning	Prepare an audit plan for the different phases of the Life Cycle of the facility and define the audit teams.
		The Audit plan should be designed to consider the management practices applicable to the life cycle phase of the facility.
		The audit plan should present the areas and activities to be audited.
		Previous audits, performance reviews, accident investigations and accident risks will be considered in the preparation of the audit plan.
		The composition of the audit team will be within the scope of the audit.
	7.3 Execution of the Audit	All necessary information will be made available to the audit team.
		Stipulate the audit cycle, considering a maximum term of two (2) years. In special situations the maximum period may be changed to 3 (three) years.
		The first audit in management practice No. 11 - Critical Elements of Operational Safety must be performed before the start of the operation.
		The first audit of the management system shall be carried out within one year after the start of the operation.

TECHNICAL REGULATION (RT)	CONTINUATION PG 7. AUDIT	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGSS / RTSGIP	7.3 Execution of the Audit	For production facilities, the requirements established in management practice 10 - Project, Construction, Installation and Deactivation will be audited after completion of the project detail, but before the start of the operation.
		Practice # 4 - Work environment and human factors - should be audited in the design phase and checked periodically during the operation.
		The Operator of the Installation must have the reports of the audits carried out.
		The Installation Operator shall prepare the action plan for the treatment of nonconformities and disclose the actions in progress to the workforce.
	7.4 Evaluation of the Audit	The Operator of the Facility shall prepare the action plan for the treatment of nonconformities and disclose the actions in progress to the work force.

Fig. 9 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices

Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

The audits should be carried out by a multidisciplinary team, with specialist in the areas of audit scope, carried out in a maximum period of two (2) years, with elaboration of audit report, plan of action for the treatment of identified nonconformities, and disclosure of the actions in progress for the workforce involved in the activity.

In PG 8 (*Fig. 10*) defines the process of information and documentation management where the organization must define documented procedure for the development, updating, distribution, integrity control and guarantee of

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adequate access to the operational procedures of the production processes, information and documentation of the installation required to comply with the ANP's technical regulations.

TECHNICAL REGULATION (RT)	PG 8 INFORMATION AND DOCUMENTATION MANAGEMENT	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTSGSS / RTSGIP	8.1 Purpose	The Operator of the Installation will define in its system of management, procedures of control and access to the documentation regarding the operational safety.
	8.2 Responsibilities in Information Management	Establish a documentation control system for the development, updating, distribution, control and integrity of the information and of all documentation necessary to comply with this Technical Regulation.
	8.3 Access to Information	Ensure adequate access of personnel to installation information and documentation that are relevant to this Technical Regulation.

Fig. 10 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices

Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

The information and documentation in an organization are strategic to the process of internal communication and decision making, to reach the objects and goals of the management systems of the ANP.

In order to comply with PG 9 (*Fig. 11*), of incident investigation, the organization shall establish a procedure with the guidelines and criteria for conducting the investigation of incidents that is affecting operational safety, reporting by the investigation team, corrective action plan for the basic causes, communication to the workforce of the facility and filing of the report for consultation of the ANP, when necessary.

TECHNICAL REGULATION (RT)	PG 9 INVESTIGATION OF INCIDENTS	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGSS / RTSGIP	9.1 Purpose	The purpose of this management practice is to describe the requirements that must be considered in conducting the investigation of each incident.
	9.2 Procedures and Organization of Research	Prepare a procedure to investigate incidents with adverse consequences to the Operational Safety and include: team size and composition, criteria for conducting the incident, conducting interviews, collecting and identifying appropriate records and records.
		Conduct the investigation with strict observance of the legal impositions.
	9.3 Execution of Investigation	The investigation team shall commence work within 48 hours of the closure of the incident, except by force majeure.
		Prepare the incident investigation report.
	9.4 Corrective Actions	Prepare the incident investigation report.
RTSGI	9.5 Preventive Actions	The incident investigation report should be archived and always available for consultation by the ANP.

Fig. 11 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices

Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

Communication to the workforce of the installation of incident investigations and lessons learned is characterized as a process of awareness and continuous improvement for operational safety.

For the organization meeting the PG 10 (*Fig. 12*) must meet the criteria defined in the project and make acquisitions, according to standards, industry standards and good engineering practices, structure mandatory documentation and management on aspects that may pose risks to operational safety.

TECHNICAL REGULATION (RT)	PG 10. DESIGN, CONSTRUCTION, INSTALLATION AND DISABLED	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS	10.1 Purpose	The objective of this management practice is to describe the requirements of management systems to promote safety in the design, construction, installation and deactivation phases.
	10.2 Management and Organization	Meet project criteria to identify and consider industry standards, industry standards, and good engineering practices related to Operational Safety.
		Procurement of installation items and equipment must meet engineering standards, standards and best practices.
		At the design stage it should reduce human exposure to the consequences of eventual equipment or system failures.
	10.3 Safety in the Design, Construction, Installation and Deactivation Phases	Identify all aspects that could introduce operational safety risks.
		Identify the human factors and those related to the work environment and define ways to change design when identifying.
RTDT	10.4 "As Built"	In case of duct operation must have a procedure that guarantees the availability of the document "as built" in the construction and assembly phase.
RTDT	10.5 Commissioning	Provide the duct commissioning certificate (s), in accordance with legal regulations, after the completion of the construction and assembly services.
		The Commissioning certificate (s) must be properly archived and available for consultation throughout the life of the Duct.
		At the commissioning stage you should check if: the construction and equipment are in accordance with the project; the procedures for safety, operation, maintenance and inspection are up to date and adequate; the risk analysis was performed and the recommendations met; and if there was training for the qualification of all personnel involved.

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TECHNICAL REGULATION (RT)	CONTINUATION PG 10. DESIGN, CONSTRUCTION, INSTALLATION AND DISABLED	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSS	10.6 Manufacture and installation of submarine system	For the mechanical integrity and operational safety of the subsea system, the minimum requirements for manufacturing, installation and commissioning must be established.
		Manufacturing and Installation must meet the requirements of standards and codes, best practices in the industry, conditions of the environmental license.
		Transport, Handling, Storage and Preservation of Materials, procedures for transportation, handling, storage, preservation and inspection of materials and the protection measure must be developed, implemented and documented. Welding must be developed, implemented and documented qualified procedure, with the requirements to be carried out in the welding processes.
		Launching, before starting the work, a contingency procedure for risk analysis scenarios should be developed, implemented and documented. To elaborate, implement and document submarine system launch procedures.
		Post-Laid Survey should perform underwater inspection with record post-release images and prepare Post-Laid Survey Report.
		Commissioning should establish, implement and document procedure for the Commissioning containing leak test and / or hydrostatic test and others.
		Commission Report should prepare a Commissioning Report, containing description and location of the part of the Submarine System and others.
		Manufacturing and Installation Documentation shall ensure that the "as built" documents generated during the manufacturing and installation phase are properly filed.
		For the mechanical integrity and operational safety of the subsea system, the minimum requirements for manufacturing, installation and commissioning must be established.
		Manufacturing and Installation must meet the requirements of standards and codes, best practices in the industry, conditions of the environmental license.

TECHNICAL REGULATION (RT)	CONTINUATION PG 10. DESIGN, CONSTRUCTION, INSTALLATION AND DISABLED	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSS	10.7 Reuse	Undertake a new project, analyze the tensions and applied loads of the collection, the new launch and the operational phase in the new location.
		Perform and document integrity assessment of the reused Subsea System, remaining life and damages that may occur during collection.
		Ensure that static functions are not reused for dynamic functions and perform decommissioning.
		Elaborate, implement and document a procedure for the collection of the duct in order to preserve its integrity.
		The reuse report should contain the previous and current location of the Submarine part of the Submarine System, the physical limits, the result of the Integrity assessment, and others.
RTSGSS	10.8 Extension of life	Perform an assessment with risk analysis for life extension, Integrity assessment, operational history analysis, maintenance, monitoring and control of Corrosion, inspection, testing and testing, interventions and history of integrity and other assessments.
		The useful life extension report should include the location of the part of the Submarine System, with the physical limits, results of the evaluations, expected Corrosion rate and others.
		Determine new Security Envelope, review and adjust the integrity management program, operational procedures, maintenance, inspection, testing and testing, in accordance with the new conditions set out in the Security Envelope.
		Communication of the project life extension shall be made to the ANP at least 01 (one) year in advance.

TECHNICAL REGULATION (RT)	CONTINUATION PG 10. DESIGN, CONSTRUCTION, INSTALLATION AND DISABLED	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGIP	10.9 Well Life Cycle Steps	The well design must adhere to legal requirements, industry best practices, and project assumptions, with procedures and standards.
		In the construction of the well, carry out a technical meeting before well construction with the contractor, to review the well program, risk analysis and well delivery documentation (Well Handover).
		In the Production or Injection of the Well, it shall ensure that the operational parameters related to the elements of the CSB are monitored and managed, with limits for each operational parameter, contingency procedures if the limits of operational parameters are reached, with operational procedures for starting and stopping well, upgrade and passing of well delivery documentation (Well Handover).
		In the intervention of the well to elaborate, document and implement intervention program or procedure; detail the activities of the Intervention Stage with the participation of the Contractor, signed Intervention program, update and pass the well delivery documentation (Well Handover).
		In the Abandonment of the Well, they must guarantee the isolation of the intervals that present Flow Potential, current and future. In the Permanent Abandonment of wells, it is necessary to isolate the formations with Potential Flow connected by well drilling and others. In the ground well remove the equipment from the wellhead and cut the linings and the conductor at the level of the base of the well and update the documentation of well delivery (Well Handover);
		In the temporary abandonment of the well, it must guarantee the preservation of the integrity of the wellhead, in order to provide a safe return to the activities, establish an adequate periodic visual inspection program in the vicinity of the well, years, upgrade and pass well delivery documentation (Well Handover).

Fig. 12 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices

Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

From the design phase to the decommissioning phase, it becomes strategic to adopt practices of study of process risks, with analysis of the different scenarios, definition of causes and consequences, safeguards for protection and mitigation, with quantitative and qualitative evaluation criteria, recommendations, deadlines and responsible, monitoring and monitoring of performance indicators and records control.

The PG 11 (*Fig. 13*) is characterized by the identification, management and control of the critical elements of operational safety, such as: critical equipment, systems and procedures, defined as protection or mitigation safeguard, after analysis of causes and consequences for the scenarios analyzed.

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TECHNICAL REGULATION (RT)	PG 11. CRITICAL ELEMENTS OF OPERATIONAL SAFETY	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS	11.1 Purpose	Describe the requirements for identifying, managing, and controlling Critical Operational Safety Elements of the facility.
	11.2 Identification of Critical Elements of Operational Safety	Identify and describe the essential characteristics and functions of Critical Elements of Operational Safety: Critical Equipment; Critical Systems; and Critical Operational Safety Procedures, essential for safeguarding prevention or mitigation, where failure causes an accident.

TECHNICAL REGULATION (RT)	CONTINUATION PG 11. CRITICAL ELEMENTS OF OPERATIONAL SAFETY	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS	11.3 Management and Control of Critical Operational Safety Elements	Establish contingency procedures and approval and control system for degraded or non-operational Critical Equipment or Systems.
		Establish temporary measures with deadlines for lack of Critical Equipment or Systems due to failure, degradation or out of operation.
		Implement equivalent alternative controls; Reduction and limitation of production; isolation and shutdown of equipment, systems, installations.
RTDT	11.4 Operation	Identify equipment and systems critical for operational safety.
		Implement a maintenance and calibration program for the reliability of the critical equipment and systems of the Pipelines and their facilities.
RTSGIP	11.5 Critical Elements of Well Integrity	Identify Critical Elements of Well Integrity including Barrier Solidarity Sets (CSB); the equipment, systems and procedures responsible for activating the elements of the CSBs and monitoring the integrity of the CSBs and the Diverter System.
		Ensure at least 02 (two) independent CSBs (Primary and Secondary) or 02 (two) during Construction Stages throughout the Life Cycle of the Well.
		In the intervention and temporary abandonment of well assess the risks and apply mitigation and control measures, in order to maintain them at an ALARP level. Install a DHSV (SSSV) into the well as a CSB and periodically evaluate the non.
		The hydrostatic column of the fluid in the non.

Fig. 13 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices
Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

In the organization critical equipment and systems need management, control, maintenance plan and calibration, to guarantee their reliability.

In PG 12 (*Fig. 14*), for identification and risk analysis, the organization shall establish a procedure with methodology, criteria and guidelines for tool application, with the objective of identification, control measures and recommendations for mitigation and risk prevention.

TECHNICAL REGULATION (RT)	PG 12. IDENTIFICATION AND ANALYSIS OF RISK	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	12.1 Objective	Establish requirements for identifying and analyzing risks that can result in incidents to be conducted at different stages of the installation's life cycle through the use of recognized tools and documented results.
		Identify and analyze qualitative or quantitative risks, with the purpose of recommending actions to control and reduce incidents.
	12.2 Types of Risk Analysis	Define the scope considering the Critical Elements of Operational Safety, other analyzes of risks in the Installation or similar installations; historical analysis of incidents occurring in the Installation or similar ones; layout, human factors and external causes applicable; classify identified risks; identify the actions necessary for risk mitigation and prevention.
		Risk identification and analysis must be performed by a multidisciplinary team and approved by the person in charge of the Installation or by a person designated by the company or organization legally responsible for the Installation.
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	12.3 Methodology for Identification and Risk Analysis	Prepare the report of identification and analysis of risks with the objective, scope of the study, description of the Installation, part of the installation, system or equipment that will be submitted to the analysis; justification of the risk analysis methodology used; description of the risk analysis methodology used; risk identification and analysis; classification of risks; and recommendations and findings and make it available for consultation in audits, inspections or verifications.

TECHNICAL REGULATION (RT)	CONTINUATION PG 12. IDENTIFICATION AND ANALYSIS OF RISK	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	12.4 Execution of Risk Analysis	Implement corrective actions referring to the recommendations contained in the risk analysis. In case of changes in the implementation of these actions or in their rejection, they must justify their decisions, evidence that risks were systematically assessed.
	12.5 Elaboration of the Report of Identification and Analysis of Risks	Elaborate the report of identification and analysis of risks with the scope of the study, description of the installation, part of the installation, system or system that will be submitted for analysis; justification of the risk analysis methodology; description of the risk methodology used; risk identification and analysis; classification of risks; and recommendations and exits available for consultation in audits, inspections or verifications.
	12.6 Results	Implement corrective actions to the recommendations in the risk analysis. In the case of actions that require their action or their rejection, they must justify their decisions; evidence that risks were systematically assessed.

Fig. 14 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices
Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

Process risk studies are aimed at ensuring operational and personal safety, preserving the environment and meeting the legal requirements of regulatory agencies.

In PG 13 (*Fig. 15*), for the mechanical integrity of the installations, they must be inspected, tested and maintained in a planned and controlled manner, as defined in the manufacturers' manuals, procedures, standards and good engineering practices.

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TECHNICAL REGULATION (RT)	PG 13. MECHANICAL INTEGRITY	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	13.1 Purpose	Describe the requirements for inspections, tests and maintenance required for installation, systems, structures and equipment, for mechanical integrity.
	13.2 Materials Inspection, Testing, Maintenance and Procurement Planning	Establish plans and procedures for inspection, testing and maintenance, which contain clear instructions for the safe conduct of activities.
	13.3 Control of Activities	Document all activities related to mechanical integrity developed.
		Ensure that operating procedures, manuals, or any other document relating to the facility, systems, structures and equipment are accessible to maintenance personnel, where applicable.
		Establish quality assurance requirements in the execution of procedures. Change in project must have Change Management.
		Critical Operational Safety Equipment and Systems must be covered by inspection, testing, calibration and maintenance plans.
	13.4 Monitoring and Evaluation of Results	The Installation Operator will be responsible for monitoring and evaluating the results of inspections and tests.
RTDT / RTSGSS	13.5 Integrity Management Program	Establish, implement and document the Integrity Management Program (PGI) throughout the life cycle of the Submarine System.
		PGI should be a risk analysis; integrity assessment, monitoring of corrective and preventive actions and evaluation of PGI.
		Establish records management, control and traceability of integrity management, monitoring and operational control information.
		Update the designs and coordinates of the duct, the documentation of geological, geotechnical and oceanographic nature that represent a risk to integrity.

TECHNICAL REGULATION (RT)	CONTINUATION PG 13. MECHANICAL INTEGRITY	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTDT / RTSGSS	13.5 Integrity Management Program	Establish, implement and document program and procedures for monitoring and control of Corrosion of the Submarine System.
		Set deadline for finalizing and approving integrity management reports.
		Documentation should be based on technical recommendations, standards, standards, regulations and industry best practices.
		Control quality in the execution of activities and procedures.
		Ensure that activities are only performed after issuing the necessary licenses and authorizations.
		Keep all pipelines out of operation in maintenance or temporarily deactivated under safe conditions, with inspection and maintenance plans.
		Design, implement and document procedures for visual inspection, underwater inspection, instrumented PIG, water tightness test and hydrostatic test, integrity assessment, system and equipment functional verification, and vent system inspection, when applicable.
		Record in reports all the results obtained in inspections and actions.
		Analyze the results of integrity assessments.
		Implement quality control procedures and indicators.
		Ensure material traceability and Workforce certification.
RTSGI / RTDT	13.6 Inspection of Equipment and Piping	Implement systematic compliance with the Inspection Recommendations, establishing the classification, execution according to maximum deadlines defined in the classification A, B, C and D, and quality control, through inspections, tests and tests: A HIGH 10 DAYS; B HIGH 30 DAYS; C MODERATE 180 DAYS; D LOW 1 YEAR.
RTDT	13.7 Maintenance of Equipment and Piping	Elaborate and implement pipeline maintenance program to perform the necessary services for stabilization, containment, drainage and monitoring of the Pipeline Bands and adjacent areas, revised and updated whenever necessary, or at least every 3 (three) years.

TECHNICAL REGULATION (RT)	CONTINUATION PG 13. MECHANICAL INTEGRITY	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTDT	13.7 Maintenance of Equipment and Piping	Keep up to date the drawings of the construction and assembly of the Duct and of the location of the Strip, "as constructed" in a term not exceeding 180 (one hundred and eighty) consecutive days after completion of the works.
RTDT	13.8 Control of External and Internal and Atmospheric Corrosion	Implement a corrosion control program for the Duct, with limits in accordance with the Protocol of Responsibilities.
		Implement control of external corrosion of the Duct and metallic installations, buried or submerged, establishing procedures to control the installed anti-corrosion system.
		The external corrosion control must contain identification of the critical elements, procedures for monitoring the cathodic protection system.
		Resources needed for the monitoring and execution services, control of records, control and traceability of information.
		Implement control of internal corrosion of ducts and other metallic installations, with procedures to control the installed anti-corrosion system.
		The internal corrosion control must include identification of the critical elements, procedure for the determination of the corrosiveness of the transported products, procedures for the periodic passage of cleaning pigs.
RTSGIP	13.9 Well Integrity	Ensure well integrity throughout your Life Cycle.
		Establish, document and implement acceptance criteria, plans and procedures for inspection, verification, maintenance and monitoring of well integrity in compliance with industry best practices.
		Ensure that CSBs and other critical systems and equipment are functional, appropriate and available for use.
		Carry out the verification of the elements of the CSB, preferably, by means of test or by means of confirmation with a justification.
		Ensure that the cutting elements have the ability to cut tubular or cables down into the well.
		The cutting capacity information must be available to the relevant Workforce.

Fig. 15 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices

Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

The management of the mechanical integrity of the facilities, in order to anticipate, prevent, manage and mitigate the risks and exposures of the workforce to these conditions, with the elaboration of an integrity management program (PGI), with corrective, preventive and evaluation actions from the program.

For PG 14 (*Fig. 16*), the organization shall define an operational procedure with the emergency preparedness and response plan, with resources and response structure, including contractors providing emergency response services, accidental scenarios of risk installations, alarm systems, simulation exercises, report generation and action plan.

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TECHNICAL REGULATION (RT)	PG 14. LARGE EMERGENCY PLANNING AND MANAGEMENT	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT /RTSGSS / RTSGIP	14.1 Purpose	Ensure proper planning and management of major emergencies that may occur during the installation operation.
	14.2 Emergency Situation Planning	Define the team responsible for drafting emergency plans, the qualification and experience of the team.
		Determine the size of the scenario considered and the complexity of the activity, installation, operation or undertaking to be analyzed.
		Identify from the analysis of Risks, the major emergencies and describe the associated accidental scenarios; evaluate the capacity of response to each scenario.
	14.3 Response to Major Emergencies	Establish the Emergency Plan for the Installation, which should contain the preparation and response procedures for emergencies.
		Define the features and response structure available in another location. The plan should indicate how structures and shared resources will be triggered.
		Establish a training program that includes emergency response team members and people exposed to accidental scenarios.
		The Plan should also include the identification of the Installation, legal responsible, description of access to the Installation, accident scenarios, warning systems, accident reporting, organizational response structure and others.
		Accidental "oil leak" hypothesis may be treated only in a specific emergency plan, such as "Shipboard Oil Pollution Emergency Plan" and / or other specific Emergency Plan.
	14.4 Management of Response Resources	Identify all response resources, including emergency systems and equipment, and contractor companies providing support services.
	14.5 Communication System	Establish reliable and effective communication and alarm systems, internal and external communication procedures, including regulatory agencies, government agencies and others.

Fig. 16 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices
Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

For effective response to a major emergency, a trained workforce is needed with specific training and participation in emergency simulation, with application of resources defined in procedure and with knowledge of the results.

PG 15 (*Fig. 17*) deals with the establishment of operational procedures with starting and stopping activities of the equipment, clear instructions, updated and made available on the operational fronts, for training and consultation of the workforce, to perform the tasks aimed at the safe operation of the facility.

TECHNICAL REGULATION (RT)	PG 15 - OPERATING PROCEDURES	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGH / RTDT / RTSGSS / RTSGIP	15.1 Purpose	Describe the requirements that must be considered by the operational safety management system in establishing safe operating procedures.
	15.2 Elaboration and Control of Operational Procedures	Elaborate, document and control the operational procedures for the operations that are carried out in the installation, with clear and specific instructions for carrying out the activities, updated and available, for all personnel involved.
	15.3 Starting and Stopping Procedures	Establish and implement procedures for start-up and deactivation operations, with updated pre-operation information, where applicable.
	15.4 Simultaneous Operations	Specify the various categories and types of concurrent operations where there are considerable operational interfaces and when presenting new hazards that were not considered in the risk assessment.
		Implement an adequate and reliable communication system between remote points and the control room responsible for the operation of the Submarine System and pipelines.
RTSGI / RTDT	15.5 Operation Manual	Establish the Operation Manual considering existing processes, static, dynamic equipment, existing pipelines / pipelines; design features; limitations of equipment operation; specifications; safety critical elements; operational controls; and qualification of the work force for the execution of the operations, general description of the system, pipelines and the data of the equipment and process systems, the physicochemical and safety characteristics of the products, flowcharts, indication of the operational parameters of the project, launchers and (PMBOs), maximum operating pressures (PMO), volumes and temperature, procedures for starting and stopping equipment, procedures for switching redundant equipment, reference to the Emergency Plan , list of instruments, protection devices and alarms.
	15.6 Operational and Safety Records	Registering and controlling operational variables, evaluating and addressing abnormal operating conditions affects the operational safety, operation and structural integrity of static, dynamic and piping equipment.
RTDT / RTSGSS	15.7. Operation	Implement and document a Mutual Operation Procedure - PMO, with other companies or managements directly involved in the Operation of the Submarine System and Pipelines, in order to establish interfaces, actions and operational criteria.

Fig. 17 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices
Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

Operational procedures and data collection instruments should be objective and user-friendly because they are the primary documents used by the facility's workforce in the execution and recording of critical operational safety tasks.

For PG 16 (*Fig. 18*), all temporary or permanent changes must be analyzed, evaluated, managed and documented, with action to control the risks, approved by appropriate managerial level, communicate, train the workforce in the change of the standard and maintain records control.

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TECHNICAL REGULATION (RT)	PG 16. MANAGEMENT OF CHANGES	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	16.1 Purpose	Ensure that permanent or temporary changes to be made to the installation comply with the Safety Requirements as defined in the Technical Regulations and the relevant legislation.
	16.2 Types of Changes	Changes in operations, procedures, standards, facilities, equipment, systems or personnel should be evaluated and managed.
	16.3 Control Procedures	Implement a procedure to manage changes that may affect the Operational Safety considering the description of the proposed change, justification for the change and the project specification, when applicable; the assessment of hazards and the overall impact on activities, prior to the implementation of modifications, updating procedures and documentation affected by the change.
		Train and communicate to all staff whose work is impacted by change.
		The authorization for proposed changes should be issued by management level.
		The documented change must be archived and available for consultation for a minimum period of five (5) years.

Fig. 18 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices

Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

Change management seeks to identify the risks of changes to the operational safety and integrity of the facility, with the definition of actions by team of installation specialists and approval by management level, for the effectiveness of the change.

Safe work practices and control procedures in special activities defined in PG 17 (*Fig. 19*) are characterized by the application of the Work Permit (PT) and Risk Analysis (AR), according to a documented operational procedure, with guidelines for the emission, periodic verification of the critical services, closure, archiving of documentation and performance indicator, for monitoring and follow-up.

TECHNICAL REGULATION (RT)	PG 17. SAFE WORK PRACTICES AND CONTROL PROCEDURES IN SPECIAL ACTIVITIES	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTSGSO / RTSGI / RTDT / RTSGSS / RTSGIP	17.1 Purpose	Control and manage the risks to the Operational Safety during the special activities of the Installation, not contemplated.
	17.2 Work Permit	Establish a work permit system and other means of control to manage activities in hazardous areas.
		The work permit must be documented, with clear and concise authorization instructions and forms, controls, and work permits approved at the appropriate level by the facility manager.
		Work Permit information should be known to all involved in the execution of the service, keeping them in 3 (three) ways: one at the service location, one with the supervisor and the third at the office.
		Define the filing system for each type of Work Permit. PT's services in Critical Elements of Operational Safety must be maintained for at least two (2) years.
		The procedures for issuing the Work Permit must be reviewed and updated whenever necessary and filed, at least 3 (three) years. List the filing deadlines for each type of PT in the procedure.
	17.3 Monitoring	Monitor the performance of activities and ensure that work permits and controls are used until completion of work.
RTSGIP	17.4 Environmental Preservation	Prevent and minimize impacts to the environment and the risks to well integrity.
		Activities associated with the life cycle of the well should be supported by the environmental permits in effect issued by the environmental agencies.
		Wells temporarily abandoned should be protected by existing environmental permits. Wells permanently abandoned will not be required to prove environmental authorization.
RTSGIP	17.4 Environmental Preservation	Environmental authorizations should always be available for consultation on the land well locations during the execution of the Construction, Intervention and Abandonment activities, and in the maritime units during the execution of the Construction, Production, Intervention and Abandonment activities.
RTSGIP	17.4 Environmental Preservation	Develop land lease project for the Construction, Production, Intervention and Abandonment Stages in order to preserve the environment.
		Prepare and implement inspection and maintenance plans for all Well Life Cycle Stages, except for Permanent Abandonment.
		Evaluate the uses of technologies, materials, equipment and products that prevent and minimize impacts to the environment.
		Use environmentally sound materials and products.
		The final destination of materials and equipment must occur in an environmentally correct manner.
		Solid wastes and effluents from the Well must have temporary storage, treatment and environmentally appropriate final disposal.
		Documentary record of the final destination of equipment and materials, treatment and final disposal of solid waste and effluents.
RTDT	17.5 Duct History Log	Keep updated historical records of each duct operated by him and filed in hard, GIS or other digital media, throughout the life of the duct.
		Updating Duct designs, both new and existing, must be completed within 180 (one hundred and eighty) days after the modification.
	17.6 Signaling of Pipelines	Install and maintain landmarks duct range limit, Duct signaling landmarks buried anode bed frameworks, frameworks for aerial surveillance, access plates indication, facility identification plates on the surface of the Strip and warning signs and guidance with Incident prevention information and messages addressed to neighboring communities.
RTDT	17.7 Public Awareness	Implement written program of public awareness and mobilization in order to maintain public authorities, companies with potential risk to neighboring Pipelines and communities tracks, informed and sensitized to the risks inherent in the operation of pipelines, disseminating preventive procedures for mitigation incidents, to control emergencies and for eventual abandonment of the affected area.

TECHNICAL REGULATION (RT)	CONTINUATION PG 17. SAFE WORK PRACTICES AND CONTROL PROCEDURES IN SPECIAL ACTIVITIES	MAIN COMMON AND SPECIFIC PRACTICES MANAGEMENT AND OPERATIONAL
RTDT	17.7 Public Awareness	Implement procedures to record the events related to Incidents with impact around the Pipeline Band;
		Hold meetings, meetings, personal contacts with neighbors of the Strip and contacts with municipal agencies, schools, companies and others.
		Implantation of a telephone line with free access, with 24-hour service, including weekends and holidays, with the disclosure of the number.
		Keep program documentation and records of community outreach and mobilization activities available.
	17.8 Prevention of Third Party Damages	Maintain damage prevention program by activities of Third parties involving works of any nature on, under or in the vicinity of the Duct Bands.
		The Third Party Activities Damage Prevention Program, the Third Party Interference Management Procedure and its documentation should be reviewed and updated as necessary, and archived for at least 3 (three) years.

Fig. 19 - Integration of Technical Regulations, Requirements, Management Programs (PG) Main Management and Operational Practices

Source: Prepared by the author of ANP, 2007; ANP, 2010; ANP, 2011; ANP, 2015 e ANP, 2016.

PT is a formal authorization issued by the work force involved in the operation, for the maintenance team to

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execute a preventive or corrective action service (OS) order, and the risk analysis (AR) actions in a safe manner.

V. FINAL CONSIDERATIONS

5.1 Conclusion

The matrix with the integration and matching of the ANP technical regulations will simplify the implementation and integration with other management systems such as QMS&ST (SGI) in the global management of concessionaire or operator of oil and natural gas fields, and will also contribute to the elaboration of data collection instruments of the type: interview script with open questions or affirmations, questionnaire with closed questions on a five-point Likert scale and checklists, to periodically perform diagnoses and/or evaluation of implementation performance and/or maintenance of management systems applied in the exploration and production of oil and natural gas.

5.2 Future research

The integration matrix of the 17 (seventeen) Management Practices and the common and specific requirements of the 5 (five) ANP technical standards will be integrated into the SGI (QMS&ST) management systems, with an interview script for managers, a questionnaire with five-point Likert scale questions and checklists to perform a diagnosis and / or evaluation of the performance of management systems practices in the perception of worker force in mature fields of the oil and gas exploration and production area in the Northeast of Brazil.

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Implementation of Program 5s in a Refrigeration Industry

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Abstract *— The implementation of the program of quality and improvement in the process of production based on the methodology in 5S was implemented in a refrigeration company located in the Industrial Pole of Manaus, based on bibliographic research in books. This philosophy is intended to inform and train the people who are involved in the process of organizational change. The 5S technique was used to apply the improvement in the assembly line, in relation to cleaning in the work environment, organization of the utensils of immediate use, creation and demarcation of layout to attend the process flow, as well as the verification of the lighting of the environment among other factors.*

Keywords *— **5S, Layout, process flow, refrigeration industry.***

I. INTRODUCTION

The integration of the 5S quality program in a refrigeration company located in the Industrial Hub of Manaus (PIM) -AM, Brazil, aims to emphasize the characteristics and possible implementation specificities. The proposed benefits and how to promote the improvement in the behavioral areas, as well as a new structuring of the work routine, besides reducing the costs by wasted time, and better use of the layout of the company benefiting significantly the factory environment. "5S is a set of concepts and practices that have as main objectives the organization and rationalization of the work environment, the 5S program appeared in the 50s as a program of the Japanese Total Quality Control" [1].

The objective of this work is to present the 5S knowledge opportunities, it has as a goal a case study, referring to a refrigeration company, on the perspective of the research was used the PDCA cycle, observation and other tools, where annotations were constituted with regard to the positive and negative aspects, the survey carried out on the assembly line, information was collected, both from the employees' interviews and from observance in relation to the structure of the sector. As the research target was the people and their respective jobs and productive environment, it was possible to initiate the improvements in the aspects of organization and cleaning, and for the detailing of the problem was used the 5W2H, following after the resolution of the problems began, if trainings with employees knowing that they need to know the benefits and raise awareness about the problems in the company, were shown photos on slides and videos related to positives and negatives, following after implementation of 5S, comes the Management for Total Quality (TQM)), Second [2], total quality management can be understood as a philosophy or a management approach that consists of a set of techniques.

According to [3], Any process of total quality is subject to failure if there is not a very strong support base.

II. THEORETICAL FOUNDATION

The benefits of the 5S methodology are explicit in virtually all large multinationals and local companies, however this program emphasizes their organizational improvements in a clear and detailed way, many are their improvements some academic works even deal with this philosophy called 5S as gateway. input to other tools that aggregate in the production process as 5W2H [5]. This tool is used to verify if all the resources are available in relation to the project, its main function is to assist in the decision making, according to [6], and a kind of check list that must be developed with maximum clarity and efficiency to the performance of the activities and those involved with the project, the estimated deadlines, and how much human and financial resources will be required to carry out the activities, what will actually be done, why will be done, how will it be done, and thus taking into tool guidelines.

In his work, [7] emphasizes that in 5W2H "each specific goal can be detailed through this tool. This

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procedure requires that the implementation of the programs reflect the coherence, the harmony and the compliance with the organizational guidelines ".

For [8], PDCA is a methodology that serves as a basis for analyzing a process after any improvement has been made, since this tool allows one to analyze the problem using the parts of its cycles in order to apply them, to know the results and perfect the possible problems encountered and thus acting with the solutions of their methods. For [9] this methodology has the purpose of guaranteeing the process in a way that creates a culture of continuous improvement to the point of producing products with high quality.

2.1 PROGRAM IN THE REFRIGERATION INDUSTRY

The 5S program can be deployed in any company, be it microenterprise, medium, large, private or public company, because it is a universal tool it has no use restriction [10]. It provides all of the great benefits, makes the manufacturing environment more enjoyable and using only what is needed according to the 5S philosophy, as well as promoting health and ordering. According to [11] the philosophy of use and its beliefs of improvement determine, it is known that it does not depend exclusively on the methodology, but rather on all those involved in the business environment, but for this to occur, the employees must be made aware of the benefits of the tool . Although the 5S is simple to implement, it should be borne in mind that top management should be focused on its feasibility because without proper monitoring by the managerial and operational levels it will not be possible to continue with the improvement changes. In order for the 5S methodology to be clearly established, it is necessary to have meetings with employees to demonstrate their benefits, since we know that investments are very low in relation to their gain, whether in the production process, or in the offices, or in industry, but all its mechanisms for improvement must be weighed. It is important to remember that it is necessary to respect the culture of each company, and if there is a change of culture the leaders must be willing to dialogue with the employees who are involved, so that the plan can continue without obstacles.

According to [7] in his work, he affirms that the characteristics and the procedures of implantation of the Program 5S depend on the characteristics of each company and each organization must create his own method of application.

2.2 PDCA CYCLE IN PROBLEM ANALYSIS.

The PDCA cycle is a tool to analyze problems, where each cycle has a meaning, shown in Figure 1, the first cycle "PLAN" means to plan the actions in relation to the problem, in the second "DO" cycle after having done everything the planning comes execution, following with the third cycle comes "CHECK", where a verification of all activities is done, the fourth cycle "ACTION" in this phase is made a verification of all steps of the cycle, if it is verified that there are points that needs to be improved, then the cycle will be run again.

[14] adds that by using the PDCA cycle unfolding of problem analysis, the improvement team follows a structured methodology that avoids hasty decisions about the problem.

Fig. 1: PDCA Cycle, Source: adapted From [13]

The essence of this cycle is continually co-ordinated efforts towards continuous improvement, it emphasizes and demonstrates which improvement program should begin with a careful planning phase [15].

The systematic use of the methods in problem analysis, management and improvement of results is a concrete way to demonstrate and obtain the commitment of the people in the long-sought growth of the organization [14].

2.2.1 The following steps represent a suggestion to unfold the PDCA cycle.

Step 1- Identify the problem - Select the problem to solve, prioritizing the existing themes.

Step 2 – Observation - Understand the problem by raising your history and frequency of occurrence; Observe local characteristics such as environment, instruments, reliability of standards, training, among others.

Step 3 – Analysis - Identify and select the most likely causes of the problem.

Step 4 - Action Plan - Elaborate the strategy of action; Draw up the action plan.

Step 5 – Action - Disclose the plan of action; Train and empower people, seeking the commitment of all; Perform and monitor the action, recording the results; Collect data.

Step 6 – Verification - Compare the results with the expected goals; check whether or not the problem

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persists. If the expected results are not achieved, return to step 2. List any side effects.

Step 7 – Standardization - Elaborate or change the standard; Communicate changes internally; Educate and train everyone involved in the new pattern.

Step 8 – Conclusion - Record the progress achieved by the group; Relate the remaining problems; Plan the solution of the remaining problems, returning to execute the PDCA cycle; Reflect on the work, aiming at future improvement.

2.3 5W2H UNDERSTOOD AS A PLAN OF ACTION

For the implementation of another tool, the 5W2H methodology was used to survey the variables of the problems, it was necessary to research and verify the points from which resources could be extracted, since knowing that without the resources it is not possible to continue making improvements in the productive process , or in a service, in this method of surveying possible peculiarities in a process and necessary, because it is through these surveys it is possible to verify how much we have so we can follow the project.

According to [16] The action plan comprises several factors: available technology, resources in general, being thus used, a table to compose the tool 5w2h can assure the elaboration and effectiveness.

This tool serves as a reference and assists in the monitoring and development of certain strategic management, in this case in the decisions of the actions taken in the implementation of the 5s.

The action plan describes how to put strategic planning into practice. It should indicate changes proposed in management or in the organization itself, as well as new challenges and procedures that the strategist should adopt [17].

What - what will be done? Determine the goals;

Who - who will do what? Defines who will be responsible for planning, evaluating and achieving objectives;

When - when will what be done? Establishes deadlines for planning, evaluating, and achieving goals;

Where - where will be done? Determine the location or physical space for the various proposed objectives;

Why - why will what will be done? Formulate the indicative of the necessity, importance and justification of executing each objective;

How - what will be done? Plan the means for the execution, evaluation and achievement of objectives;

How much - when will it cost? It determines the efforts and costs to achieve the objectives.

According to [16], the action plan comprises several factors: available technology, resources in general, thus using a table to compose the 5w2h tool, which can ensure elaboration and effectiveness.

III. TOOLS AND METHODS

This case study occurred in a process of manufacturing air conditioners in a "U" shaped assembly line located in an industrial complex in the industrial hub of Manaus. In this productive factory environment there are four processes of preparation until it reaches its stage main that is the line.

It was carried out the survey of the current situation and after the implementation of the 5s, 5W2H tools, along with the PDCA, the optimization of the process was carried out.

3.1 PROCESS OF MANUFACTURE OF AIR CONDITIONERS

At the beginning of the assembly line has a robot that raises piece by piece, throwing on the treadmill giving total agility in the assembly, then goes through the operators, where each one assembles his piece and finally arrives in the packaging process, these units apparatuses In this process, several models of different IBTU'S, 30,000, 36,000, 60,000 and 80,000 are assembled in this process. The assembly process is composed of 32 employees who produce in a normal day up to 400 devices.

In this research one of the main problems encountered in the company sector was the organizational question regarding the cleanliness of the environment because it was continually dirty, it lacked order in the materials of routine use and of sporadic use, the office materials as expired document and others of use less common. There was also no layout for the benches, there was the absence of bins and cabinets in the assembly line for the organization of items that could not be in the benches as the documents of the process.

3.2 THE PROBLEMS AND INDICATORS OF THE PROCESS

The problems found were the lack of hygiene of the benches and tables, lack of aspiration of the floor, besides being in need of a painting, the ceiling was dirty needed a cleaning, lacked adequate lighting for the environment, because the lamps were few in relation to the This indicator was created to measure production efficiency, as shown in figure 01, there are several indicators in this graph, but the main focus of the research was to measure the quality index of the production process before the 5S quality.

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LINE: 02 Indicator:	INDICATORS - 2019				February		
Indicators before the implantation of the 5s							
Months	**Nov 2018**	**Dec 2018**	**Jan 2019**	**Feb 2019**	**Mar 2019**	**Apr 2019**	**Accumulated**
Scheduled Product	3.498	1.885	3.168	2.640	**1.388**	1.200	13.779
Product Produced	3.535	2.776	3.197	3.505	1.398	1.250	15.661
Product Target	90%	90%	90%	90%	90%	90%	90%
% Production	101%	147%	101%	133%	101%	104%	114%
Product defects	33	21	22	40	**16**	10	142
Defect target	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%
% Defects	0,93%	0,76%	0,69%	0,66%	**1,14%**	0,80%	**0,9%**
Quality Score	99,8%	100,0%	100,0%	78,0%	68,0%	100,0%	**91%**
Quality goal	98,0%	98,0%	98,0%	98,0%	98,0%	98,0%	**98%**

Fig. 2: Indicators before the implantation of the 5s

The purpose of this chart was to show the production in the light of the problems presented here, where the defect index is represented in March, circulated in red, the quality index of this process can reach up to 98% of the total production, in this case the index of defects is higher than the stipulated by the company, this percentage is inadequate for the process, it remains above expectations.

LINE: 02 Indicator:	INDICATORS - 2019				May		
Indicators after the implantation of the 5s							
Months	**Nov 2018**	**Dec 2018**	**Jan 2019**	**Feb 2019**	**Mar 2019**	**Apr 2019**	**Accumulated**
Scheduled Product	3.498	1.885	3.168	2.640	1.388	1.200	13.779
Product Produced	3.535	2.776	3.197	3.505	1.398	1.250	15.661
Product Target	90%	90%	90%	90%	90%	90%	90%
% Production	101%	147%	101%	133%	101%	104%	114%
Product defects	33	21	22	23	16	10	125
Defect target	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%
% Defects	0,93%	0,76%	0,69%	0,66%	1,14%	0,80%	**0,8%**
Quality Score	99,8%	100,0%	100,0%	100,0%	100,0%	100,0%	**100%**
Quality goal	98,0%	98,0%	98,0%	98,0%	98,0%	98,0%	**98%**

Fig. 3: Indicators after the implantation of the 5s

In this second indicator, shows how it was after the 5S quality program, in the month of May the percentage of defects dropped significantly, as shown in Figure 03.

In this demonstration concerning the quantity of defect, shows that it hears a decrease of the defect quantities, there are several indicators in the table of Figure 2, the main focus and the quality index after implantation of the quality program 5S, in the table can be noted the indices circled in green, demonstrating the effectiveness of the program, where this percentage reached the mark of 100%, in relation to the quantity produced.

3.3 METHODOLOGY 5S IN THE FACTORY

The method of the 5S program was used to compose the organization of the work environment, in this stage the 5 senses were used, in the first phase the seiri method was used to make the organization of the work tools, separating the tools like keys, pliers , bolts, empty packaging without any utilities, obsolete capacitors, nuts, springs and others, these were taken to a disposal sector, then separated materials that were used from those that were not used routinely, sporadic materials can be kept in a separate cabinet.

The sector was in need of this ordering so the "seiton" method was used to put in this room the organization of the tools and all the work items, these had to be positioned correctly in the benches and in the cabinets, in this way the count was made of all the routine use items, beginning ordering of industry tools such as philips screwdrivers, manometers, goniometer, allen wrench, pressure pliers, precision scale to measure gas load, item that were out of use such as bolts , nuts, wires, defective electronic boards, and do a series of sorting in the industry documentation.

At this stage the third phase of the 5S was used the "SEISOU" method, following with the philosophy was made a cleaning in the environment, began by cleaning the cabinets, where it was removed from the corners to be able to do the proper hygiene of the furniture, then was designed layout for these utensils, followed by this action the drawers also received special treatment such as cleaning with cleaning products, tools like keys and others were cleaned and put in their place of origin, the floor was waxed by the local conservator, and the conditioners were cleaned by an external conservation company.

In the fourth sense "SEIKETSU", the people of the company sector were left with the philosophy of the first three senses already commented, that is, the hygiene and health in this area became part of the work routine of these people, where rules are established among employees of operational levels to the top level of the industry, knowing therefore that these program standards need to be maintained

In this fifth sense "SHITSUKE" was verified whether the deployment plan had really been successful. It was therefore concluded that the plan is actually being carried out in accordance with 5S standards and internal standards. And if people are meeting the standards, use only what is necessary for their immediate use, in addition to leaving the objects in their proper places, cleaning is in compliance with deployment, the sense of discipline has changed for the better, knowing that in the fourth sense deals with the health of the collaborator. In synthesis, the fifth sense (shitsuke) makes a self-evaluation of the first four senses.

3.4 PDCA CYCLE IN THE INDUSTRY PRODUCTION SECTOR

It was used to verify the process after the improvement of the 5S quality program, using its four cycles, in that phase some errors were corrected.

- Planning was defined as the goals to be achieved using (PLAN), in this way the assembly process was

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verified where the organizational problem was occurring, at that point it was observed that in some points of the line had improved. It was defined where the intervention could be made in relation to cleanliness of the workplace, such as the organization of tools and other items of common use of the production process.

- Following with the second method (OD), the annotations of the problems already encountered were used in this phase, and necessary steps were taken to solve the problems. In the case, the tools in an inappropriate place, disorganized and without proper cleaning, a countermeasure to solve the gap, metal boxes were made to store these tools, also a routine of morning meetings with employees was created in relation to the problem.

- The third cycle (CHECK) was used, following the same line of reasoning in relation to the tool, some collaborators were assigned to do a check on the work already performed, noted that in order to continue it would have to do and have more commitment on the part of the idealizers of the project, was soon creating a committee to discuss and discuss all the variables of the problems detected in the process.

- After performing the three steps, it was time to gather the whole team to give positive feedback on all the checks in the production process.

3.5 THE 5W2H IN THE FACTORY PRODUCTION PROCESS

The focus of this tool, as shown in Figure 4 was to highlight the possible problems with the resources, such as the tools used in the research, the research materials such as: drawing boards, writing pens, marking labels, layout strips, a microcomputer was given by the company to make notes and send e-mail, and a financial resource was made available by the company to attend the project.

Deployment Schedule

Tasks	2019							
	Feb	Apr	Mai	Jun	Jul	Aug	Sep	Oct
Management commitment								
Activities planning								
5S Documentation								
Training								
Measure and monitor								
Corrections and changes								
5S program performance								
Evaluation of the program								
Measuring rich								

Fig. 4: Improvements with PDCA and 5W2H

Afterwards, the implementation of the study in the company will be demonstrated, detailing the elements used.

IV. IMPLEMENTATION OF THE STUDY IN THE COMPANY

At this stage of implementation of the 5S quality program, the senior management of the organization will be formally advised of the beginning of the improvement in the sector of the company, knowing that it is through this employee that it will be possible the capitation of resources to go ahead with the improvement in the process , in addition to the commands that will be given, where a member will be chosen for the 5S program commission, that collaborator will be responsible for implementing the program in the company.

Based on the analysis of the assembly line problems, with the high index of materials rejected every day, by the process inspector, a hypothesis was raised that this could be happening because of the industry environment, because the bulbs did not were with their luminosities as they should, following from the lack of order with the tools like: the screwdrivers with lack of maintenance, besides the test apparatus, without gauging, adding with the dirty environment.

In order to arrive at this conclusion for the implementation of the 5S program, a survey was made with rejection indices by quality control, using a tool of the company itself, the FMEA analysis, where this methodology detected that the risk associated with these failure modes , because the environment is low light, and dirty environment and disorganized tools, could be the cause of the problems with regard to product quality.

4.1 PROGRAM IMPLEMENTATION PLANNING 5S.

In this first part of the improvement was carried out survey of all the variables of the sector, as the most critical points to be improved in the company, this way was used the tools of decision making, the 5W2H to verify the resources and which points to be attacked immediately, the PDCA cycle was also used to analyze the problems of the company sector.

Following the initial phase of implementation, a survey was made of all points in the sector to know the deficiencies in relation to the improvement, using materials of use of bração as: photographic camera and office materials to do all the annotation.

4.2 IMPLEMENTATION OF 5s IN THE COMPANY

In this first phase of implementation, leaflets were used with the 5 phases of the 5S to be pasted in place visible to the collaborators, as a way of disseminating; was chosen one day of the week to make the day of awareness, in this case on Fridays, on that day, all were

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warned to fulfill the "D" day in which all come together to make a cleaning effort in the company.

The reorganization of the production sector was reorganized, where these were allocated at strategic points of production, layout was drawn around assembly lines, and a meeting was held to inform the importance of the program.

• Seiri: sense of use - identification of the materials, tools and objects required in the workplace, identifying the excesses and wastes, and the reason for the excess and defined standards were verified so that the problem will no longer happen.

• Seiton: sense of ordering - the organization of the tools, materials and objects was carried out and defined that each was returned to the appropriate place after use.

• Six: a sense of cleanliness - the workspace was organized, making it as clean as possible, so it was necessary to first eliminate the sources of dirt and investigate the root causes of the problems.

• Seiketsu: sense of health - after applying the first three senses and creating a climate conducive to continuity of improvements, dialogues are applied so that everyone will always check if the sine links are being maintained.

• Shitsuke: sense of discipline - the verification and revision of standards is performed. It is carried out the involvement of the workers so that the first four senses are maintained it is necessary to make verification of each one, made this observation to see if it is really being fulfilled.

4.3 CHECK VALIDATION CHECK LIST 5S

This document serves to validate the 5S quality program, aims at verifying the compliance of program goals in the sector, once a week the enclosure will be audited by internal auditors to measure program effectiveness, as shown in Figure 5, of the document the scan will be in ascending order.

CHECK LIST			
	5S TERMS	5S DEFINITION	SLOGAN
1	Seiri (Order)	Remove unnecessary items from the workstation	If in doubt remove
2	Seiton (Organize)	Create a specific place for all that's left	A place for everything and everything in its place
3	Seisou (Cleaning)	Clean and inspect the workstation	Clean and inspect
4	Shitsuke (Standardize)	Standardize best practices	Set the rules and follow them!
5	Shitsuke (Keep)	Make 5S a part of daily work culture	Do not fall back on old habits

Fig. 5: check validation list

4.4 TRAINING OF THE 5S PROGRAM

People attended lectures in relation to 5S, in this training all the employees of the sector got to know each sense, example: it was said in the following way that the first sense server to organize the objects and to let that is used only what is of routine use , the sense, was explained as follows; that the senses serve to order the objects of use of the people, in the third sense was that said that serves to clean a certain place of work or service, already in the fourth sense, people were aware that to maintain their mental and physical integrity free of any pollution, should be concerned with the other previous senses, thus the sense of health reaffirmed its importance in this improvement.

V. ANALYSIS OF RESULTS

Before the implementation of the 5S program there was a major problem with the production process. Because the problems were due to the lack of order in the production area, it was known that production could not meet its goal of quality efficiency, because people did not have the base of support to keep the workplace in perfect condition.

The organizational mechanisms in the sector were outdated and had no effect on employees in the sector, ie employees were not motivated to perform these hygiene activities on the assembly line, employees perform their organizational tasks when the area leader requested that it be done.

There was no schedule of activities regarding the cleanliness and order of each operator's station and the process as a whole. In addition to the problems already mentioned, there were other factors that influenced the poor quality of the production process, one of the most serious being the low luminosity of the assembly line. With the help of the occupational safety professional, it was possible to measure and point out that the lack of luminosity had a direct impact on the activities carried out by the employees of the sector, thus causing the low quality index. Figure 2 shows how production was in the face of these problems.

After the implementation of the 5S program the quality index improved satisfactorily, the improvement occurred in the following problems, in the first point the cleaning of the area was precarious and consequently directly affected the productivities of the products. With the introduction of the 5s program using all its 5sense the operators started to mount with more freedom, because the layouts were unobstructed giving better agility the activities performed there. In the second point was made the packing of all materials of routine use, such as pneumatic, screwdrivers among other tools. In this way the production obtained its best quality index. In the third

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point the environment was cleaned, and the next day the whole sector was painted.

Giving a pleasant sensation to the sector, and consequently impacting on the activities carried out and giving motivation to the employees of this sector. Following with the improvement, it was seen that, faced with the problems already solved, there was one that would also cause the problems: the low luminosity of the process, based on this information was requested the presence of the professional of the area, the (labor engineers) was activated to verify the problems raised by the developer of the 5S deployment. It was verified, however, that the sector needed to change all its lighting, and thus all the exchange of all luminaires in the industry was made, and the result of these changes are shown in Figure 03. In this indicator it shows that the gain with quality index was satisfactorily satisfied as the company's projection.

VI. FINAL CONSIDERATIONS

With the implementation process of the 5S program it was possible to notice that the change comes with the people's engagements and that it is no use trying to make any changes if there is not a team work besides it should be emphasized that the participation is an act of adding work in a team. People are the primary components in trying to make any improvement situation in any activities undertaken.

In these activities, many situations were verified in order to reach an improvement agreement, lectures were given in situations where listeners could ask and ask questions about subjects related to the 5S program, people did program-related gymnastic activities, and in the end it was applied to test their learning.

Posters were presented in the four corners of the process in order to help the productive sector, in these posters had the information pertinent to the 5S program, where he taught the good practices of this philosophy in order to fix the learning in the professional area or even in the personal life of each individual.

It is concluded that the improvement was fundamental in the aspects related to the conditioning of the people on the project schedule, knowing that the tool is of continuous use and can be considered as a tool of short term, medium and long term depending on how the company but in this case the tool was used with a view to achieving its short-term improvement according to previous information.

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Analysis of Genetic Algorithm for synthesis digital systems modeled in finite state machine

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Abstract*—To achieve smaller digital systems, like microprocessors, controller, etc., it is require design them with a small area and the treats the power dissipation. These issues are important because can prolong the time of use of the equipment and reduce the manufacturing costs. To do so, digital circuits can be modeled as finite state machines with a large amount of states for most practical problems. To achieve a minimum result, you need to optimize a state assignment. Find a solution that meets these characteristics, i.e., find the optimal state assignments is a complex task, because it is an NP-Complete problem. Thus, this research analyzed the Genetic Algorithm to obtain an optimization in the state assignment in a reasonable time. The experiments showed good results, however, the adjusts of the parameters of GA must be investigated to find better results.*

***Keywords*—*Digital Systems, Finite State Machine, Genetic Algorithm, Metaheuristic, Synthesis of Circuits*.**

I. INTRODUCTION

Nowadays, transistor fabrication technology has reached such a scale of miniaturization that physical limitations can become an obstacle to continuous evolution proposed in Moore's law [1]. The production scale of the transistors is currently very small, about 10 nm, reducing more than this is challenge, because as the transistors get smaller, they are subject to more imperfections during the manufacturing process. Which makes it increasingly difficult maintain the integrity of the electrical signals. Therefore, it is necessary to plan more efficient logical structures, able to reduce the area in silicon. Hence the importance of the work in revisiting the area of Finite State Machine (FSM) optimization with the goal of designing efficient logic circuits.

Minor digital circuits occupy a small area and additionally have low power dissipation. These characteristics can be obtained with the optimization of the state assignment in FSM.

FSM is a sequential circuit design technology widely adopted at the system level [2],FSMs are composed of inputs, outputs and states. A state is a record of the main information of a system, each state must receive a specific binary code (which is named assignment state). According to [3], FSM is a generic sequential circuit consisting of a section made of combinational logic and a section of memory (usually flip-flops).

An FSM called X can be defined as the mathematical model $X = (I, O, S, \delta, \omega)$, where I, O and **S** are finite and non-empty sets of inputs, outputs and states, respectively. $\delta: I \times S \rightarrow S$ is the next state function, $\omega: I \times S \rightarrow O$ is the output function for Mealy Model and $\omega: S \rightarrow O$ is the output function for Moore Model.

Note that minimal FSMs are desirable because they consume less resources, that is, transistors, which in turn will consume less power, occupy less area on the viable surface of the silicon chip, dissipate less heat and can work in higher frequencies. To optimize the combinational circuit of FSMs a very important factor is the assignment of states. Optimizing the state assignment is a complex task, since all possible arrangements must be tested to obtain the optimal assignment, the total number of possible single assignment for an FSM is given by.

$$A(n,b) = \frac{(2^b - 1)!}{(b!\,(2^b - n)!)} \quad (1)$$

where n is the number of states and b is the number of bits needed to represent each state, therefore, it is an NP-Complete problem.

The general objective of this work is to evaluate the results of the application of metaheuristic (Genetic Algorithm - GA) algorithms in the search for an optimization in the assignment of states in polynomial time.

II. RELATED WORK

Algorithms specializing in heuristic searches are becoming popular for solving complex optimization problems, which are in the class of NP-Complete

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problems, and many researchers have used these algorithms to try to solve the problem of assigning states. [4], used a GA that adopts the Pareto Ranking scheme, to find the state assignment that minimizes both area and power dissipation. The applied multi-objective GA allows the hardware designer to prioritize power dissipation or logical complexity that can reduce the circuit area, or select a solution that reduces both, but does not guarantee the absolute minimum in any of them.

Another research that applies a genetic algorithm seeking to optimize state allocation is performed by [5], to reduce power dissipation and circuit area. In the same way [6], presents an approach based on the GA for the synthesis of an FSM, with the objective of reducing power dissipation. [7]uses an Immunological Algorithm. The proposed algorithm combines the immunological operator with a local search. In addition, this algorithm has modified mutation and crossover operators. Local search is adopted to avoid premature convergence of the algorithm and to maintain population diversity.

The immune algorithm takes into account two objective functions, the first is related to the energy dissipation of the sequential circuit that is proportional to the switching activity between the states of the circuit, and the second objective function is the minimization of the number of terms because the sequential circuit area is proportional to the number of terms. This minimization is obtained by an external tool, called ESPRESSO, this tool generates the minimized circuit, and the number of terms provided by it represents the size of the circuit area.

[8]has its research focused on finding the minimum number of state variables in an FSM, for which a GA was used. However, the FSM presented by it has a different characteristic because it uses the output signal as a state variable.

In another recent work, [9] proposed an Evolutionary Strategy (ES), based on a state assignment model called ESSA. According to the study, this method has selection and mutation operators specifically designed based on analyzes of the state assignment problem. Their conclusions show that this approach achieves a significant reduction of area.

III. METHODOLOGY

In general, a basic AG consists of the following steps: coding is the way the solution is represented, the initial population is randomly generated, the objective function determines the cost of each individual (solution), selection of individuals that will participate in the production of the later generation and the mutation that is performed in order to avoid that the algorithm is stuck in a local minimum.

The implemented AG has an array of size $2 \times n + 1$, with n being the number of states of the FSM. In the first line each position from 0 to n corresponds to a read state of the file, position $n + 1$ refers to the cost of this individual. The second line contains the values assigned to each state respectively, and the cost value, these values are in the decimal basis, as shown in Fig. 1.

A	B	C	D	E	Cost
2	5	7	4	1	37

Fig. 1: Possible assignment of states to FSM of five states.

The coding was performed using decimal numbers, because in this way the treatment of the infeasible of the problem of assignment of states (PAS) becomes simpler, infeasibility occurs when two or more states are allocated with equal values.

In this step, the fitness value of each individual of the population is calculated through a given function. This is the most important component of anyGA. It is through this function that you measure how close an individual is to the desired solution or how good this solution is.

It is essential that this function be very representative and differs in the correct proportion the bad solutions of the good ones. If there is little accuracy in the evaluation, a great solution can be set aside during the execution of the algorithm, in addition to spending more time exploring less promising solutions.

The objective function of the algorithm implemented takes into account the cost of each individual. It seeks to better assignment states to an FSM, in order to minimize area size and energy dissipation, so the best individuals are those who have the lowest cost.

The logical module of the SymPy (from Python language[1]) library is used to calculate the cost of each individual. After the generation of the individual, we obtain the list of mintermsand don'tcare states, which are passed as a parameter to the function SOP (Sum of Product) form, of the mentioned module. This function returns the minimum Boolean expression, as previously quoted to obtain the cost value, the weight "1" is assigned for each of the terms and literals present in the expression.

The generation of the initial population is performed randomly, since the quality of the solutions presented must be independent of the initial population.

[1]https://www.sympy.org/pt/index.html

https://dx.doi.org/10.22161/ijaers.6726 *ISSN: 2349-6495(P) | 2456-1908(O)*

The number of individuals forming the population is obtained by

$$I = 3 \times n \times v \quad (2)$$

where, I is number of individuals in population, $n$number of states, and $v$the minimum number of state variables necessary to assignment the states$n$, and v the smallest integer greater than or equal to $\log_2 n$.

The state assignment problem has a constraint, all states must have distinct binary representations, i.e., two or more states cannot have the same assignment.

Due to randomness in the generation of the initial population, infeasible individuals may arise. To avoid this problem a resource has been used, so that individuals do not violate the restriction.

In short, this feature consists of assembling a map that contains all the possible values that state variables can assume, to determine the size of the map the equation is used,

$$t = 2^v \quad (3)$$

with each assignment of a value to a state of the individual, this value is taken off the map to prevent another state of the same individual from assuming it.

A demonstration of the operation of the strategy used to generate the initial population is shown in Fig. 2.

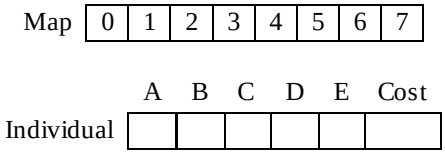

Fig. 2: Representation of the strategy of generation of the population, used in the proposed algorithm.

Initially the map is complete, and no value has been assignment to a particular stateindividual. A map position is chosen randomly and the value of this position is assignment to state A, so the cell is excluded from the map to prevent its value from being assigned to another state. This procedure is observed in Fig.3.

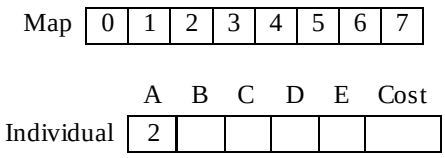

Fig. 3: Example of an iteration in the production of an individual, value 2 is removed from the map and assigned to the individual.

The process is repeated until all states receive a value, a new map is generated for each individual.

The cost is calculated later using SymPy's SOPform function.

In this work we used the roulette selection method, this method works as follows, each individual of the population is represented in roulette in proportion to his fitness index. Thus, for individuals with high fitness a larger portion of the roulette wheel is given, whereas for individuals of lower fitness, a relatively smaller portion is given.

As the interest is to find the best assignment of states, the individuals with greater aptitude and which consequently will occupy a greater portion of the roulette, are the ones that have the lowest costs.

Through crossover, new individuals are created by mixing features of two individuals, “parents”. This mixture is made by trying to imitate (at a high level of abstraction) the reproduction of genes in cells. The result of this operation is an individual who potentially combines the best characteristics of the individuals used as a basis.

The crossover implemented in this algorithm was at one point. After the execution of the crossover, the generated individuals can be infeasible, that is, having two or more states with the same value, to solve this to the same procedure applied in the generation of the initial population, and one of the valuesrepeated by some value contained in the map is changed. The following example illustrates how this process works.

The Fig. 4, presents a demonstration of the execution of the crossover operator proposed in this work.

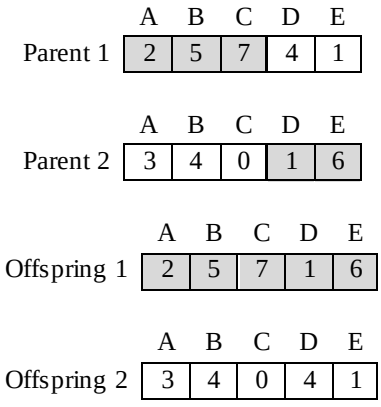

Fig. 4: Example of a crossover operator application.

Parent 1 and Parent 2 represent two possible allocations for the FSM, and the gray color indicates the crossover point.

Note that in Offspring 2 states B and D were assigned with the same value, which makes the individual

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infeasible. To solve this problem we use the map, which contains the possible values that have not yet been assigned, a random value is chosen on the map and allocated to one of the states whose values are the same. This procedure is exemplified in Fig. 5.

Map	2	5	6	7

	A	B	C	D	E
Offspring 2	3	4	0	7	1

Fig. 5: Resolution of infeasibility in an individual.

As seen in Fig. 5 the decimal representation of the D state has been changed from 4 to 7, thereby inserting a random information, and a new infeasibility is avoided.

The individual with the greatest aptitude of each generation, that is, the one with the lowest cost is stored. The solution is the most fit individual after *x* iterations.

The mutation operator is important to introduce and maintain the genetic diversity of the population, and prevent the algorithm from being stuck in a local optimal. The mutation function implemented in this algorithm randomly selects a gene from the chromosome and changes its value by some available value on the map, also randomly selected. If the map is empty, another gene from the chromosome itself is chosen randomly, and the values of these two genes are exchanged. This strategy was adopted to avoid the problem of infeasibility mentioned previously.

IV. EXPERIMENTAL RESULTS

The proposed GA has been implemented in Python and applied to MCNC benchmark circuits [10]. Test results are given in Fig 6.

Benchmarks	**In / Out / Num. States**	**GA**
		Ter / Lit
beecount	3/4/7	20/66
dk14	3/5/7	43/130
ex3	2/2/10	26/81
mc	3/5/4	16/58
tav	4/4/4	21/62
train11	2/1/11	28/100

Fig. 6: Results obtained during the experiment

SOPform SymPy library function is used to minimize the expression of each state assignment. From the expression it is possible to extract the number of terms and literals.

The second column in Fig 6 denotes the number of inputs bits, number of output bits and number of states for the given benchmark in the first column. The set of results produced by the GA is giving in column 3. "ter" denotes to number of minterms and "lit" the number of literals.

The results were obtained using population size defined by Equation (2), mutation rate=0.02, crossover rate = 0.4, selection rate = 0.6 (percentage of individual will be select to compose the new generation) and 300 for the number of generations. All rates were used in total values and the specific individual and gene are selected randomly.

The graph shown in Fig. 7 shows the curve of the behavior of the algorithm during the 300 iterations, we notice the evolution in search of lower costs during the execution. Each curve refers to a specific benchmark as indicated in the legend.

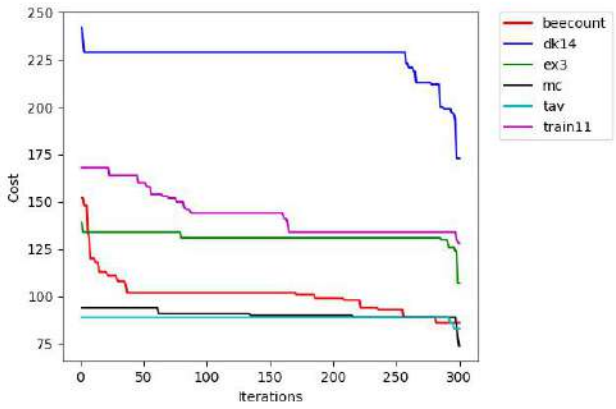

Fig.7: Costs of each benchmark during execution of GA proposed.

In the experiments was noticed the decrease of costs in final generations of the GA. Perhaps, it will be more suitable adjust the criterion stop to increase the results. The same way, FSMs with more states could require more generations to achieve better results.

The graph of Fig. 8, shows the normal distribution of the costs of the best individual of each generation. The curves are dislocated because of the different values of costs.

https://dx.doi.org/10.22161/ijaers.6726 *ISSN: 2349-6495(P) | 2456-1908(O)*

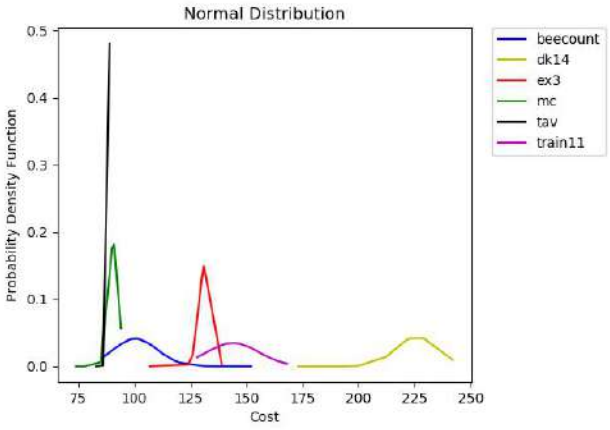

Fig.8: Normal distribution of results of each benchmark analyzed.

This graph was built to show the probability density of the solution to be a good solution. To plot the graph was used,

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} \quad (4)$$

where x is value of cost, μ is the mean of distribution and σ is the standard deviation of distribution [11].

From Fig. 8, benchmarks `train11`, `beecount` and `dk14` curve is very low, meaning the result can be improved. So, this fact corroborated with hypothesis of use more generations to achieve better results. The best result was with `tav` benchmark.

Another hypothesis is to use different parameters in the GA, other rates of crossover, mutation and selection.

V. CONCLUSION

In this paper was analyzed an implementation of GA in Python to solve the assignment state problem to FSM. In the experiments, the GA was able to find a good solution to the benchmarks tested. However, it is necessary to study a better criterion stop to GA.

Another issue is that performance of the GA. It was observed the long time to reach the solution for FSM with large number of states. Thus, the complexity of algorithm is exponential.

The great problem for such time is the evaluation of fitness function, i.e., the FSM cost. In our experiments was used an external library and there is not control about its implementation, which is probably not heuristic. This means all combination of expression is tested for each bit, in each assignment, in each chromosome, in each generation.

One possible solution is divided the in many thread and in others unit functional (CPU) to divide the overload e achieve more performance. Or to try implement a better cost function with another criterion or another algorithm.

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Traffic Forecasting for Monitoring in Computer Networks using Time Series

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Abstract*—*With the expansion of connectivity and information exchange, monitoring Internet traffic becomes a priority in network management to identify anomalies and resource use. This paper presents a study of data traffic forecasting on a computer network, by using known approaching methods for Time Series analysis. The objective of this work is to monitoring the connection of users to network-based applications, including resource availability and network stability of a Brazilian educational institute. To estimate the traffic at a given time, the adjustments made with Exponential Smoothing, AR and ARIMA models were compared in order to detect possible future abnormal behavior of network usage. The results indicate that the chosen models, mainly the ARIMA, can be used to predict both input and output traffic of a network, also allowing the generation of alerts in real time. It is possible to predict how Internet traffic will be in the next few moments in order to detect possible anomaly on the network in a short period of time when they differ considerably from the forecast made for that specific period. Efficient network monitoring favors the quality of applications and services available to users, helping the network manager to make decisions for maintenance and constant improvement.

***Keywords*—*Computer network, Information security, Time series analysis*.**

I. INTRODUCTION

Internet access in many organizational environments has grown especially in the last decade with the expansion of network technologies. In an educational institution, for example, Internet and network resources are fundamental in several academic and administrative activities. The growth of Internet usage and the search for information in research bases requires an increase in the connection bandwidth by constantly expanding the data traffic in the network, which directly impacts on the performance of the services provided.

Furthermore, evil-wishing users can take advantage of security vulnerabilities and failures on the network or systems to practice intrusions and attacks, which can be prevented by using tools such as anti-malware applications, firewall and intrusion detection systems. Security in computer networks is a very important and increasingly studied subject, as for example in the work of Andreas Schilling [1], in which is implemented a framework for secure IT operations.

However, in order to recognize attack patterns, the traffic monitoring management is also very important, helping the network manager to make important decisions in critical cases, like unavailability of resources and inappropriate or unusual use of the network. In short, there is a strong need for monitoring computer networks properties in order to diagnose any problems and manage them in the best possible way, due to their expansion [2].

In order to monitor the network traffic, the Information Technology Management of our educational institute uses the Multi Router Traffic Grapher (MRTG), a free network monitoring software, which generates data charts collected from SNMP - Simple Network Management Protocol [3]. The charts provided by MRTG display the bit rate per second of the data traffic in the network at certain time intervals.

Forecasting of Internet traffic is also very important for tasks such as resource allocation, network planning and detection of network anomalies caused by attacks. An accurate prediction model can be used to detect security attacks in computer networks, by comparing predicted with actual traffic. [4] Moreover, predicting future traffic on a computer network, based on current traffic, allows the network manager to take measures before attacks, congestion, connection drops or downtime. Forecasts like that can be made by modeling the traffic of the data input and output of the network as Time Series. There are several studies in this area nowadays [2] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17].

Section 2 of this paper describes basic concepts about Time Series and forecasting methods. Section 3 presents the comparison of the experimental results of the series

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adjustments corresponding to the traffic in the network of our educational institute, with different models of Exponential Smoothing, AR and ARIMA. Conclusions and final considerations are presented in Section 4.

II. MATERIALS AND METHODS

2.1 Network characterization

In this paper is presented a study of forecasting of data traffic in the computer network of an educational institution. The analyzes were based on Internet traffic, input and output. In this network are constantly used various services and applications based on the Internet, available to students, employees and external community, equivalent, on average, to 300 different users per day. The connections can be wired or via Wi-Fi, in institutional or personal computers and mobile devices, with a total of 10 switches and 15 access points. The Internet link is provided by an outsourced company, with the connection being made through a single central router.

2.2 Time Series Forecast Models

Methods of approach by Time Series have been used by several authors in the study of forecast of data traffic in computer networks, such as Thanasis Vafeiadis, Alexandros Papanikolaou, Christos Ilioudis and Stefanos Charchalakis [2] and Sangjoon Jung, Chonggun Kim and Younky Chung [7], who proposed the use of AR, MA, ARMA and ARIMA models. Christos Katris and Sophia Daskalaki [4] studied predictions using ARIMA, FARIMA and Holt-Winters methods, and Vander Luiz Proena da Silva [8] applied Simple Exponential Smoothing, Holt and Holt-Winters methods. Other authors such as Renata Lussier Spagnol [9] and Roben C. Lunardi, Bruno L. Dalmazo, Erico M. H. do Amaral and Raul C. Nunes [10][11] wrote works where forecasting with various ARIMA models were used for the tra_c in the network. The ARIMA prediction method can also be used in many different applications, for example, many areas of Engineering and Econometrics, as studied by Ozden Ustun and Refail Kasimbeyli [18]. Landauskas, M., Navickas, Z., Vainoras, A. and Ragulskis, M. proposed an effective time series forecasting technique based on algebraic weighted moving averaging. The functionality and feasibility of the proposed short-time series forecasting technique is demonstrated by computational experiments with real-world time series [19].

A Time Series can be defined as an observation set of a particular variable ordered in time, usually equidistant [20], which have serial dependence, in other words, dependence between instants of time. A stochastic process can be classified as a model that describes the probability structure of a sequence of observations, that is, systems that evolve in time or space according to probabilistic laws. It can be said that a Time Series is the fulfillment of a stochastic process.

In order to model network traffic as a Time Series, the variable to be considered may be the rate of trafficked bytes, for example. Since this variable is random, the Time Series can be defined as a sampling of a stochastic process. However, most of the Time Series are not actually stochastic, and may present trend level variations. In this paper, the results obtained with the following prediction models were compared: Simple Exponential Smoothing, Double Exponential Smoothing (Holt Method), AR (Auto Regressive) and ARIMA (Auto Regressive Integrated Moving Average).

In this paper is presented a study of forecasting of data traffic in the computer network of an educational institution. The analyzes were based on Internet traffic, input and output. In this network are constantly used various services and applications based on the Internet, available to students, employees and external community, equivalent, on average, to 300 different users per day. The connections can be wired or via Wi-Fi, in institutional or personal computers and mobile devices, with a total of 10 switches and 15 access points. The Internet link is provided by an outsourced company, with the connection being made through a single central router.

Simple Exponential Smoothing (SES) [17], or Exponential Damping, is a well-known Time Series forecasting method. It is a simple algorithm used to predict the next value in a series, based on the current value and the current forecast. It consists of the idea of obtaining a weighted average, where the recent values have a greater weight than the older ones [8]. This technique can be used in series where no trend is observed. The adjustment P at the instant of time t + 1 is calculated as follows in (1).

$$P_{t+1} = \alpha D_t + (1 - \alpha) P_t \quad (1)$$

Where α is the smoothing coefficient ($0 \leq \alpha \leq 1$) and Dt is the actual value observed in time period t.

It can be said that the smoothing coefficient α regulates the speed with which the series fits the data [8]. For values close to 1, a rapid adjustment is achieved (when old effects have little impact on prediction, and recent effects have a high impact). And a slow adjustment (damping of old and recent effects) is obtained with values of α close to 0.

Double Exponential Smoothing (DES), or Holt Method, is a variation of the Simple Exponential Smoothing, used in series that present a linear increasing or decreasing tendency [8]. This method consists in

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obtaining an estimate of trend of the series, through the (2).

$$T_t = \beta(N_t - N_{t-1}) + (1-\beta)T_{t-1} \quad (2)$$

Since β is the smoothing coefficient for the trend estimate ($0 \leq \beta \leq 1$) and N the level component, given by the (3).

$$N_t = \alpha D_t + (1-\alpha)(N_{t-1} + T_{t-1}) \quad (3)$$

Where α is the smoothing coefficient ($0 \leq \alpha \leq 1$) and Dt is the actual value observed in time period t. The prediction P at the instant of time t is calculated in Eq. (4), by seeking h periods of time ahead [8]:

$$P_{t+h} = N_t + hT_t \quad (4)$$

There are also other variations of Exponential Smoothing, such as the Holt-Winters Method, which consider the seasonal behavior of the Time Series. Nevertheless, with these methods it was not possible to obtain good adjustments for the series analyzed in this work. Therefore they will not be addressed here.

In auto regressive process AR(p) is given by (5) [9]:

$$Z_t = \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + \cdots + \phi_p Z_{t-p} + a_t \rightarrow \phi(B)Z_t = a_t \quad (5)$$

Since $_t$ is the white noise and $\phi_1, \phi_2, \ldots, \phi_p$ constants. This equation must satisfy certain conditions for the process to be stationary [9].

This method of approximation is based on the premise that each observation in a Time Series is related to one or more previous observations in the same series [17].

A moving average model MA (q) is a process in which the averages are adjusted according to the seasonal or cyclic components of the Time Series [17]. It is a weighted moving average, fixed-number model, in which the most recent value generally carries a weight greater than the farthest backward values. For a stationary Time Series, its average or the immediate past value can be used as a forecast for the future period. The process is given by (6).

$$Z_t = a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \cdots - \theta_q a_{t-q} = \theta(B)a_t \quad (6)$$

Where $_t$ is the white noise and $\theta_1, \theta_2, \ldots, \theta_q$ are constants [9].

In an ARMA(p,q) model, for a stationary Time Series, both AR and MA terms are required, as follows in (7).

$$Z_t = \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + \cdots + \phi_p Z_{t-p} - a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \cdots - \theta_q a_{t-q} \rightarrow \phi(B)Z_t = \theta(B)a_t \quad (7)$$

ARIMA Model (Auto Regressive "Integrated" Moving Average) – For series that present non-stationary behavior, it is necessary to perform a transformation to differentiate it. The model indicated to represent the series in this case is the ARIMA (p, d, q), where the parameter d indicates the number of differentiations that the series has undergone to become stationary (8).

$$\phi(B)(1-B)^d Z_t = \theta(B)a_t \quad (8)$$

III. RESULTS AND DISCUSSIONS

The data analyzed were generated by MRTG, and correspond to the input and output bit rates per second that trafficked through our educational institute Internet link. The period of time considered was two weeks, from June 19 to July 2, 2016. The samplings correspond to the rates measured every five minutes are shown in Fig. 1.

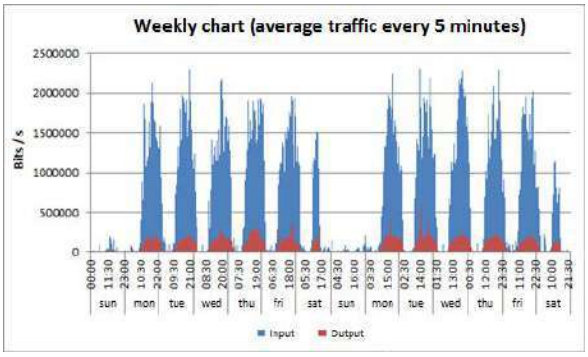

Fig. 1: Internet traffic in the network.

Figure 1 shows that in the period of time considered, Internet access is more intense between 9am and 11pm Monday to Friday, and Saturdays in the morning. It is noteworthy that in these two weeks no network usage were considered abnormal, nor did there occur significant drops in connection.

This information can now be used to try to predict how the Internet traffic in this network will be in the next few moments, through Time Series prediction methods. The objective is to make short-run forecasts to use them to detect possible abnormal traffic in the network in a short period of time, such as connection drops and abnormally intense traffic in the next few minutes, which have distanced themselves considerably from the forecast for that particular period.

The following are the results of the Time Series adjustments with the Simple Exponential Smoothing and Double Exponential Smoothing methods, corresponding to the bit rates per second of the input and output in the network, which are shown in Fig. 2, using Minitab1 software.

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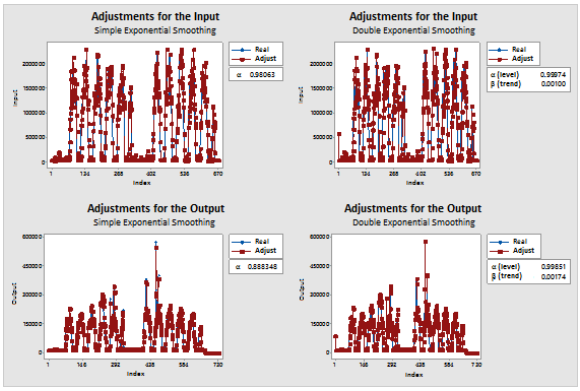

Fig. 2: Charts of adjustment using Simple Exponential Smoothing and Double Exponential Smoothing.

Figure 2 shows the charts that characterize the input traffic, both with the Simple Exponential Smoothing method and with the Double Exponential Smoothing. The obtained results indicate good adjustments with the real data and the models of the Time Series. But for the output traffic, better results were obtained with the Double Exponential Smoothing. The smoothing coefficients α and β were calculated automatically by the software.

To make predictions with AR and ARIMA models, it is first necessary to verify if the Time Series corresponding to the input and output traffic satisfies the stationarity condition. When a series is not stationary, it must be transformed through the differentiation process. If the differentiated series is stationary, the autocorrelation function (ACF) and partial autocorrelation function (PACF) are calculated, for then choosing the most appropriate model to perform the predictions for the series.

The procedure introduced in Fig. 3 was performed to identify the best model for series adjustments [7].

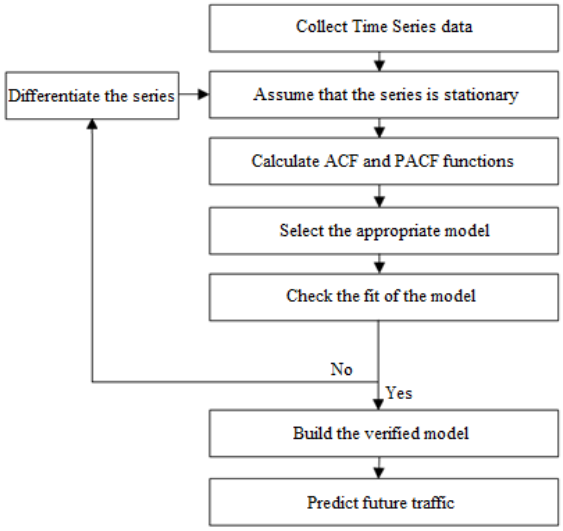

Fig. 3: Procedure for identifying the best model for series adjustment.

All of the results and charts in Fig. 4 were also obtained with Minitab software. Assuming initially the stationarity of the Time Series of the input and output traffic, the following autocorrelation and partial autocorrelation functions are obtained:

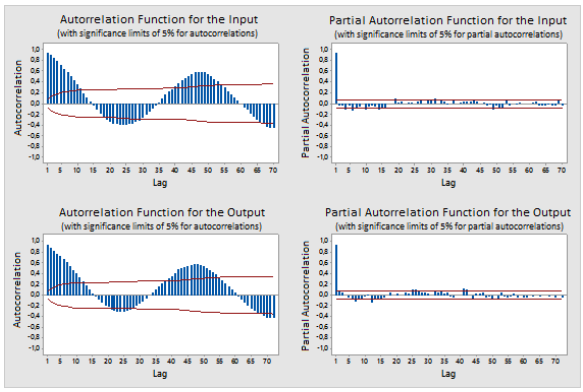

Fig. 4: Autocorrelation and partial autocorrelation functions for the input and output series

For both input and output traffic, the sinusoidal behavior of the autocorrelation function and a peak in the partial autocorrelation function suggest an AR(1) model, according to the adjustments obtained in Fig. 5.

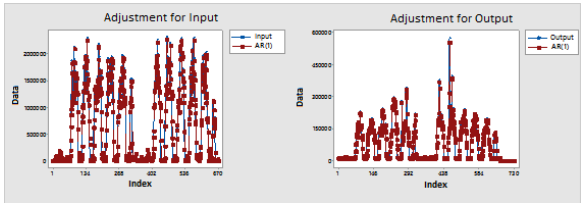

Fig. 5: Charts of adjustments using AR(1) model

As the AR(1) model did not _t the data so well, the Time Series analyzed were transformed through the differentiation process. The new ACF and PACF functions are in Fig. 6.

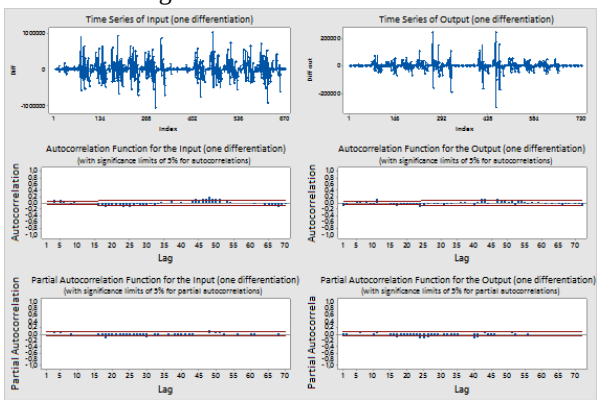

Fig. 6: Autocorrelation and partial autocorrelation functions for the input and output series, with one differentiation

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Once a single differentiation has been performed in the series, and according to the autocorrelation and partial autocorrelation functions, a possible model to be tested is ARIMA(1; 1; 1), which provides the following adjustments presented in Fig. 7.

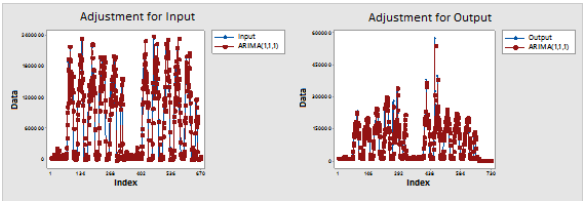

Fig. 7: Charts of adjustments with ARIMA(1,1,1) model

From the charts in Figure 7, it can be verified that with the ARIMA(1,1,1) model a better adjustment is obtained for the input series. However, the setting for the output series is still not appropriate. For this reason, a further differentiation was made in the two series, obtaining other ACF and PACF functions, according to Fig. 8.

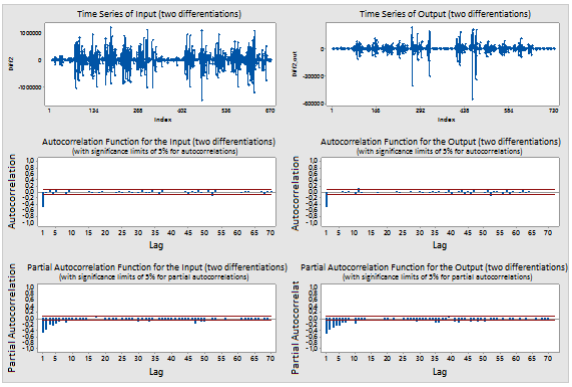

Fig. 8: Autocorrelation and partial autocorrelation functions for the input and output series, with two differentiations

The new autocorrelation and partial autocorrelation functions finally seem to indicate a more appropriate model. A peak in the ACF and the decreasing behavior of the PACF suggest an MA(1) model. As two differentiations were made in the series, the most appropriate model would be ARIMA(0,2,1). Fig. 9 shows the charts of this model. In this way, good adjustments are made both for input and for output traffic.

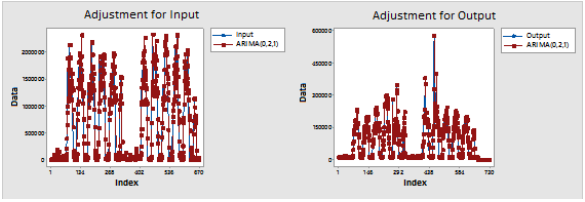

Fig. 9: Charts of adjustments using ARIMA(0,2,1) model

Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE) were calculated in order to compare the results of the adjustments obtained with all models tested. The values obtained are shown in Table 1:

Table 1: Comparison of the errors obtained from the adjustments obtained.

		MAD	MAPE
SES	**Input**	140,625.12	70.13%
	Output	15,104.24	21.19%
DES	**Input**	140,625.91	69.11%
	Output	15,124.65	19.90%
AR(1)	**Input**	146,448.44	144.67%
	Output	17,064.37	37.53%
ARIMA(1,1,1)	**Input**	141,240.61	74.82%
	Output	15,620.86	22.29%
ARIMA(0,2,1)	**Input**	**140,421.06**	**69.01%**
	Output	**15,083.73**	**19.77%**

With the results obtained, it was observed that it is possible to get good predictions with the application of the methods studied, since most of the models _t well to the traffic data in the network. The computational implementation of these methods is proven to be inexpensive and quite affordable compared to other methods used for the same purpose of this work. With the quality of these results, continuity of studies and the practical use of tools based on these methods will be possible.

IV. CONCLUSION

This paper addressed the monitoring of network traffic in an educational institution through Time Series models to support the network manager in making decisions in critical situations such as unavailability of resources and inappropriate or unusual use of the network, besides helping in the planning and dimensioning of this network.

The Time Series approach models provided good adjustments for Internet traffic on the network. With the results achieved it is possible to carry out traffic forecasts with real-time alerts using the models studied.

According to the metrics considered, all models were adequate to be used in predictions of both input and output traffic, although AR and ARIMA models provide smaller errors. On the other hand, analyzing the charts shown previously, it can be concluded that the ARIMA(0,2,1) model is the one that provides a better fit for both Time Series studied, being therefore the most suitable model to estimate with more precision the future traffic on the network.

This paper presented a study of the best method to predict Internet traffic in a particular educational institute. As a continuation of this work, it is intended to use

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mechanisms and tools to compare expected traffic with current real traffic, in a dynamic and automated way, in order to provide the network manager with alerts and reports in case of discrepancies in the comparisons, which may indicate possible abnormal behavior of network traffic. Machine learning implementations will be used with the aim of eliminating false positive alerts, and it also to compare the methods studied here with other implementations, including applications with hybrid methods.

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The Importance of Measuring Functional Independence for Rehabilitation Therapy in Older Trauma Patients

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Abstract— *Traumatic injuries can have an impact on the functional capacity and quality of life of older adults. Given that, we sought to measure the functionality of older trauma patients and its implication for rehabilitation therapy. This is cross-sectional study of 257 trauma patients aged 60 years and older admitted to a public hospital in Brazil. A sociodemographic questionnaire and the Brazilian version of the Functional Independence Measure (FIM) were used. Mean FIM total score was 42.5±19.9, mean FIM motor score was 30.2±21.5, and mean FIM cognitive score was 74.5±28.0. The most affected FIM domains were self-care (mean of 25.6±26.6), mobility (mean of 14.6±28.7) and locomotion (mean of 9.7±21.9). Men (mean total FIM score of 48.1±23.1) were more independent than women (mean total FIM score of 39.0±16.8), with statistically significant differences in mean FIM total score ($p<0.001$) and in the motor ($p=0.002$) and cognitive ($p=0.029$) subscales. Self-care ($p<0.001$), mobility ($p<0.001$), locomotion ($p=0.002$) and social cognition ($p=0.024$) scores were significantly different between genders, with women exhibiting the worst scores. Lower body injuries significantly impaired motor ($p<0.001$) and cognitive ($p=0.002$) functionality. There was an impairment in functional independence, mainly among women, with a greater impact on the motor domain.*

***Keywords*—Epidemiology; Trauma; Functional independence; Older adults.**

Contribution of the paper:

- The present study assesses the three domains (FIM total, FIM motor and FIMcognitive) of the Functional Independence Measure.
- After the occurrence of a traumatic injury, older people present with theirfunctional capacity at different levels of consequences.
- The FIM instrument can be used in clinical practice as an assessment toolintended to monitor individuals during the rehabilitation process.

I. INTRODUCTION

Aging is defined as a sequential, individual, cumulative, irreversible, universal, non-pathological process of deterioration of a mature organism that is common to all members of a species and that with time makes it less able to cope with environmental stress, thus increasing the probability of death [1].

Brazil has a population of over 200 million inhabitants, 14.3% of whom are people aged 60 years and over [2]. The country has a high older population growth rate, with estimates for 2025 of about 30 million people aged 60 and older [3]. Maintenance of functional capacity in aging can be affected by demographic, social, economic, epidemiological and behavioral factors [4].

The demographic and epidemiological transition is a global problem in developed and developing countries [5]. This conjuncture gave rise to the concern of the World Health Organization regarding the conditions for "active" aging basedon the process of optimizing opportunities for health, participation and safety to improve the quality of life of aging people [6].

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Two concepts define aging: the senescence, the period when there is a gradual physical and mental deterioration but that is a natural process in the life cycle, and the senility, the stage in which there is a physical decline accompanied by mental disorganization that may suggest a pathological process [7].

Therefore, aging is a physiological process characterized by a gradual reduction of organic functional reserves which determine the progressive loss of ability to adapt to the environment, causing greater vulnerability to and higher incidence of pathological processes [8].

In the context of aging, disability for daily life activities and instrumental daily life activities present characteristics that suggest a complex casual network. Therefore, preventive actions are needed to improve older adults' quality of life [9].

Aging is accompanied by a significant increase of comorbidities and chronic and degenerative diseases which are closely related to a cognitive decline and dependence in functional activities [10]. Therefore, it is important to pay attention to the cognitive and functional performance of older adults with the aim of preventing their decline, which is quite frequent in public health services [11].

People aged 75 years and over have increased odds of becoming dependente and needing assistance to perform activities of daily living. Falls are the main leading cause of fractures, trauma admissions and loss of independence [12]. Furthermore, falls cause pain, isolation, disability, loss of confidence, and have a significant impact on quality of life and health-related costs [13].

Thus, the maintenance of the functional capacity of older adults can be affected by several factors that generally propagate chronic health problems, which are important components for assessing the health of older people, especially those with disabling diseases such as the ones resulting from trauma [14]. Functional capacity is understood as the product of the interaction between physical and mental health, the independence in activities of daily living and the integration into the social environment supported by family and economic independence [15].

Population aging is found to be associated with the increased occurrence of certain diseases, including those with external causes – accidents and violence [16] These events are significant in the older population because with advancing age older people often get frail and dependent and are hence more vulnerable to various types of trauma [17].

The concept of older adults' health is related to functional capacity, but the relationship between trauma and dependence/independence is still little discussed. Thus, the application of the Functional Independence Measure (FIM) in older people allows to assess whether trauma can lead to a decreased functional capacity in both basic activities of daily living (ADL) and instrumental activities of daily living (IADL), loss of independence and autonomy, and decreased quality of life [18].

Given the growth of the older population and the occurrence of traumatic injuries that impact on their functional capacity and quality of life, the present study aimed to measure the functionality of older trauma patients and its implication for rehabilitation therapy. This study is deemed important due to the increasing numberof older people in society and the preservation of functional capacity as a key aspectof the concept of health of the older people.

II. METHODS

This is a quantitative, descriptive and analytical cross-sectional studyconducted in a reference university hospital for polytrauma care in the city of Fortaleza, Ceará, Northeastern Brazil. The hospital has 425 beds and performs na average of 15,500 consultations per month 24 hours a day. It is also equipped with a Center for Studies and Research suitable for the development of a continuing education program.

The study population consisted of older victims of trauma due to external causes admitted and hospitalized for clinical or surgical treatment in the hospital. Older adults aged 60 and older were selected and identified based on a census of patients organized by unit and bed of the five trauma centers. The census contained information on patient admission obtained from the hospital information system of Brazil's Ministry of Health – DATASUS.

Data were collected from April to August 2014 using a socioeconomic and demographic questionnaire (age, gender, education, income, marital status, household, and self-defined ethnicity) and the Brazilian version of the Functional Independence Measure (FIM). The FIM contains 18 items divided into two subscales: the motor subscale (13 items) and the cognitive subscale (5 items). The motor subscale collects information on self-care, sphincter control, transfer, and locomotion. The cognitive subscale collects information on communication and social cognition. All items are scored using a seven-point ordinal scale based on the number of assistance required for thee patient to perform each activity. Higher FIM scores indicate higher levels of independence. The total FIM score ranges from 18 to 126 [19].

Since each FIM domain assesses a different number of items, the scores were standardized into a single scale to facilitate understanding of the results. Standardization of the scores followed the procedures described by Brazil's

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Ministry of Health [20]. A scale of 0 to 100 was built using the following formula:

$$\frac{100 \times [\text{score obtained} - \text{minimum value}]}{\text{maximum value} - \text{minimum value}}$$

The study included people aged 60 years and older admitted to the university hospital with trauma. Eligible participants should present with physical and mental capacity to answer the questionnaire or be accompanied by family members, caregivers or nurses who could deliver the information requested. Patients with previous functional sequelae of trauma or any pathological associations such as Stroke, Alzheimer's disease, Parkinson's disease or any other physical diseases, amputation or mental disorder that limited the application of the questionnaires were excluded from the study.

Data were analyzed using the Statistical Package for the Social Sciences – SPSS version 20 (SPSS Inc., Chicago, IL, USA). Dependence in FIM domains and the degree of dependence according to location of injury and gender were assessed using analysis of variance (ANOVA), Tukey test and Chi-squared test. Inferential procedures were carried out considering a significance level of 5%.

This research is in accordance with all ethical standards of Resolution 466/12 of the National Health Council, which regulates research involving human subjects. Participants were explained about the research objectives and anonymity was ensured. Written informed consent was obtained from all the participants. Datacollection took place after the project was approved by the Research EthicsCommittee of the University of Fortaleza (UNIFOR) under Protocol No.564.088/2014.

III. RESULTS

Of the 280 older people enrolled, 23 were excluded from the study due toprevious functional sequelae of trauma. The study included 257 older people hospitalized due to different types of trauma. The age of the participants ranged from 60 to 99 years, with a mean age of 75.8 (± 9.74). There were 158 (61.5%) women and 99 (38.5%) men. There was a predominance of individuals with incomplete primary education and uneducated individuals. Most of the participants received one minimum wage, were married and lived with family members. There was a predominance of pardos (mixed-race Brazilians) and white individuals.

The mean time of bed rest taken at the hospital by older people in the presente study was 7.83 days (SD±15.55): men spent 14.11 days (SD±21.99) and women spent 4.39 days (SD±8.87). The mean scores in the subscales and their domains are described in Table 1. The mean FIM total score was 42.5±19.9, the mean FIM motor score was 30.2±21.5, and the mean FIM cognitive score was 74.5±28.0. The most affected FIM domains were self-care (mean of 25.6±26.6), transfer (mean of 14.6±28.7) and locomotion (mean of 9.7±21.9) (Table 1).

Table 2 shows that men (mean total FIM score of 48.1±23.1) were more independent than women (mean total FIM score of 39.0±16.8), with statistically significant differences in the mean FIM total score ($p<0.001$) and in the motor ($p=0.002$) and cognitive ($p=0.029$) subscales. Self-care ($p<0.001$), transfer ($p<0.001$), locomotion ($p=0.002$) and social cognition ($p=0.024$) scores were significantly different between genders, with women exhibiting the worst scores (Table 2).

Table 3 depicts the mean FIM total scores and it subscales and domains in relation to location of injury. Lower body injuries were the ones that mostly impaired functional independence, both in the motor ($p<0.001$) and cognitive ($p=0.002$) subscales. Lower body injuries significantly ($p<0.001$) impaired self-care, transfer, locomotion, and social cognition (Table 3).

Table 4 shows that most patients had lower body injuries (214; 83.3%) and a high prevalence of lower body fractures – fracture of femur (86; 33.5%) (Table 4). The clinical diagnosis of injuries was based on the codes of the International Classification of Diseases – ICD-10 described in the medical charts.

IV. DISCUSSION

The present study stands out for assessing the three domains (FIM total, FIM motor and FIM cognitive) of the Functional Independence Measure in 257 older hospitalized patients to assess functional capacity after a traumatic injury. In our study, the mean age of the participants was 75.8±9.74. Research conducted with geriatric trauma patients found a similar mean age (78±8.2) [21]. Evidence on the association between age and functional dependence is well reported and the risk for dependence increases per year of age [22, 23, 24].

The predominance of individuals with incomplete primary education and uneducated individuals is in line with evidence on the association between low literacy and functional dependence [25]. Education is an important component of health as it transforms general intelligence into higher-order cognitive skills that promote risk assessment and decision making abilities related to health [26]. In the case of patients with low literacy skills and poor functional independence, healtheducation could be provided by health care professionals, particularly nurses, asthey are in contact with the patients more often than any other member of the healthcare team.

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The mean time of bed rest taken at the hospital by older people in the presente study was 7.83 days (SD±15.55): men spent 14.11 days (SD±21.99) and women spent 4.39 days (SD±8.87). Shorter hospital length of stay is associated with better functional outcomes and lower mortality [27]. It should be noted, however, that determining whether hospital length of stay is short or long is difficult because it depends on several variables, such as the type of trauma and the patient's recovery time.

In our study, the variation obtained in the scores of the FIM domains corresponds to the possible range of variation. A similar study that aimed to identify changes in functional independence of older patients admitted to medical centers at the time of hospital admission, hospital discharge and one month after returning home, found – at admission – FIM total scores of 109.2, FIM motor scores of 76.8, and cognitive FIM scores of 32.4 [28]. These values are proportionally similar to the values found in our study.

The most affected FIM domains in our study were self-care, transfer and locomotion. Care dependence in old age has major implications for older adults as many of them will be vulnerable to suboptimal care and care failures [29]. Therefore, assessing older adults' functional dependence is important to identify potential care vulnerabilities to which they may be exposed to and thus develop and implemente interventions to provide dependent older adults with quality care.In our study, men presented higher mean scores in nearly all the domains.

This finding demonstrates that women had a more compromised functional independence. Other studies have shown similar results [19,30], thus confirming that the female gender is an independent risk factor for functional dependence. Estimates of the prevalence of functional disability resulting from trauma reveal that many people, mostly women, have greater difficulties or disabilities in daily activities, and these difficulties increase with age [23, 24].

Another study that compared men and women in all age groups found that functional limitation is more common among women and older adults [31].

Functional capacity differences in relation to gender are well known. Poorer functional independence in women may be associated with the fact that women live longer than men on average, but with a poorer health status, which results in a survival with limitations. Therefore, the female gender stands out as an independente risk factor for decreased functionality because women have an increased life expectancy and are at higher risk of developing chronic diseases which can result in functional limitations and disabilities [32, 33].

In our study, the analysis of the association between functional Independence measure and location of injury revealed that lower body injuries were the ones that mostly impaired functional independence, both in the motor ($p<0.001$) and cognitive ($p=0.002$) subscales. Lower body injuries significantly ($p<0.001$) impaired self-care, transfer, locomotion, and social cognition. These findings are consistent with the findings of research which showed that 73.0% of the interviewees had injuries in the lower limbs compared with 13.5% in the upper limbs [34]. Lower body functional limitation is a well-known risk factor for functional dependence as it can directly affect locomotion and transfer and hence lead to decreased self-care, cognitive function and social cognition [25].

Researchers, supported by clinical and neural data, argue that motor andcognitive processes are functionally related and probably share a similar evolutionary history. In addition, the authors argue that cognitive processes coincide with complex motor output and support the reverse notion that motor processes can contribute to cognitive function, i.e., motor and cognitive processes possess dynamic bidirectional influences on each another [35].

It should be noted that all the participants included in our study presented with injuries from external causes. In this regard, Itami et al.[34] emphasize that trauma caused by accidents and violence cause tremendous economic costs due to the potential years of life lost, hospitalization, treatment and rehabilitation, which in turn lead to social and psychological/emotional damages.

The FIM is a multidimensional instrument that is mainly aimed at assessing the patient's progress in rehabilitation therapy on a hospital basis, particularly in victims of traumatic injuries. In this regard, researchers have found that there was a considerable increase in the mean FIM scores (FIM motor and total FIM) at discharge, suggesting functional independence gain in relation to the moment following the traumatic injury [36,37].

The FIM Instrument was intended to monitor individuals during the rehabilitation process and aims to analyze the individuals' efficiency in performing activities of daily living independently. Studies on trauma reveal that clinicians and researchers require reliable and valid measures of long-term outcome. They report that the FIM instrument should be used in clinical practice as an assessment tool intended to monitor individuals during the rehabilitation process, and the early onset of rehabilitation will enable patients to perform more comfortable daily life activities and to achieve more functional gain [34, 38]. In addition, the use of the FIM instrument enables the members of the interdisciplinary

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rehabilitation team to be continually aware of the progress being achieved by each team member and by the team as a whole [39, 40].

One of the limitations of the present study was the lack of information about the FIM before the traumatic injury, which could be compared to the findings after the traumatic injury; thus, such information was limited to the patients' or caregivers' selfreports. Another limitation is the fact that some older patients or caregivers had no prior knowledge of the presence of systematic diseases; additionally, as they are patients admitted on an emergency basis, the records did not always contain the results of complementary tests. However, it should be noted that the FIM instrument should be used for decision making in clinical practice during the rehabilitation process.

More importantly, as the present study was limited to patients of a single reference traumatology hospital, its findings cannot be extrapolated to the rest of the older population who suffered a traumatic injury. However, because it is a large hospital of excellence in Northeastern Brazil, similar results are expected in other populations with the same characteristics.

Furthermore, it is believed that health promotion and prevention and self-care should be emphasized in reference to the senescence process, both for undergraduate students and for continuing education professionals in the health field.

Further research is recommended to deepen knowledge in the area and support the development of strategies aimed to minimize the impact of trauma on the functional capacity of older adults and hence contribute to a healthy aging.

V. CONCLUSION

The results revealed an impairment in functional independence, particularly among women. Such impairment has greater impact on the motor domain, with a loss of the ability to perform self-care, transfer and locomotion activities, which show that after the occurrence of a traumatic injury, older people present with their functional capacity at different levels of consequences.

Therefore, the Functional Independence Measure – a sensitive and reliable instrument – can be a great ally of health professionals, particularly in traumatology, to assess the performance and progress of patients with functional disability resulting from trauma who receive recovery and rehabilitation therapy.

ETHICAL APPROVAL

This study was approved by the Research Ethics Committee of the University of Fortaleza (UNIFOR) under Protocol No. 564.088/2014.

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Table 1. Descriptive analysis of original and standardized FIM scores.

FIM	Scale	Mean ± Standard deviation	Minimum Maximum
Total	Original	63.9 ± 21.5	19 – 126
	Standardized	42.5 ± 19.9	0.9 – 100
Motor	Original	36.6 ± 16.8	13 – 91
	Standardized	30.2 ± 21.5	0 – 100
Cognitive	Original	27.4 ± 8.4	5 – 35
	Standardized	74.5 ± 28.0	0 – 100
Self-care	Original	15.2 ± 9.6	6 - 42
	Standardized	25.6 ± 26.6	0 - 100
Sphincter control	Original	12.6 ± 3.3	2 - 14
	Standardized	88.2 ± 27.7	0 - 100
Transfer	Original	5.6 ± 5.2	3 - 21
	Standardized	14.6 ± 28.7	0 - 100
Locomotion	Original	3.2 ± 2.6	2 - 14
	Standardized	9.7 ± 21.9	0 - 100
Communication	Original	11.8 ± 3.5	2 - 14
	Standardized	81.9 ± 28.8	0 - 100
Social cognition	Original	15.5 ± 5.4	3 - 21
	Standardized	69.5 ± 29.9	0 - 100

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Table 2. Association of FIM total score and domains with participants' gender.

FIM	Scale	Men	Women	p
		Mean ± Standard Deviation		
Total	Original	70.0 ± 24.9	60.1 ± 18.1	**<0.001**
	Standardized	48.1 ± 23.1	39.0 ± 16.8	
Motor	Original	41.8 ± 20.1	33.3 ± 13.4	**0.002**
	Standardized	37.0 ± 25.8	26.0 ± 17.2	
Cognitive	Original	28.1 ± 8.7	26.9 ± 8.2	**0.029**
	Standardized	77.1 ± 29.1	72.9 ± 27.2	
Self-care	Original	18.3 ± 11.1	13.3 ± 8.0	**0.001**
	Standardized	34.0 ± 30.8	20.3 ± 22.2	
Sphincter control	Original	12.5 ± 3.2	12.6 ± 3.4	0.434
	Standardized	87.8 ± 27.0	88.4 ± 28.2	
Transfer	Original	7.2 ± 6.2	4.6 ± 4.1	**<0.001**
	Standardized	23.3 ± 34.5	9.1 ± 22.8	
Locomotion	Original	3.9 ± 3.2	2.7 ± 2.1	**<0.001**
	Standardized	15.5 ± 26.6	6.0 ± 17.4	
Communication	Original	11.9 ± 3.5	11.8 ± 3.4	0.581
	Standardized	82.4 ± 29.4	81.6 ± 28.5	
Social cognition	Original	16.3 ± 5.4	15.1 ± 5.3	**0.024**
	Standardized	73.6 ± 30.1	67.0 ± 29.6	

Mann-Whitney U test.

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Table 3. Association of FIM total score and domains with location of injury.

FIM	Scale	Location of injury			p
		Upper body	Lower body	Skull and face	
		Mean ± Standard deviation			
Total	Original	80.8 ± 19.5	60.0 ± 17.5	87.6 ± 37.9	<0.001
	Standardized	58.1 ± 18.0	38.9 ± 16.2	64.5 ± 35.1	
Motor	Original	50.1 ± 16.5	33.2 ± 12.8	58.8 ± 30.6	<0.001
	Standardized	47.6 ± 21.2	25.9 ± 16.4	58.8 ± 39.2	
Cognitive	Original	30.7 ± 6.2	26.8 ± 8.4	28.8 ± 9.9	0.002
	Standardized	85.5 ± 20.8	72.8 ± 28.1	79.4 ± 33.0	
Self-care	Original	21.3 ± 9.0	13.6 ± 8.1	25.9 ± 16.1	<0.001
	Standardized	42.5 ± 24.9	21.2 ± 22.5	55.2 ± 44.6	
Sphincter control	Original	13.0 ± 2.8	12.6 ± 3.4	11.9 ± 3.7	0.603
	Standardized	91.7 ± 23.1	88.2 ± 28.0	82.8 ± 30.7	
Transfer	Original	10.8 ± 5.7	4.4 ± 3.7	13.1 ± 8.6	<0.001
	Standardized	43.2 ± 31.7	7.8 ± 20.4	56.2 ± 47.7	
Locomotion	Original	5.0 ± 2.4	2.6 ± 1.8	7.9 ± 5.1	<0.001
	Standardized	25.3 ± 19.8	4.6 ± 14.6	49.0 ± 42.6	
Communication	Original	12.9 ± 2.3	11.7 ± 3.5	12.2 ± 3.6	0.118
	Standardized	91.0 ± 19.6	80.6 ± 29.5	84.8 ± 30.2	
Social cognition	Original	17.7 ± 4.6	15.2 ± 5.3	16.6 ± 6.6	<0.001
	Standardized	81.8 ± 25.6	67.5 ± 29.6	75.8 ± 36.8	

Kruskal-Wallis test

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Table 4. Distribution, location and identification of traumatic injuries.

	Location	N	%
Injury	Upper body	26	10.10
	Lower body	214	83.30
	Skull and face	17	6.60
ICD according to location			
Lower body	s72 – Fracture of femur	92	43.0
	s72.2 – Subtrochanteric fracture of femur	40	18.7
	s72.0 – Fracture of head and neck of femur	33	15.4
	s82.2 – Fracture of shaft of tibia	29	13.6
	s72.3 – Fracture of shaft of femur	11	5.1
	S92 – Fracture of feet	6	2.8
	S82 – Fracture of lower leg, including ankle	3	1.4
Upper body	s42.2 – Fracture of upper end of humerus	5	19.20
	s42.3 – Fracture of shaft of humerus	10	38.5
	s53.1 – Unspecified subluxation and dislocation of ulnohumeral joint	4	15.40
	s42 – Fracture of shoulder and upper arm	2	7.7
	s62 – Fracture at wrist and hand level	3	11.5
	s42.0 – Fracture of clavicle	2	7.7
Skull and face	s02.4 – Fracture of malar, maxillary and zygoma bones	4	23.50
	s02.6 – Fracture of mandible	3	17.6
	s02.7 – Multiple fractures involving skull and facial bones	2	11.80
	s06.9 – Unspecified intracranial injury	5	29.4
	t07 – Unspecified multiple injuries	3	17.6

N= Number of individuals; %= frequency in percentages

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Optimization of Flow Test Quality Indicators in a PIM Air Conditioner Line

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Abstract*— *The present article aims to describe the process of detection by flow measurement in a window air conditioner refrigeration system of a company of the Industrial Pole of Manaus PIM. The equipment used is a flow sensor model SFAB-200U-HQ8-2SA-M12, which was installed in a production line, connected to a supervisory system, which will indicate through a visual device Andons, the approval of the product in real time . The process occurs through the sending of flow data, with the early detection of capillary blockage, ie, before the final assembly of the product, the objective is to optimize the quantity of products reworked internally, which will cause an increase in the indicator of FPY (First Passed Yield), as well as a reduction in field failure rates due to the non-detection of capillary obstruction in the process. For this, it was necessary to identify the normal flow of product, and to define new parameters of approval, next to this the methodology 6 sigma was applied to make the analysis of the data.

Keywords*— *Flow meter; 6 sigma; Quality.

I. INTRODUCTION

The manufacturing processes of air conditioners, the problem of capillary obstruction, have proved to be a complicating factor in terms of manufacturing cost and product warranty in the field. In the investigated process, the identified problem is potentially relevant since perception detection was only possible, ie if the operator visualized capillary tube freezing during the performance test of the product. The capillary tube being the expansion device in cooling systems of air conditioners, acting as pressure reducing element and coolant mass flow regulator. The study aims to analyze the flow data for parameter definition as well as the evaluation of the measurement system.

The refrigeration system is applied in several areas in today's society, with cooling of electronic components, thermal comfort of environments and food preservation. Even little known to those who do not work in the area, the capillary tube component is a key item for the refrigeration system.

Taking into account the need for a company to produce air conditioners and taking into account the late detection of capillary tube clogging (important part of the refrigeration system), this paper aims to answer the following question: what are the appropriate parameters of a flow detection device for capillary tube clogging? It is seen that controlling the flow of this component is of fundamental importance for the performance of the refrigeration system.

The idea was to detect the capillary clogging through the flow sensor model SFAB-200U-HQ8-2SA-M12, bringing it closer to where the fault is generated, not by perception and by measuring the flow rate.

II. THEORETICAL FOUNDATION

The problem of approach of the research verified through a bibliographical analysis the elements that compose the process of manufacture of air conditioners of window. It is also important to understand the process of operation of the flow sensor, which aims to solve the problem of capillary obstruction in the production process.

2.1 THE AIR-CONDITIONING FUNCTIONING THEORY

This stage shows the systems and theories that involve the operation of air conditioning, addressing concepts of thermodynamics, gas flow and sensors [1].

2.1.1 Thermodynamics

In his work [2] he states that the second law of thermodynamics deals with energetic transfers between bodies. Heat is a form of energy, hot and cold is related to temperature variations. The thermodynamic process

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draws the heat from an isolated system into the environment through the refrigerant. The thermodynamic systems are 3, the isolated, the open and the closed.

- Open system: exchange mass and energy;
- Closed system: only energy exchange;
- Isolated system: it does not exchange mass or energy.

Mechanical compression of steam is used in most refrigerators, which basically consist of four components: compressor, condenser, expansion device and evaporator, where the refrigerant fluid forms a thermodynamic cycle [3].

The refrigerant gas is sucked by the compressor, in the superheated vapor state and the low pressure, being compressed during the work (W). Then the fluid goes to the condenser where the cooling, condensation and subcooling occurs with the rejection of the heat (Qcond) to the external environment. Then the high pressure fluid passes through the expansion device, generating the mixture of liquid and vapor at low pressure and temperature, arriving at the evaporator that absorbs the heat (Qevap) of the refrigerated environment, becoming vapor [3].

The expansion or capillary device has the function of controlling the passage of refrigerant in the evaporator and the amount of steam that is sucked by the compressor. The most widely used expansion device in small refrigeration systems (residential air conditioners, household refrigerators, freezers and drinking fountains) is the capillary tube [4].

2.1.2 Flow concept

The flow is expressed in mass or volume, the unit of flow is the unit of volume per unit of time or unit of mass per unit of time [5]. The volumetric flow rate is the product of the velocity of the fluid through the cross-sectional area of the pipe and the mass flow is equal to the product of the volumetric flow by the specific mass of the fluid. Because direct measurement of the specific mass of the fluid is difficult, temperature and pressure measurements are used to infer it, since the gas composition is constant [6].

The complexity of fluid flow is not always subject to exact mathematical analysis. The measurement can be quite difficult, since the fluid elements can move at different speeds of acceleration [5].

2.1.3 Gas sensors

The gases have excellent compressibility and exceptional expansion capacity. The gases do not have a fixed volume, since they always occupy the total volume of the container in which they are confined. Another property inherent to the gases is that they are miscible in any proportion, that is, they form a homogeneous mixture [7].

According to [8] sensor is a term used to designate devices sensitive to some form of energy from the environment. [9] complements this concept when it states that such energies of the controlled environment can be luminous, thermal, kinetic and so on, in order to relate the information about the physical quantities to be measured, such as temperature, pressure, velocity, current , voltage, acceleration, position, and so on.

2.2 QUALITY SYSTEM

Quality can be applied in multiple directions, which depends on person to person, although there is not only a definition of quality, there are definitions adapted by expert gurus in most situations. For [10], a quality product or service is one that perfectly meets, reliably, affordably, securely and on time to the customer's needs.

The table in Figure 1 identifies how it classifies the most common points that demonstrate the breadth of inclusion or exclusion in firm quality definitions.

PRODUCT FEATURES THAT MEET CUSTOMER NEEDS	ABSENCE OF DEFICIENCIES
Superior quality enables companies to:	Superior quality enables companies to:
• Increase customer satisfaction; • Make products salable; • Increase your market share; • Obtain sales revenue; • Guarantee better prices. • The biggest effect and on sales. • Higher quality usually costs more.	• Reduce error rates; • Reduce repetition of work and waste; • Reduce usage failures and warranty costs; • Reduce customer dissatisfaction; • Reduce the deadline for launching new products on the market; • Increase yields and capacity; • Improve delivery performance. • The greatest effect and cost. • Higher quality usually costs less.

Fig. 1: Definitions of quality of enterprises, Souce: [11].

For [12] quality is everything that improves the product from the point of view of the customer. Only the customer is able to define the quality of a product. The concept of quality changes meaning in the same proportion as the needs of customers evolve.

For [13] quality is to develop, design, produce and market a quality product that is more economical, more useful and always satisfying to the consumer. "

2.2.1 QUALITY INDICATORS

Quality indicators help companies measure their performance. With the evolution of the concept of quality it was proposed the systematization of performance indicators in quality management adopting a reference model following the principles expressed in the works of [13] and [14].

According to [15], the indicators of productivity, return on investments and standard cost are the most common, and it is important that all employees of the company are trained to interpret the indicators so that they know what actions to take with the results achieved

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and with this information is not restricted only and management. Quality indicators need to have benchmarks, which may be benchmarking results or organizational guidelines, where tolerances are determined by these standards. It is essential to listen to the four indicators of the 6 sigma philosophy, being vital to gain acceptance of the philosophy of the administrators and employees of the organization.

2.2.2 Methodology 6 sigma

The main goal of 6 sigma is the elimination of waste, improving the quality of processes and products with consequent increase in customer satisfaction and business profitability [16].

Because there are several definitions of the methodology 6 sigma becomes complicated since methodology deals with solutions of problems, which is due to its historical evolution. Some factors emerged in the 1980s that contributed to the evolution of quality in organizations around the world. The beginning of mass production that opened the global market allowing the Japanese to introduce their electronic products in all the world markets, having an immediate acceptance of the consumers, since they had the low price and superior quality.

In their work [17] they affirm that 6 sigma represents a global approach aiming to obtain the perfection of all the processes and products of an organization, through a rigorous survey of data and statistical analysis for elimination of sources and causes of errors and forms of the to eliminate.

In the view of [18] there are two essential sides to 6 sigma methodology, statistics and business. The statistic represents the origin and essence of 6 sigma, defined as the goal for achieving less than 3.4 defects per million opportunities, equivalent to an efficiency ratio of 99.9997%, and Sigma represents process variability. In contrast, the business point of view [19] defines the methodology as a strategy to improve and optimize the efficiency and effectiveness of all the operations of a process in order to meet and satisfy the needs of the final consumer.

When a customer or consumer acquires a product or service he expects them to have quality and meet their expectations and with the 6 sigma methodology being a powerful process improvement tool together with the use of good quality practices in services, measuring customer satisfaction clients and performance results being for a selection of 6 major sigma projects hear the following four indicators:

- Customer voice;
- Business voice;
- Process voice;
- Voice of Stakeholders.

After collecting the information the methodology can be used to obtain process parameters, resulting in the improvement of them and consequently in the final product. The training in 6 sigma aims to achieve the highest level of skill for the application of techniques [20].

With daily observations and an initial knowledge of the process, the definition of control parameters can be easily achieved with the use of VOC, which is a method of easy application, correctly following the use of the tool, can guarantee improvement in quality with reduction manufacturing defects, being one of the main statistical tools for this purpose. The MSE evaluates the measurement system in order to learn as much as possible about the measurement process in a short period of time.

To reduce the variability of the process, the 6 sigma uses several statistical tools, such as simple pareto graph, analysis of variance and components of variation (VOC) [21].

In his work [22] explains that VOC (Variation components). It consists of planning the appropriate sampling strategy to define the critical parameters and where the greatest variation is found. After planning, data collection occurs where it is important to document and observe any behaviors other than expected [23]. Finally, the analysis of the data compared to the technical specification of that product or process makes it possible to establish whether the variation is acceptable and, if not, where it is necessary to act.

At this stage it is important to focus and make clear what the objectives of the experiment are, what information has already been obtained and what the experimental strategy will be. This strategy should contain:

- Response variables (Y's);
- The study factors with theories and forecasts already formulated;
- Noise variables and their control methods, when possible;
- The necessary resources, such as machine downtime for the experiment or cost with prototypes in case of a product change.

III. METHODS AND TOOLS

This study was carried out in an air-conditioning company in the city of Manaus-Amazonas, the research was developed using quality tools that will be applied.

3.1 AIR-CONDITION MANUFACTURING PROCESS

https://dx.doi.org/10.22161/ijaers.6729 *ISSN: 2349-6495(P) | 2456-1908(O)*

The process of manufacturing window air conditioners is initiated by attaching the compressor to the plastic base, then fitting the condenser, evaporator and the pipes as well as the suction, discharge and capillary line according to the product configuration, plus The pressure test for leak detection in the still open system is carried out. In the course of the process we have the pre-vacuum and vacuum that performs the cleaning of the system for later application of the gas charge and sealing of the product, from there it is already made the assembly of the ventilation system, hypot and leak test, ending with the final test and packaging of the product that is still submitted in the form of sampling for final product auditing.

3.2 PARAMETERS AND EQUIPMENT

The SFAB-200U-HQ8-2SA-M12 flow sensor has the function of monitoring changes in airflows for media in piping systems or end devices in the industry. The measured mass of air is emitted by SFAB. According to the value obtained after parameter setting, a signal is sent to the installed command by turning on the red (if faulty) or green (if approved) andon (visual alert), where the timer will turn off the andon after 3 seconds, the product is sent to the repair to confirm the failure and if confirmed will perform the capillary exchange, the parameter must be controlled to avoid the approval of a product with the flow that does not meet the performance of the product.

3.3 COMMON PROBLEMS OF THE PRODUCTION OF AIR CONDITIONING

Among the most common problems raised from history and added to process losses in both volume and raw material values scraped by the manufacture, it was identified that the prioritization would be to treat the failure related to the capillary obstruction from the performance test.

During the observation of the problem, the conditions under which the problem occurred were clearly indicated and also evaluated under different points of view.

Analyzing the problem variables, we verified that there is a blind spot at the time of capillary welding in the pipe, together with the ability of an inexperienced welder, the amount of reprocessing increased.

Since this is an operational failure linked to the conditions of work, method, ability and criticality of the activity, the action plan has appeared in order to contain such failure.

As a start of the actions was defined the research, identification and how to use in the process a device or equipment that is carried out the measurement of the flow of the capillaries in a post to be defined later.

It was understood that the flow sensor could be used in the process, giving continuity of the acquisition of the remaining items for its operation.

Still following the actions were made the quotations and purchases of the necessary items for execution of what was foreseen in the plan.

The materials used for the problem solving process were the items flow sensor, electrical panel, PU hose (polyurethane), quick connectors, andons (red and green).

From the implementation will be done monitoring and data collection to measure the effectiveness of the implemented solution.

The quality indicator used is the FPY. FPY (First Passed Yield) indicates the number of approved products on the line the first time they were produced. It is given by the FPY formula below:

FPY = (Prod Qty / Produced Qty) * 100

The monitoring of this indicator is done online during the production process. Being this monitoring by a system called Quality Wall, accessed from any computer connected to the intranet. The indicator is given in percent, and the closer to 100 the better, and the farther from 100 the worse.

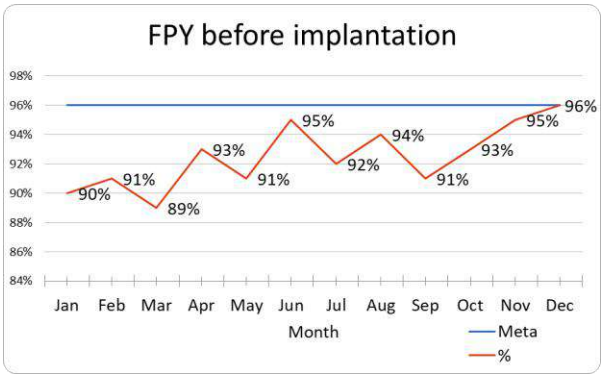

Fig. 2: FPY before Implementation

Figure 2 represents FPY data prior to project implementation.

IV. APPLICATION OF THE STUDY

During performance of the product performance test, the capillary tube freezes where it is identified through visual perception, being characterized by the clogging of the same. The product is sent to the repair where it is made the analysis and confirmation of the failure, impacting the FPY indicator as shown in Figures 3.

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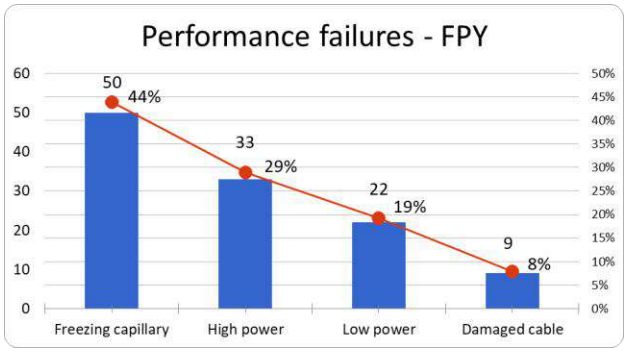

Fig. 3: Performance failures - FPY before Implementation

Figure 4 shows the causes of the problems, having as the source of the fault the welding station, due to the existence of a blind spot, the operator uses excessive welding, causing the capillary to become clogged, starting from there the study to detect the failure before the application of the gas charge on the product.

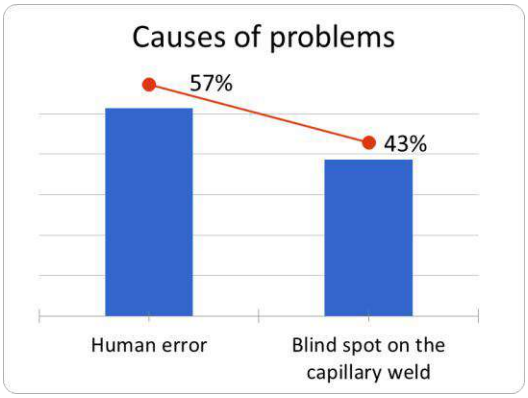

Fig. 4: Acknowledgment of reprocessing

After the analysis of the flaws shown in the previous figures, six sigma was applied in the solution of the problems.

4.1 APPLYING SIX SIGMA IN THE SOLUTION OF THE PROBLEM

The solution tool studied is the flow sensor model SFAB-200U-HQ8-2SA-M12 for the detection of capillary clogging, bringing it closer to where the fault is generated, being no longer by perception and being by flow measurement of the same.

To identify how the failure occurs the MSE and VOC were made, being important six sigma tools since they make it possible to identify which factors are relevant to the occurrence of the failure.

The tool used to evaluate the measurement system was the MSE, where it is necessary to have important characteristics in the measurement process as shown below:

Discrimination: The technological ability of the measurement system to adequately differentiate between repeated measurements.

Accuracy / Repeatability: The variation between measurements of the same characteristic in the same person, using the same instrument.

Accuracy: The difference between the mean value observed in the measurements and the master value.

Reproducibility: different operators, machines, etc. It gets basically the same average when measuring the same characteristic in the same piece.

Stability: The ability of a measurement process to maintain discrimination, accuracy, accuracy and reproducibility over time.

The related data presents the sampling tree of the measurement system evaluation (MSE) and the values found in samples collected respectively 7K and 10K.

In the Xbar charts in figure 5, below it can be seen that there is precision and repeatability since 75% of the points are outside the control limits and by rule 50% of the points must be outside the limits or the variations are between the measurements of samples.

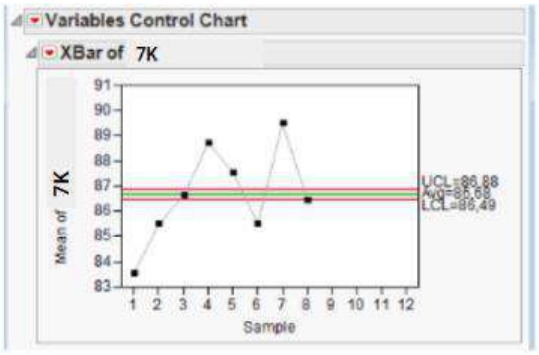

Fig. 5: Control variable 7k (MSE)

The equipment has accuracy since it is calibrated and registered, having a good state of conservation ie the equipment is accurate.

Once the measurement process manages to maintain the discrimination, precision, accuracy over time it has stability Figure 6.

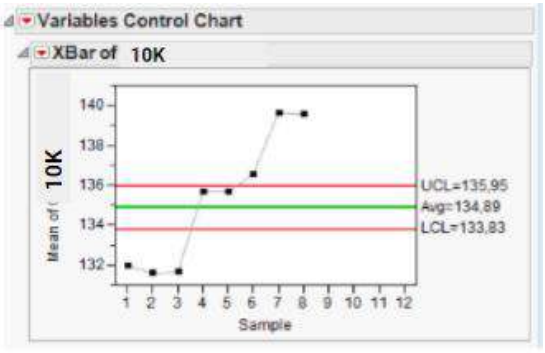

Fig. 6: Control Variable 10k (MSE)

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It is noted in chart R in Figure 7 below that the variations of the measurements repetitions vary within the amplitude of the letter R.

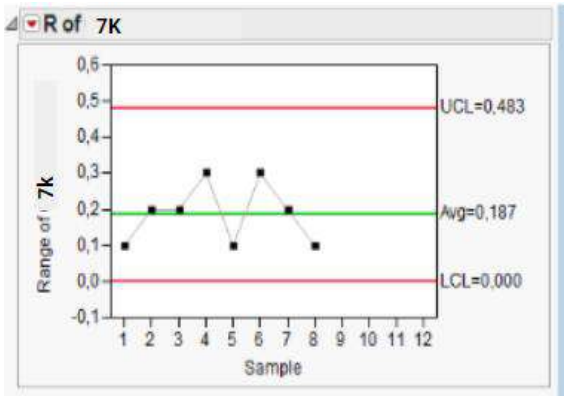

Fig. 7: Ranger 7k (MSE)

Therefore this letter is SPC (stable, predictable and constant) and has discrimination because the equipment can discriminate the variations of product flow Figure 8.

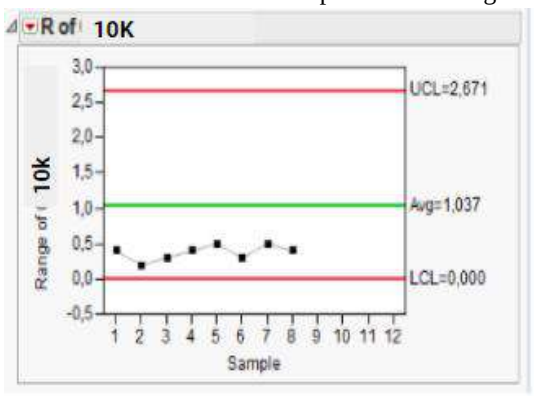

Fig. 8: Ranger 10k (MSE)

Conforme a aprovação do sistema de medição(MSE), seguimos com o COV criando a árvore de amostragem como mostra na Figura 9, coletando em 5 dias, 2 horários diferentes o total de 200 amostras.

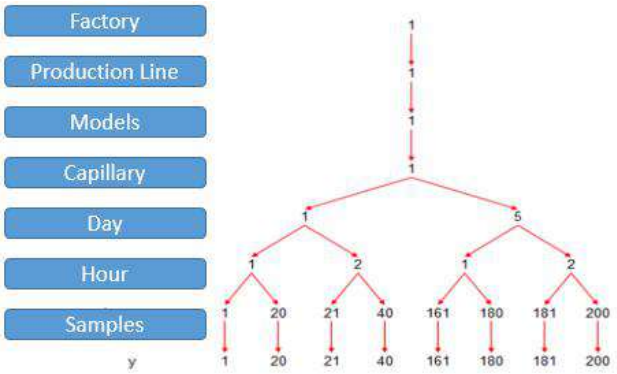

Fig. 9: Sampling Tree for (MSE)

Com a árvore de amostragem criada seguiu-se com a coleta dos dados para posterior aprendizado conforme mostra a Figura 10.

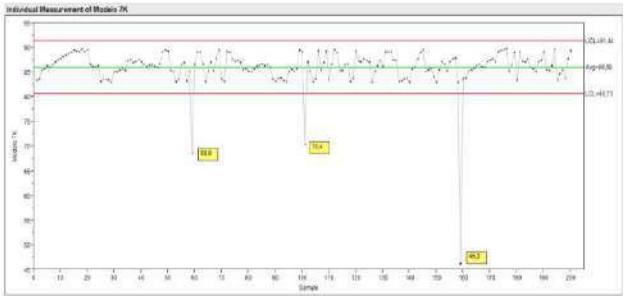

Fig. 10: Evaluation Component 7k (MSE)

Através da Figura 11, podemos observar o comportamento normal de produto dentro dos limites superior e inferior, no entanto tivemos 3 produtos identificados em amarelo que fugiram esse comportamento e foram separados para análise.

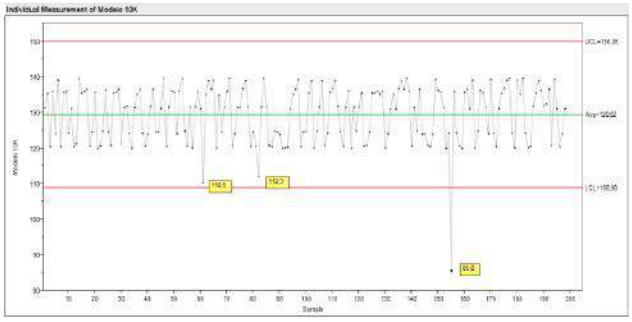

Fig. 11: Evaluation Component 10k (MSE)

The capillary tube is made of copper and is intended to receive the refrigerant from the condenser and take it to the evaporator inlet. As the refrigerant flows through the tube, the pressure decreases due to friction and the refrigerant acceleration increases, resulting in the evaporation of the fluid at the end of the capillary tube. The evaporation of the refrigerant fluids occurs at temperatures close to 0 ° C or negative up to -35 ° C. With the thermal exchange that happens in the evaporator, the interior of the refrigerators is cooled. From the analysis it was verified the capillary clogging, evidenced in Figure 12 below:

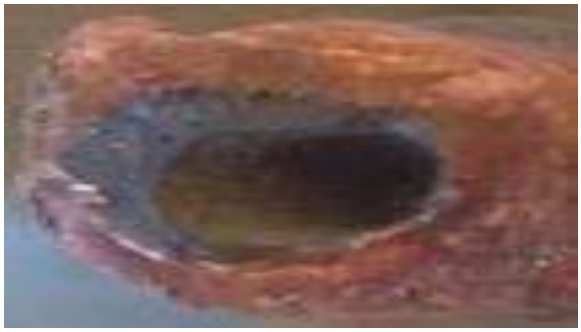

Fig. 12:Clogged Capillary Image

The internal diameter of the capillary tubes varies according to the application of each equipment, and can

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have internal diameters of 0.5 to 2.5 mm, with different lengths as well. Because it has a reduced internal diameter, special care must be taken in the installation of the capillary tubes to avoid obstruction.

Samples outside normal product behavior were excluded in Figure 13 below.

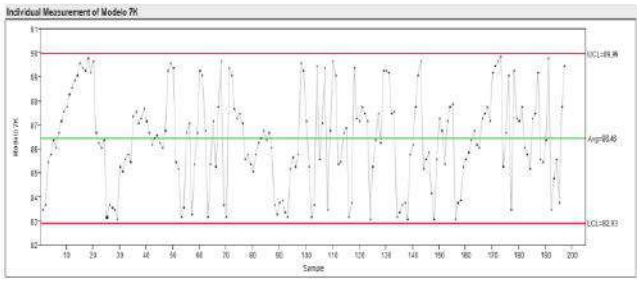

Fig. 13: Componente de variação(COV) 7K

Since as already evidenced they were with capillary obstructed and would affect of the final result for definition of the parameters figure 14.

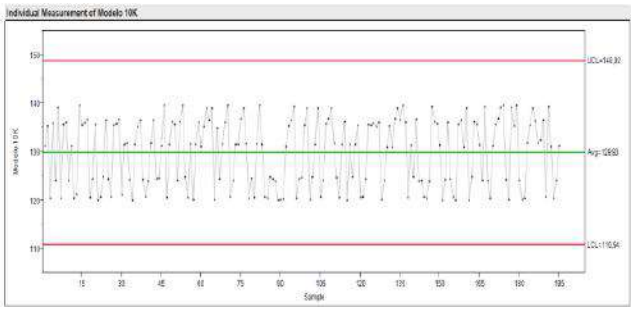

Fig. 14: Componente de variação(COV) 10K

Moisture, solid residues, or collapsing of the tube by folding may cause total or partial clogging, preventing refrigerant flow, damaging the performance of the refrigerator.

4.2 IMPLEMENTATION OF THE SOLUTION

In the process used for the implementation stages of the studied solution, it was necessary to plan until its execution, it was requested the opening of a service order for installation of the equipment at the station where the flow test will be done, request for change of working instruction and curve ramp up for pilot execution, as well as the necessary alignments for pilot execution and operator training as a new working method and the subsequent project submission for committee evaluation, if approved case the project is implemented.

4.3 SERVICE ORDER

With the flow sensor, solenoid valve, PU hose, quick connectors and accessories, we requested the opening of the maintenance order in order to install the equipment in the position where we identified the opportunity.

Initially we understood that the equipment could be installed in a station just after the welding station, however it was noticed that the piping needed a certain time to cool because of the high temperature of the torch flame. Again it was analyzed in which station we would have the opportunity to install the equipment and soon we realized that we could connect two tests in a single station and thus it was done, we installed the equipment in the same position of leak test by pressure where it starts with the flow test.

4.4 WORK INSTRUCTION

With the definition of the station for installation of the equipment, we can start with the request to change the working instruction of the affected station.

The process engineering team evaluated the takt-time for the station since the line could not be impacted by its production deliveries.

It was identified through the chrono-analysis, that for the affected station, its time would increase in 3 seconds, being above the time allowed for the station and being able to generate bottleneck and non-delivery of line productivity. We suggested to the process team to balance some of the activities already performed at the station in order to remain with the test in the station in question, the evaluation of the process team was positive, that is, a two activity balancing was done adding the time of 3 seconds, leaving the station still with 1 second of spare of its total time.

4.5 RAMP UP

With the change in the method of operation of one of the activities of the affected station, it was necessary to request a ramp-up curve from the production planning area, aiming at the gradual increase of the production and compliance of the plan according to the percentage phases of the curve. main objective is the gain of the operator's ability due to new activity inserted in the station.

4.6 PILOT TEST

According to the anticipated planning of the ramp-up curve to perform the pilot on the assembly line, training was started with the operator of the station, where despite the change in the method of one of the activities the operator was open to changes not demonstrating resistance, it was observed that the same felt more difficulties in the first two days because it is adapted to the old method of the activity, following as the training already in the fourth day it was possible to perceive an improvement in the performance of the operator who was already able to carry out the activities of the station at a rate of 80% of the production volume of the line. On the sixth day, with the line already working at 90% of its capacity, it was noticed that the operator maintained the

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ability of the new activity inserted, and that remained after the pilot in the normal volume of production of the line.

4.7 PRESENTATION TO THE COMMITTEE

In the presentation of the results and difficulties pointed out in the accomplished pilot, it was defined that first we would have to correct the sequence of activities of the station, not being necessary the realization of a new pilot due to the low risk for the operator. Due to a failure in the project approval system we are waiting for more than 30 days for the opinion of the submitted project, being approved by all the areas involved.

4.8 WORK INSTRUCTION FINAL VERSION

Due to the previously mentioned points, the process engineering team was requested to make the appropriate changes in the sequencing of the activities of the affected station, with the final version of the work statement being carried out, the implementation of the flow test was carried out within the planned deadlines.

V. ANALYSIS OF RESULTS

Figure 15 below shows the freezing of the capillary as the main offender in the FPY indicator, the fault is characterized by the clogging of the same and is detected only by visual perception in the line performance test, which is at 16 stations of the fault generating station, starting from this premise we will understand the flow behavior of the products and later define test parameters and approximation of the detection.

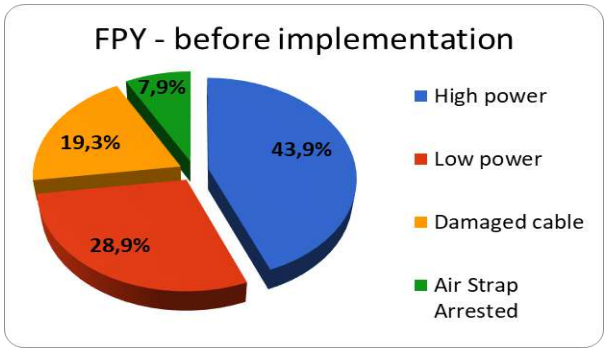

Fig. 15: FPY before Implementation

According to Figure 16, after completion of the project implementation stages, it was observed that during the first month there was no launching of the "capillary freezing" fault due to the performance, detected by visual perception by the freezing of the capillary.

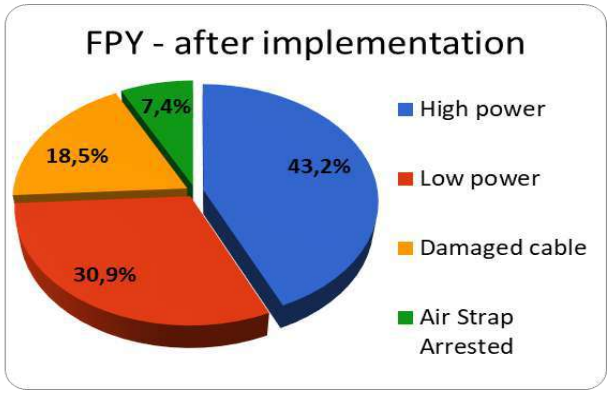

Fig. 16: FPY after Implementation

The high power and low power failure modes became more visible in the data and with this we had more assertive treatments, noting that as shown in Figure 17.

The implementation of the design and approximation of the failure detection, obtained a high failure rate in the flow test performed on the products, this shows that the test is effective in its detection, not allowing products with flow outside the parameters defined in the study go to the next station.

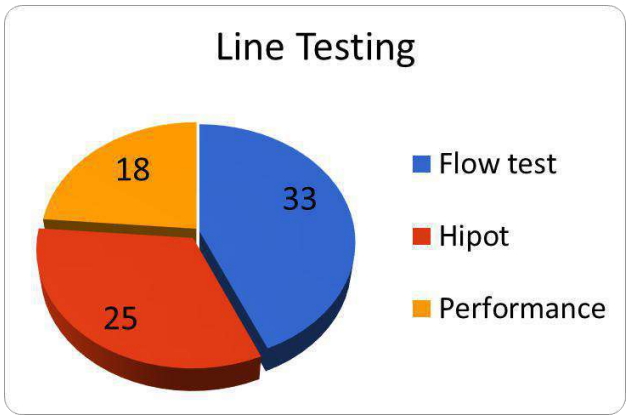

Fig. 17: FPY Line Tests

In addition to fault detection, other gains can also be noted, such as scrap reduction, due to the breakdown of the gas load that was generated prior to implementation with the freezing mode of capillary failure.

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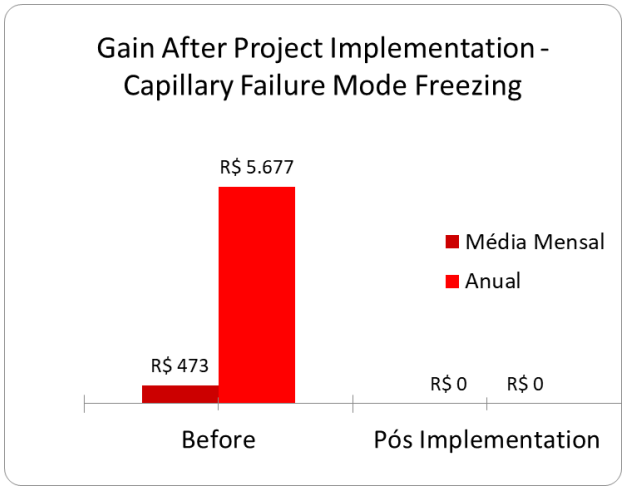

Fig. 18: Line scrap

In Figure 18 it can be observed that after the implementation, there was a reduction of the scrap related to gas load once the detection is performed before the application of the same.

VI. FINAL CONSIDERATIONS

In the face of problems that occur daily in the manufacturing processes, six sigma tools are used, which help in the improvement and solution, avoiding the occurrence of the flaws studied.

With the analysis of MSE and VOC, we can evaluate the measurement system and understand the normal behavior of the product, as well as show that the samples that did not obtain the normal behavior had capillary obstruction. Samples outside the normal product behavior were excluded for the definition of parameters, as they could impact the results. The defined parameters are confidential, so they belong to the company where the project was applied, not being fully detailed in this study due to security issues.

From the case study we can conclude that the elaborate solution is sufficiently robust. And a failure in the experiments before implementation would result in losses of company resources as well as the time spent by the professional.

Before the implementation, the detection of the fault was only made through visual perception, being a vulnerability, since it could go unnoticed by the operator at the moment of testing products in the performance. With the implementation the failure is detected near where it is generated, not allowing to move to the next station, therefore does not add value to the products with the late detection.

During the chronoanalysis performed by the process engineering team, we were informed that the position chosen to include the test activity would be 3 seconds above the standard time, we were suggested to balance activities for other stations, so that the flow test was in the previously chosen.

It was possible to perceive the existence of opportunities for new projects that improve the visualization, methods and welding techniques of the welder.

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To the engineering coordination of the FAMETRO university center, and the teachers M.Sc. Marden Eufrasio dos Santos and Dr. David Barbosa de Alencar, for the support in the development of this work.

To the Institute of Technology and Education Galileo of Amazon (ITEGAM), Brazil.

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The Physical Arrangement Based on the SLP Method, an Analysis on the LCM Fabrication Process

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Abstract *— Physical arrangement or layout is a term widely used in corporate language, it is the configuration of productive elements and transformers. In the industrial hub of Manaus in many cases it is either new installations or rearrangements of deactivated line spaces. This paper aims to show the importance of Layout study as well as its tools for process improvements and productivity increase. The methodology adopted is based on bibliographic and documentary research (internal corporate documentation) using the method SLP (systematic planning of Layout) that seeks the best configuration between: man, machine and equipment. The aim of this work is to compare other academic works, books by great authors and to report a little of the experience lived in the industry of the industrial pole of Manaus in lines of manufacture of Monitors and televisions, in particular introduction of lines of LCD panels and LED, thus collaborating with the academic community.*

Keywords *— **SLP, Physical Arrangement, Television screens.***

I. INTRODUCTION

The competitive market has led us to the configurations of companies and products of the most varied possible with previous margins of 12 months between a new product and another, currently many products are world launches with differences of days between one country and another.

In times of globalization, companies do not want to stay behind any other, so processes, products, physical arrangements must be dynamic and functional and in many cases, new products, follow new assembly lines, as if a new product or process the physical arrangement installed.

This article has analyzed papers, scientific articles, scientific report, Samsung technical documentation, and specialized books.

This work raises the following problem: How the systematic use of the physical arrangement can optimize processes and increase productivity, focusing on the SLP methodology.

On the basis of this question, this work seeks the support within the vast literature to show the efficiency of the systematic use of the physical arrangement through the SLP tool with the objective to demonstrate during the work how this tool was internalized in the academic doctrine and the innovative methods of arranging arrangements physicists in particular, in the lines of panels of TV of the Industrial Polo of Manaus.

Therefore the present work compares and demonstrates the importance of Layout as process optimizer and productivity increase through physical rearrangements of entire production lines or workstations.

This research is justified by the importance of studying the SLP methodology even with a whole current computational environment, the SLP methodology has not become obsolete, but few academics know and use it.

II. THEORETICAL REFERENCE

Layouts or physical arrangements are provisions of transforming and transformed resources, people, and equipment. At Manaus industrial hub, many factories adopt reuse structures, jigs and deactivated line equipment, others use new equipment and structures, new equipment, a high cost, shipping logistics (maritime), but everything developed for that new application , new process or new product, avoiding rework and line stops for suitability, having only ramp-up (curve of growth of production) as a hindrance.

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2.1 LAYOUTS

According to [1] the physical arrangement, or even layout, of a company or just a department, is nothing more than the physical distribution of machines and equipment within the organization where, through calculations and definitions established according to the the product to be manufactured, is organized so that the work can be developed in the best possible way and with the least waste of time [2].

According to [3] the Layout study was driven shortly after World War II and conceptualized layout taking into consideration 05 factors of industrial management: Man, material, money, machines and market. Neumann classifies the 05 types of layouts: Positional, by Product (in line), by Processes, cell layout and mixed layout. Of all the works this opens a special chapter for the cellular physical arrangement for line projects. [3] and [4] lists 2 variables that are variety and volume, indicating the application of each physical arrangement.

For [5] the physical arrangement of a productive operation refers to the physical positioning of its transforming resources. [4] is much more traditional in its concept and encompasses in transforming resources everything that modifies or transforms the raw material of production. [6] conceptualizes in a much more complete way the 05 types of physical arrangements that are used by several companies, they are: Positional (fixed) physical arrangement, functional physical arrangement (by processes), cellular physical arrangement, physical arrangement by product and arrangement mixed physical

According to [6] it tells us that the study of physical arrangement is concerned with the physical location of the transformation resources. [7] also lists and conceptualizes the 05 types of arrangements. He tells us that decisions about physical arrangement can appear in the 03 structural levels of a corporation (strategic, tactical, and operational level).

2.1.1. Layout Types

Layout by fixed position, for [8] in this Layout the element to be transformed remains still, in fixed position, here the dimensions of this material to be transformed are verified as it is a large element and the operations, operators and tools are moved around the element to be transformed, here low production or single production is verified.

By process or functional layout, for [7] physical arrangement widely used in tooling in the companies of the industrial pole of Manaus, here is the transforming resources grouped in places and both the operator and the resource to be transformed move to the tool transformation.

Layout by products or online layout, for [9] the most usual of the layouts used in the industrial complexes installed in the industrial pole of Manaus is observed, since it is a layout compatible with high production and little variation.

Layout in Cells, is the physical arrangement that has been gaining the preference of Asian companies in the production lines of Cell Phones and Tablets Samsung all models are assembled in cells because it is easy to programming and calculating efficiency in cell layout.

According to [1] before distributing the machines by the company, it is necessary to know the product that will be developed, what materials will be used to manufacture the same, which production processes and etc. We first define the Layout by Product that is the one that represents all the operations from the entrance of the material at the end of the process to the finished product at the other end. Then, we define the Process Layout that represents the process flow and the most varied sections that the raw material will pass inside the productive process [1]. According to [10], in order to prepare a layout it is necessary to first know the quantity of pieces / product that will be produced, according to the pre-established capacity, taking into account the number of employees, the shifts that the company will work, technology available to develop the product according to the manufacturing time of the product. From these definitions it is possible to stipulate, based on concrete data and production calculations, the number of machines / tools that will be necessary to develop the product in question and then distribute them by the company [10].

2.2 SLP (SYSTEMATIC LAYOUT PLANNING)

The industrial pole of Manaus (PIM) is dominated by Asian companies, most Japanese companies (Honda, Semp, Sony, Panasonic), soon followed the Korean companies (LG, Samsung) and finally the Chinese (a giant in china, TPV, also installed in Manaus). In changes and installations of new lines, Japanese companies are very conservative in the Asian process, I believe they are unaware of SLP, but they are used in fragments of the SLP method.

Looking for a structured approach, Systematic Layout Planning (SLP) represents a methodology that has a great applicability in design and layout redesign, especially in functional layouts. Although it has been proposed long ago by [11], the SLP system still has a great applicability in modern production systems and serves as a reference for projects of productive facilities and also for research in the area. According to [11], the SLP is composed of a structure of phases, a model of procedures and a series of

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conventions for identification, evaluation and visualization of the elements and the areas involved in the planning.

Korean companies throw away the old line and install new ones with high cost, recovering everything in high production. Chinese companies use a mix of any method that brings them low cost and high functionality, here yes, you see the SLP method being used with the combination of other methods.

In the work of [12], he directs the methodology to 03 professionals: Layout Planner, the unprofessional enthusiast and the self-directed planning team. The systematic SLP can be followed step by step and is aimed at some types of enterprises, they are: office areas of up to 300 square meters; areas of shops or laboratories of up to 500 square meters and storage areas from 750 to 1000 square meters, but nothing prevents from being adapted to other situations. The SLP is a set of six processes to be followed to be able to make the layout of an area and the 06 steps involve 03 basic elements, they are 1) Relations between the various functions or activities; 2) space in a given quantity and type for each activity; 3) The adjustment of these, within layout planning.

In his work [13] he makes use of SLP in a layout project in a confectionery industry, he shows from a case study the use of SLP methodology and its tools as a way to achieve optimization and increase the capacity of a textile industry

In the article [14] the SLP methodology was applied in the improvement of the layout of a shower production line, it re-arranges an existing layout [14] obtained a new layout but this time in arrangement in cells a to increase productivity, improve quality, reduce inventories, reduce operator downtime in order to avoid fatigue, reduce physical space and reduce movement, thus raising the satisfaction of operators, thereby obtaining multifunctional employees who used to stay limited to 2 or 3 operations and currently assemble and know the entire product to be assembled with due time study applied.

III. TOOLS AND METHODS

The methodology of this work was based on a bibliographical research of a basic nature that aims to generate knowledge with a new vision bringing a little of the reality of the industrial pole of Manaus, from the point of view of the research objectives can be characterized as exploratory research because in some points were obtained in an unsystematic, spontaneous, informal, simple, free way, and in other cases, data were systematically based on articles and scientific works that sought the same objective of the bibliographic research of this work.

3.1 MANUFACTURING PROCESS OF LCM PANELS (TV AND MONITOR)

Panels or digital displays (displays) have undergone an abrupt technological evolution from being simple 8-segment displays for touch-sensitive graphic panels Cellular screen Figure 1.

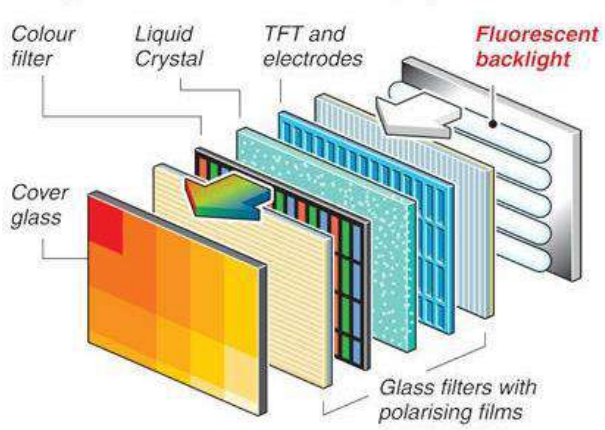

Fig. 1: Manufacturing Process of LCM Panels

There are 03 basic processes that make up an LCM panel for TV or Monitor, they are: Data Matrix Board (Tcon); Polarized glass (Open Cell); Backlight component.

3.2 TCON CARD

The first component that mounts an LCM panel is the T-con or (Matrix Board or Screen Control) board in many designs can be incorporated into the main board of the Tv or Monitor or it can be a separate board or even have the circuits incorporated into the board "Source board" which is a board attached to Open Cell through the flats Figure 2.

Fig. 2: Tcon Plate Model

A Tv or Monitor screen is with a large dot matrix, the T-con's function is to take the information from the main board and address that information in columns and lines and provide the Open Cell Source card (the information is addressed to each pixel color: red, green and blue)

3.3 OPEN CELL (POLARIZED GLASS)

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The 2nd Component that mounts an LCM panel is the Open Cell (polarized glass) has the benefit of versatility of use in various environments, its use is recommended as monitors, televisions, instrument panels and other devices, ranging from aircraft cockpit, displays on car computers, daily use devices such as video players, game devices, clocks, calculators and telephones. Among its main features are weight, portability and its ability to be produced in much larger quantities than cathode ray tubes (CRT). Its low power consumption allows it to be used in portable equipment, powered by electronic battery Figure 3.

Fig. 3: Polarized Glass Model

Open Cell has two glass plates filled with a kind of gel with particles of organic crystals. Each particle individually receives an electric discharge to block the light (which it receives constantly from the backlight), and from these electrical impulses the crystal has the information of where it should block the light of one or more colors that are not useful in the formation of image . Each particle is a pixel, and each pixel has 3 subpixels that represent the primary colors (RGB - red, green, and blue), which together form the image.

LED televisions work like LCD technology in imaging. The difference is in the backlight that is formed by micro LEDs, located in the ends of the screen (Edge LED). The LEDs send brightness through the slots of the Light Guide Plate, illuminating the pixels for image formation.

The system of opening and closing of the micro-doors for the passage of light is equal to LCD. The difference is that the LED distributes better the light emitted compared to the LCD panels, this due to not having the lamp accesses the whole time behind the screen. Another advantage of this TV is related to energy saving. It is also greener because it uses fewer environmentally harmful products, such as mercury from the CCFL lamp (present on LCD panels).

3.4 BACKLIGHT COMPONENT

The third and final component of the LCM TV panel is not just a single component, but several components that assembled together form the backlight because as shown above the lamp or LED bar is on all the time and the liquid crystal deposited on the glass layers of the Open Cell (sandwich) when being polarized let light pass or block the light working as light-pass doors to the screen.

IV. ANALYSIS OF INPUT DATA

As a rescue of the documentary research, we had as an introduction the line of panels LCM (Light component module) the panels of 32 ", 40" and 48 ". As an example of documentary research we will use the data from panel 32 ".

Panel 32 "(LTJ320AP03-K): Panel 32" Full HD (resolution 1920 x 1080 Pixels), prediction of the beginning of production 3000 pieces, pilot lot of 100 pieces, Target 3500 pieces upon reaching the growth curve, Production cycle 8 seconds, daily production.

Parts List Panel 32 "Table 1:

Tab. 1: Part List Painel 32"

AMOUNT	DESCRIPTION	NAME
01	CHASSIS TOP	METAL FRONT PANEL 32 "
01	OPEN CELL	POLARIZED GLASS 32 "
01	MlDDLE MOLD	INTERNAL PLASTIC FRAME
01	H-SHEET	HORIZONTAL DIFFUSER SHEET
01	V-SHEET	VERTICAL DIFFUSING SHEET
01	DIFUSER SHEET	DIFFUSING SHEE
01	LIGHT GUIDE PLATE (LGP)	ACRYLIC LIGHT GUIDE
01	REFLECTOR SHEET	REFLECTIVE SHEET
02	LED BAR	LED BARS
01	CHASSIS BOTTOM	METALLIC BASE OR SHIELDING
01	POWER BOARD	POWER PLATE
01	TCON BOARD	TCON PLATE

By the year 2011, Samsung had a one-room, Figure 4 production of monitors only, the Layout was functional (both the operator and the feature being processed move to the transformation tool) and the ability to production was limited and low (500 units / day). In this configuration it had no production of the TV panels, forcing the PCPM and purchases to import panels.

https://dx.doi.org/10.22161/ijaers.6730 *ISSN: 2349-6495(P) | 2456-1908(O)*

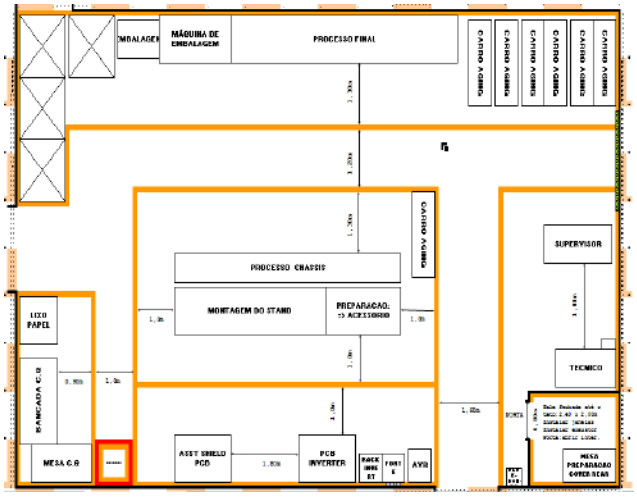

Fig. 4: Hall of Panels

As of 2011, the Samsung factory changed its address and started to operate at Av. Dos Oitis, Armando Mendes, Distrito Industrial 1, it ceased to be just a simple factory and became an industrial complex forcing Management to elaborate form to aggregate all parts that came from the supplier within the manufacturing complex, Figure 5 shows the LCM Area.

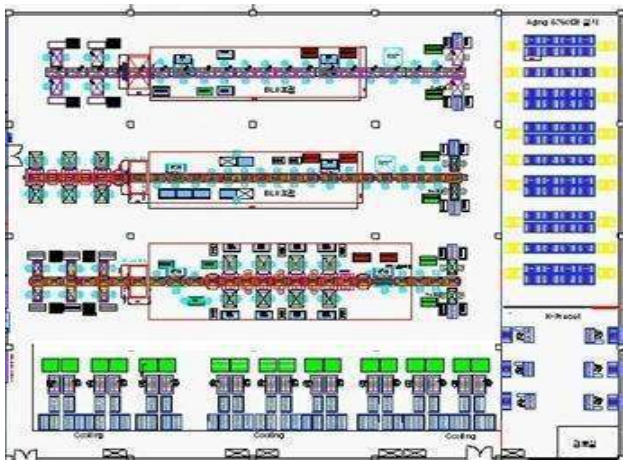

Fig. 5: LCM Area

Therefore, LCM Panels, Plastic Covers, Frontal Plastic Panels, EPS Pads, Metallic Lids, TV Cards and Monitor should be produced within the new industrial complex leaving out only Carton box and printed graphics.

So in 2012 we already had 03 panel production lines and Layout that was functional and low capacity started to target 3000 pieces per day for panels of 32 "Layout in line below, Figures 6.

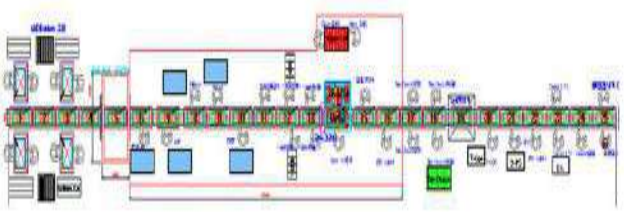

Fig. 6: Televisions production line

The production process shown in Figure 7, the sequence as below, reflector, LGP, Diffuser, BDEF-D, Blue Inspection, Middle-Mold, Final Test.

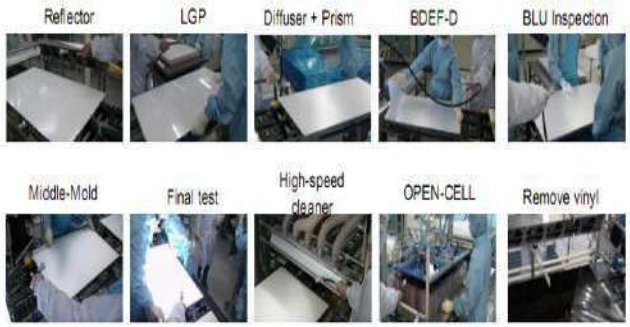

Fig. 7: Steps of the assembly process with SLP

It was demonstrated in this stage the operation of the assembly line of the television, using SLP, other methodologies are used in several other companies of the industrial pole of Manaus.

V. FINAL CONSIDERATIONS

The SLP method is used by many corporations in the introduction of rows or arrangement changes. In practice, much of the mixed physical arrangements happen, so was the line of Samsung LCM panels in 2013, she started the line in 2012 with Physical Layout by product, but due to the introduction of the line of phones and tablets in the industrial complex and the model applied here (cell phones and tablets) were assembly cells, then we tried to migrate the panel line to assembly cells, did not work, then returned to the layout by products but some cells remained on the line and the end result was a layout mixed, product and cell layout.

In addition to the previous works that had an emphasis on the assembly process of TV panels and monitor, this work sought to show the systematic SLP for the choice of physical arrangements, even with all evolution of CAD technology for modeling Layouts, systematic SLP is still widely used.

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Emancipation in Organizations: A Bibliometric Study

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Abstract*— *In this study aiming to identify theoretical referential for the development of scientific work about emancipation and organizations, a research process facing the need of scientific material able to support the study was carried out. A search of a keywords composition, whose core of work is about the thematic axes Emancipation, Organization and Management, has been performed. The process supported for Proknow-C method has identified articles, aligned with the vision of the research, in different bibliographic databases. This work performs a bibliometric analysis where it was identified manuscripts, relevant authors and keywords most used about the central theme.

Keywords*— *Bibliometrics, Emancipation, Organizations.

I. INTRODUCTION

The strong influence of Capitalism on social and work relationships, transforming labor and culture into exchangeable commodities, has motivated studies related to mass society, the industrial society and problems arising from the process of unbridled economic development.

Several study initiatives have emerged involving the organizational universe, based on the Critical Theory of Organizations, claiming more humane forms of management, as well as the emancipation of the individual at work. The research that has emerged in the last decades, involving the process of emancipation, had great influence in the studies carried out by Habermas, who in 1981, published the one that is considered his most important work, the "Theory of Communicative Action". Habermas bets on the individuals' emancipation and liberation through a constant process of interaction aiming to elaborate a truth conceived by the groups and accepted by society [14]. [4] defines emancipation, treated by this study as "the men's search for the well-being and individual and collective achievement, obtained through solidarity, through solidarity, freedom and respect in the authentic relationships among the individuals of a group".

In Brazil, he sociologist Guerreiro Ramos, brought the discussion of emancipation to the organizational environment, criticizing the Social Sciences and the Administration for their relationship with a market-centered society. With the "substantive theory of associated human life", [9], identified within the organizations, the presence of actions that lead to a search and concretization of the individuals' emancipation ideals, through freedom, autonomy, self-fulfillment and social satisfaction, mediated by the rational debate and ethical-evaluative judgment, in contrast to the "actions based on calculation, oriented towards the achievement of technical goals or social power, through the maximization of the available resources".

[14], and [4], demonstrated, respectively, in their studies, the coexistence of these two forces in any productive organization, where the predominance of one of them in the environment and in the administrative practices, determines the degree of development of the emancipatory process in each organization.

Facing the apparent antagonism of these forces in the organizational environment, the main proposal of this research arises by performing a selection of the bibliographic references, which involve the process of emancipation in organizations. They will serve as a theoretical basis for the research of the thesis that is being developed by the main author of this article, when identifying in the collected scientific literature, studies that involve the emancipatory process within organizational environments. They also identify in the scientific literature, the novelty of studies involving the proposed theme, for the development of this thesis.

Therefore, the research described in this article finds its importance when considering "through the organizations studies, that expand the possibilities of the

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work environment humanization, beyond the submission of knowledge to the imperatives of production and maximization of results" [12]. Because, according to [5], focusing in the analysis of the practices and forms, it's possible to emancipate the men from the oppression mechanisms, placing, indeed, the human being as the main element of the organizational initiatives.

In order to do so, the article will present, in sequence, the used methodology, the database research process, the bibliometric analysis of the selected articles, of their work and finally, presenting their conclusions and references.

II. METHODOLOGY

The method used in this study was the bibliometry. It consists of a technique for measuring the production indexes and dissemination of scientific knowledge, allowing one to obtain information of a certain theme and its relation with the academic areas, demonstrating the characteristics related to the scientific production of this [13]. In order to do so, the tool used to select the articles and studies, which are going to compose the Bibliographic Portfolio and for the Bibliometric study, is an adaptation of the methodology called ProKnow-C (Knowledge Development Process – Constructivist) presented in the article "Structured Process of Literature Review and Bibliometric Analysis about Performance Evaluation of Energy Efficiency Implementation Processes" from [6]. It's about a methodology developed at the Laboratory of Multicriteria Methodologies in Decision Support (LabMCDA), linked to the Department of Production and Systems Engineering of the Federal University of Santa Catarina.

The tool provides the systematic analysis of the available data, facilitating the deepening of knowledge, through the selection of studies that present alignment and relevance with the chosen theme, performing a bibliometric analysis based on quantitative evidence presented by the set of articles gathered in the Bibliographic Portfolio. It shows how a researcher can, in a structured way, under the perspective of the PROKNOW-C intervention tool, select relevant articles and identify characteristics of such publications, which may contribute scientifically to his/her topic of interest.

The Bibliometric Analysis is based on the quantitative disclosure of the parameters of a defined set of articles, which aims to contribute to the scientific knowledge about the theme. The parameters observed in this study will be: number of relevant articles; authors; areas of knowledge involved in the studies presented by these articles; their references; number of citations, characterizing the scientific value of each article; and most relevant journals[6].

III. THE RESEARCH PROCESS IN DATABASE AND BIBLIOMETRY

3.1 The Selection Process of the Theoretical Reference

The data collecting process will always follow the general knowledge towards the specific one, seeking to explore to the maximum the research interest topics. Primary sources, such as articles published in scientific journals and scientific conferences Papers, through digital access to the database Scopus, Web of Science e Scielo, will be used. Moreover, it will also be used the Thesis Bank and secondary sources such as books, through the access to Libraries and Bookstores.

The PROKNOW-C methodology is developed in two stages, being the first one concerning the procedures for the selection of articles to create a basic Bibliographic Portfolio, which has scientific recognition and it is aligned with the work approach, and the second stage, which is focused in the procedures for the bibliometric analysis of the articles selected in the bibliographic portfolio.

Initially, we will describe the first stage concerned to the procedures of collection and selection of articles to compose the bibliographic portfolio. This stage is originally composed of three phases yet one more phase has been adapted and it is intended to include the previously collected works, and so, totaling four phases that will be described next.

The first phase corresponds to: the choice of databases to be consulted; definition of the keywords set; and the collection and selection of material published in the respective databases.

The second phase consists of a review of the material discarded in the first phase, always checking whether any of them can, somehow, contribute with the research.

In the third phase, a selection of the material acquired before the research was carried out, which, somehow, has conducted the author's interest about the theme.

In the fourth phase, a scan was performed on the references of the selected articles, verifying its agreement to the study proposal, rescuing authors and seminal works, thus forming a Reference Framework on the research's specific theme.

One may follow the phases of the bibliographic portfolio formation process, beginning with the first phase, through the schemes presented below.

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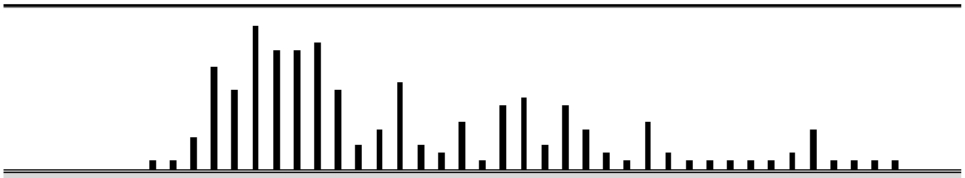
PHASE 1 OF THE METHODOLOGY
1. Definition of keywords and their combinations.
2. Research of articles at chosen databases.
3. Export of all articles found in searches to excel, creating folders with consolidated results of all databases researched.
4. Redundancy check.
5. Reading of article's tittles classifying then by degree with alignment with the theme.
6. Consult the number of quotes in google scholar.
7. Select by degree of alignment opposite to the number of quotes (google scholar).
8. Selection through the reading of summaries verifying their degrees of alignment.
9. Selection through the reading of articles align with the theme.

Fig. 1: Phase 1 of the methodology for collecting bibliographic data. (Source: Adaptation of the author's methodology PROKNOW-C).

Facing the need for scientific material, which is able to support the study, it was performed a search for a keywords composition, whose core work revolves around the Emancipation, Organization and Management Thematic Axes.

In the search procedure, we chose not to use filters per year, so that the research could generate a comprehensive frame of reference on the subject, which led the research to a raw database of 194 articles, distributed over the years, according to the Graph 1, below.



Database	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1985	1984	1983	1982	1981	1975	Total
Scopus			2	6	4	9	10	8	9	6	1	4	9	1	2	3		5	7	3	4	3	2		5	2	1	1	1	1	1	2	5	1	1	1	1		121
Web of Science			2	4	5	6	5	5	5	2	2	1	1	1		3	1	3	2		3	2		1	1														55
Scielo	1	1		3	1	3		2	2	2			1	1							1																		18
Grand Total	1	1	4	13	10	18	15	15	16	10	3	5	11	3	2	6	1	8	9	3	8	5	2	1	6	2	1	1	1	1	1	2	5	1	1	1	1	194

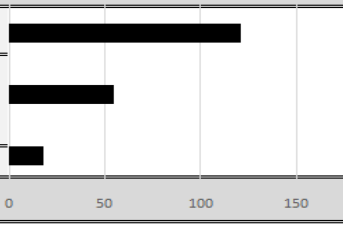
Graph 1: Raw Database, with the number of articles found per year.(Source: by the authors).

The raw database obtained in the research, point to a distribution of scientific works over forty-one years, presenting an increase in publications during the period from 2009 to 2017. However, it is worth to remember that this is raw database, which have not yet undergone a refinement imposed by the method selection steps.

Next, it may seen in the Table 1, the distribution of material collected by database, with its respective access addresses. The highlight is the Scopus database, by contributing with around 63% of the collection total.

Table 1: Total of articles collected by raw database. (Source: By the authors).

Name of the Bibliographic Database	Web Address	Total of articles
Scopus	https://www.scopus.com/search/form.uri?zone=TopNavBar&origin=searchbasic	121
Web of Science	http://apps-webofknowledge.ez24.periodicos.capes.gov.br/WOS_generalsearch_input.do?product=WOS&search_mode=generalsearch&SID=4DHohYk8dipSNhVZ5SD&preferencesSaved=	55
Scielo	http://www.scielo.org/php/index.php	18
TOTAL		194



The files were exported to the Excel platform, and put together in a portfolio with consolidated research results, where duplicate articles were checked and deleted, leaving at the end of the process 146 files in the bibliographic database, as shown in Table 2.

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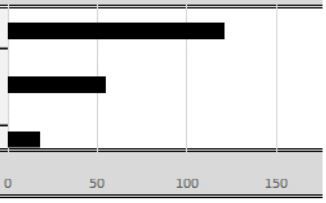
Table 2: Redundancy in the database collected material. (Source:By the authors).

Name of the Bibliographic Database	Original	Redundant	Grand Total
Scopus	110	11	121
Web of Science	21	34	55
Scielo	17	1	18
TOTAL	148	46	194



Removed the duplicate material, the method foresees the articles selection by the titles. In order to do so, an alignment scale of the titles, created in three levels, according to the importance grade of each dimension for the research theme, based on the keywords that compose it, was adapted to the method. It was established that the collected works, which represent the word emancipation, central point of this study, allied to one of the keywords Organization or Organizational or Management, would be closer to the theme, thus obtaining, grade 3 as the importance of the article for the research.

As grade 2, it was established that would be considered the articles that mentioned in their titles, just the main dimension represented by the keyword "emancipation", because this process would not necessarily be linked to the organizational environment, objective of the research. As grade 1, it would be considered the works that were related to the other dimensions without the correlation with the main dimension. These scales can be seen clearly in Table 3.

Table 3: Criteria for assessing the alignment of the text with the theme. (Source:By the authors).

Adherence to the research theme		
Criteria	Grade	Articles
Alignment of the principal dimension with one of others.	3	39
Alignment only with de principal dimension.	2	18
Alignment with the secondary dimensions.	1	91
Total		148

As a result of the selection process of articles by titles and abstracts, using the grade of alignment scale, 39 articles classified as grade 3, 16 that had grade 2 in the selection criteria and 91 articles identified as grade 1, were selected.

Then, it was performed an online search on no Google Scholar (https://scholar.google.com.br/), counting how many times each one of the grade 3 works were selected was mentioned in the academic community. This was a criteria to establish the scientific value of each article. The articles that have been mentioned in other academic works were separated and their abstracts were read in order to check their alignment with the theme. The ones that were aligned with the theme, were submitted to the last screening of the selection process, which was the reading of the whole article, closing the phase 1 of the bibliographic material collection methodology. Altogether, in the Phase 1 of the process, 11 articles with real scientific value and adherence to the theme were selected.

In Table 4, the material collected among articles and books, selected in Phase 1, with their respective authors, year of publication, periodicals and number of times that was quoted in the academic environment, can be seen.

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Table 4: Articles selected in Phase 1 of the methodology. (Source:By the authors).

Degree of alignment	Tittle	Authors	Year	Periodic	Site	Quotes
1	The substantive rationality demonstrated in the management practice.	Serva, M.	1997	RAE – Journal Business Management	Scielo	240
	Empowerment and Emancipation.	Inglis, T.	1997	Adult Education Quaterly	Scopus	204
	Cultural Imperalism: A Critical Theory of Interorganizational Change.	Grubbs, J. W.	2000	Journal of Organizational Change Management	Scopus	35
	Identity Regulation as Organizational Control: Producing the Appropriate Individual.	Alvesson, M.; Willmott, H.	2002	Journal of Management Studies	Web of Science	1.679
	A criticism to the domesticated criticism in the organizational studies.	Misoczky, M. C.; Amantino, de A. J.	2005	Journal of Contemporary management	Scielo	59
	Minority employees engaging with (diversity) management: Na analysis of control, agency, and micro-emancipation.	Amantino, de A. J.; Janssens, M.	2007	Journal of Management Studies	Scopus	139
	Emancipatory management: The contradiction Between Practice and Discourse.	Barros, M.	2010	Journal of Management Inquiry	Scopus	18
	Praxis Makes Perfect: Recovering the Ethical Promise of Critical Management Studies.	Foster, W. M.; Wiebe, Elden	2010	Journal of Business Ethics	Web of Science	12
	Down with Big Brother!' The End of 'Corporate Culturalism'?	Fleming, P.	2013	Journal Management Studies	Scopus	21
	Beyond macro and micro-emancipation: Rethinking Emancipation in organization Studies.	Huault, I.; Perret, V.; Spicer, A.	2014	Organization - SAGE	Scopus	31
	When performativity fails: Implications for Critical Management Studies.	Fleming, P.; Banerjee, S. B.	2016	Human Relations - SAGE	Scopus	2

Started Phase 2, which aims to review the material that has had grade 3 and were discarded, and the material that obtained grade 2 in the previous phase. Through the review of discarded articles, 3 articles were selected. They were selected based on the assessment criteria and the potential contribution they can provide to the research. The rescued articles can be seen in Table 5.

Table 5: Articles selected in Phase 2 of the collection methodology of the bibliographic data. (Source: By the authors).

Degree of alignment	Tittle	Authors	Year	Periodic	Site	Quotes
2	Participation, Entrepreneurship and Self-Management: A New Labor Culture?	Lima, J. C.	2010	Sociologias	Sicielo	
	Rethinking Emancipation in organization Studies. In the Light of Jacques Rancière's Philosophy.	Huault, I.; Perret, V.; Spicer, A.	2010	Symposium on the Politics and Aesthetics of Organization. St. Gallen. Suisse.	Scopus	
	Critical Approach in Organizational Studies: Conception of individual from the Emancipatory Perspective.	Mozzato, A. R.; Grzybovski, D.	2013	EBAPE Review	Scielo	

The activities developed in Phase 3 are focused on the use of conference material, documents of professional associations, books and articles obtained mainly from sources other than the searched databases, which have been previously obtained and that inspired the initiative that result in this work. Four articles were selected, as seen in Table 6.

Table 6: Articles inserted in Phase 3 of the methodology, which constitute the Bibliographic Portfolio. (Source:By the authors).

Degree of alignment	Tittle	Authors	Year	Periodic	Site	Quotes
3	A study comparing emancipatory management in community organization: it compares Bahia (Brazil) an Quebec (Canada).	Barros, M.	2002	Journal of Management and Planning.	Own Archive	
	Emancipation: historicity of the concept and the controversy in the real process of human existence.	Ciavatta, M.	2014	Work needed – UFF	Own Archive	
	Emancipation and/or oppression? Conceptualizing dimensions of criticality in entrepreneurship studies.	Verduijn, K.	2014	International Journal of Entrepreuneurial Behavior & Research	Own Archive	
	Dehumanization of the work in the era of Flexploração.	Areosa, J.	2015	Without Journal	Own Archive	

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The Phase 4 of the material collection process was developed from the bibliographic references of the articles gathered so far, in the selection process hereby developed.

All the scientific works that compose the bibliographical references of the articles that create the Bibliographic Portfolio gathered so far, went through the selection process used in previous phases. They were analyzed by the following criteria: alignment of the title with the theme; verification and discard of redundancies; assessment of the authors' relevance based on the number of times they are mentioned and referenced in the articles that compose the Portfolio; abstract and keywords reading and, finally, by reading the contents of the material. In Phase 4, 6 scientific works, among articles and books were collected and added to the Bibliographic Portfolio. They can be seen in Table 7.

Table 7: Material collected in Phase 4. (Source:By the authors).

Degree of alignment	Tittle	Authors	Year	Periodic	Site	Quotes
4	Model of men and management theory	Guerreiro Ramos	1972	Public Administration Review	Reference of the selected articles.	156
	Organization Theory and Technocratic Concienciousness: Rationality, Ideology, and Quality of Work	Alvesson, M.	1987	De Gruyter	Reference of the selected articles.	276
	The Theory of Comunicative Action: Life World and System.	Habermas, J.	1985	Beacon Press. Boston	Reference of the selected articles.	19.106
	On the Idea of Emancipation in Management and Organization Studies.	Alvesson, M.; Willmott, H.	1992	Academy of Management Review	Reference of the selected articles.	775
	Pedagogy of the Oppress.	Freire, P.	2005	Peace and Land	Reference of the selected articles.	23.329
	The Emancipeted Spectator.	Rancière, J.	2009	Verso	Reference of the selected articles.	37

In Table 8, the final material of the collection process, among articles and books, resulting from the application of the adapted methodology can be seen.

Table 8: The final material of the collection process. (Source:By the authors).

Year	Number	Article	Quotes	Authors
1972	4.1	Model of men and management theory.	156	Guerreiro Ramos
1987	4.2	Organization Theory and Technocratic Concienciousness: Rationality, Ideology, and Quality of Work.	276	Alvesson, M.
1985	4.3	The Theory of Comunicative Action: Life World and System.	19.106	Habermas, J.
1992	4.4	On the Idea of Emancipation in Management and Organization Studies.	775	Alvesson, M.; Willmott, H.
1997	1.1	The substantive rationality demonstrated in the management practice.	240	Serva, M.
1997	1.2	Empowerment and Emancipation.	204	Inglis, T.
2000	1.3	Cultural Imperalism: A Critical Theory of Interorganizational Change.	35	Grubbs, J. W.
2002	1.4	Identity Regulation as Organizational Control: Producing the Appropriate Individual.	1.679	Alvesson, M.; Willmott, H.
2002	3.1	A study comparing emancipatory management in community organization: it compares Bahia (Brazil) an Quebec (Canada).	3	Barros, M.
2005	4.5	Pedagogy of the Oppress.	23.329	Freire, P.
2005	1.5	A criticism to the domesticated criticism in the organizational studies.	59	Misoczky, M. C.; Amantino, de A. J.
2007	1.6	Minority employees engaging with (diversity) management: Na analysis of control, agency, and micro-emancipation.	139	Amantino, de A. J.; Janssens, M.
2009	4.6	The Emancipeted Spectator.	37	Rancière, J.
2010	1.7	Emancipatory management: The contradiction Between Practice and Discourse.	18	Barros, M.
2010	2.1	Participation, Entrepreneurship and Self-Management: A New Labor Culture?	0	Lima, J. C.
2010	1.8	Praxis Makes Perfect: Recovering the Ethical Promise of Critical Management Studies.	12	Foster, W. M.; Wiebe, Elden
2010	2.2	Rethinking Emancipation in organization Studies. In the Light of Jacques Rancière's Philosophy.	0	Huault, I.; Perret, V.; Spicer, A.
2013	2.3	Critical Approach in Organizational Studies: Conception of individual from the Emancipatory Perspective.	0	Mozzato, A. R.; Grzybovski, D.
2013	1.9	Down with Big Brother!' The End of 'Corporate Culturalism'?	21	Fleming, P.
2014	1.10	Beyond macro and micro-emancipation: Rethinking Emancipation in organization Studies.	31	Huault, I.; Perret, V.; Spicer, A.
2014	3.2	Emancipation: historicity of the concept and the controversy in the real process of human existence.	2	Ciavatta, M.
2014	3.3	Emancipation and/or oppression? Conceptualizing dimensions of criticality in entrepreneurship studies.	15	Verduijn, K.
2015	3.4	Dehumanization of the work in the era of Flexploração.	0	Areosa, J.
2016	1.11	When performativity fails: Implications for Critical Management Studies.	2	Fleming, P.; Banerjee, S. B.

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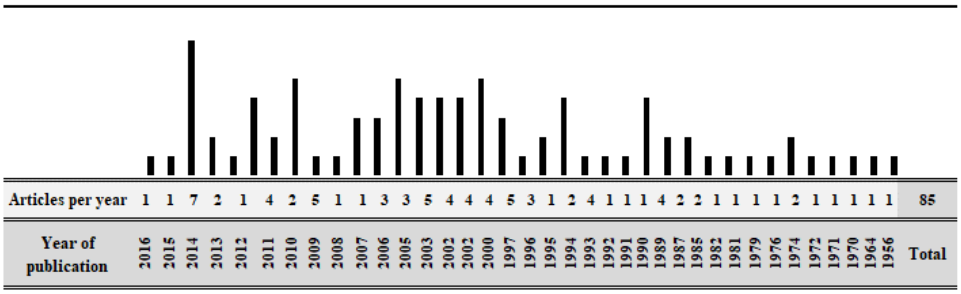
It may be noticed that although some articles are not mentioned (the ones selected in Phase 4), their authors, through other works, are mentioned in the Bibliographic Portfolio itself. The adopted and adapted methodology was able to create a Referential Chart, which is much more comprehensive than the Bibliographic Portfolio. This Referential Chart has 85 articles concerning to the emancipation, among which, the 24 files most adherent to the theme proposed by the study, compose the Bibliographic Portfolio, being the main support for the development of the work.



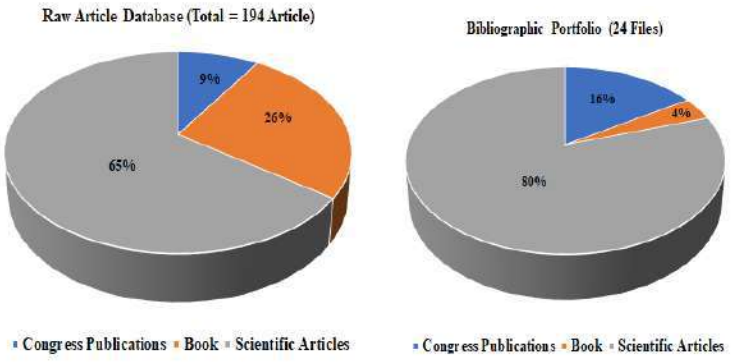
Graphic 2: Demonstration by year of the number of articles and books that form the Reference Chart. (Source:By the authors).

Ending it, by performing an analysis of the years of greatest publication on the theme. Check if the above graphic shouldn't be in the Bibliometry. At the end of the data collection process, all the files were exported to Mendeley and to Excel, where they were filed and the bibliometric analysis that will be presented in this work were created.

3.2 Bibliometric Analysis

The Bibliometric Analysis in this study, has as an objective the evaluation of the data gathered in the collection of scientific material on the theme, aiming at a comparative reading, using some statistical tools targeting a greater comprehension of the relevance of the theme, articles, most important authors, periodicals, areas that study the theme and chronology of the proposed study. As a basis for these analyzes the Bibliographic Portfolio will be used, aiming the greater proximity and adherence to the proposed study.

Graphic 2 shows the types of material obtained in two stages of the collection process. The raw file, which contains 192 items, is composed by 65% of articles, 26% of books and 9% of articles published in congresses. After going through the various selection steps, the material, already in the shape of Bibliographic Portfolio, presents differentiated contributions by file type. Articles in congress that offered the least contribution to the whole, now provide 16% of the information material. On the other hand, the books that contributed 26% of the material now represent 4% of the Portfolio. The low indices certainly correspond to their need for longer maturation time, volume of content, and consequent editing and release. While the scientific journals articles keep presenting the greatest contribution, increasing from 65% to 80% of the material that is the base for the research.



Graphic 3: Types of research files.(Source: By the authors).

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Gathered the material collected for the research, an evaluation of the distribution of journals in the time line in which the theme is studied, could be performed. One may highlight the number of contributions that each journal presents both in the composition of the Referential Chart as in the Bibliographic Portfolio, showing its relevance for the development of the study, as it can be followed in Table 13.

Table 13: Number of contributions of the Journal to the theme.(Source: By the authors).

Periodic	Referential Chart	Bibliographic Portfolio
Journal of Management Studies	3	3
Organization - SAGE	3	1
System Practice	3	
Journal of Organizational Change Management	2	1
Human Relations - SAGE Journal	2	1
Journal of Business Ethics	2	1
Journal of Advanced Nursing	2	
Journal of Contemporary management	2	1
British Journal of Management	1	
Journal of Health, Organisation and Management	1	
Journal of Management Inquiry	1	1
Journal of Nursing Management	1	
Management Decision	1	
Management Learning	1	
Nursing Philosophy: Na International Journal for Healthcare Professionals	1	
Sociologies	1	1
Source of the Document Economic and Labour Relations Review	1	
Symposium on the Politics and Aesthetics of Organization. St. Gallen. Suisse.	1	1
Facultad Journal of Economic Science	1	
RAE – Journal Business Management	1	1
Technology Analysis and Strategic Management	1	
Adult Education Quarterly	1	1
EBAPE Review	1	1
Academy of Management Review	1	1
Beacon Press. Boston	1	1
De Gruyter	1	1
Peace and Land	1	1
Verso	1	1
Public Administration Review	1	1
The Australian and New Zealand Journal of Mental Hearth Nursing Work	1	
17th European Conference on Informations Systems	1	
47th Hawaii International Conference on System Science	1	
Atencion Primaria Sociedad	1	
Gender in Management	1	
International Journal of Entrepreuneurial Behavior & Research		1
Journal of management and planning		1
Needed work – UFF		1

Analyzing Table 13, one may check the greater participation of Journal Management Studies both for the Referential Chart as for the Bibliographic Portfolio. While in the Bibliographic Portfolio the other journals just appear once, in the Referential Chart, we may highlight the journals Organization –SAGE, System Practice, Journal of Organizational Change Management, Human Relations - SAGE, Journal Business Ethics, Journal Advanced Nursing and the Journal of Contemporary Management.

As for the authors, we can verify in graphic 3 and in Figure 6, below, the degree of their contributions and relevance that their works have concerning to the development of the studies about the theme proposed in this research, reflected in the number of times they appear and that their works are cited by other authors.

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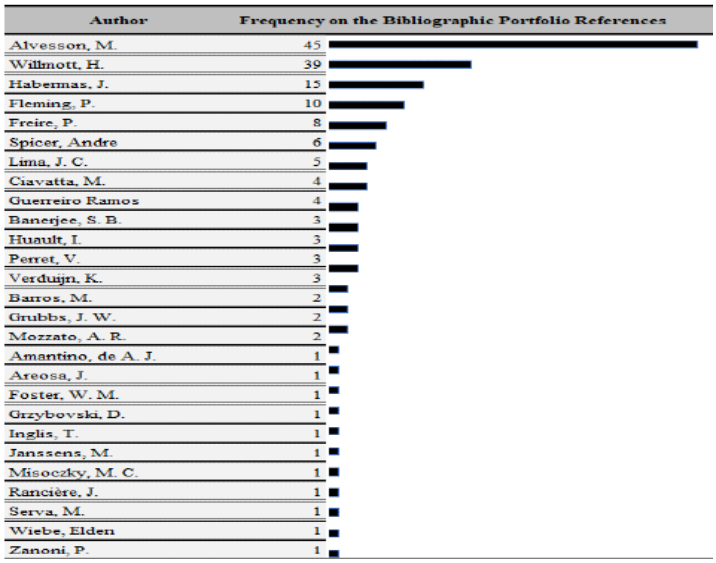

Author	Frequency on the Bibliographic Portfolio References
Alvesson, M.	45
Willmott, H.	39
Habermas, J.	15
Fleming, P.	10
Freire, P.	8
Spicer, Andre	6
Lima, J. C.	5
Ciavatta, M.	4
Guerreiro Ramos	4
Banerjee, S. B.	3
Huault, I.	3
Perret, V.	3
Verduijn, K.	3
Barros, M.	2
Grubbs, J. W.	2
Mozzato, A. R.	2
Amantino, de A. J.	1
Areosa, J.	1
Foster, W. M.	1
Grzybovski, D.	1
Inglis, T.	1
Janssens, M.	1
Misoczky, M. C.	1
Rancière, J.	1
Serva, M.	1
Wiebe, Elden	1
Zanoni, P.	1

Graphic 3: Number of contributions of the authors to the Theme in the Bibliographic Portfolio. (Source: By the authors).

Considering only the works referended in the Bibliographic Portfolio, authors like Alvesson and Willmott gain absolute prominence, appearing 45 and 39 times respectively, demonstrating its weight for the development of the study in this thematic area. Habermas also excels when he appears 15 times in the references of the Portfolio. These authors, it's worth to highlight, are not only distinguished by having several of their works listed in the references of the articles that compose the Portfolio, but also by being constantly mentioned in the body of most of these articles and in some others, which are about the theme proposed in this work.

Similarly, Freire and Guerreiro Ramos, that despite were less cited in the Bibliographic Portfolio than the authors mentioned above, are base for several of these authors, in the matter of emancipation theme, having their work published longer. Among other authors that can be highlighted, we found [7], talking about the theme emancipation in several articles, contributing significantly to the development of scientific knowledge on the subject.

Year	Number	Article	Quotes	Authors	Quotes at the Portfolio
1972	4.1	Model of men and management theory.	156	Guerreiro Ramos	4
1987	4.2	Organization Theory and Technocratic Concienciousness: Rationality, Ideology, and Quality of Work.	276	Alvesson, M.	45
1985	4.3	The Theory of Comunicative Action: Life World and System.	19.106	Habermas, J.	15
1992	4.4	On the Idea of Emancipation in Management and Organization Studies.	775	Alvesson, M.; Willmott, H.	45 39
1997	1.1	The substantive rationality demonstrated in the management practice.	240	Serva, M.	1
1997	1.2	Empowerment and Emancipation.	204	Inglis, T.	1
2000	1.3	Cultural Imperalism: A Critical Theory of Interorganizational Change.	35	Grubbs, J. W.	2
2002	1.4	Identity Regulation as Organizational Control: Producing the Appropriate Individual.	1.679	Alvesson, M.; Willmott, H.	45 39
2002	3.1	A study comparing emancipatory management in community organization: it compares Bahia (Brazil) an Quebec (Canada).	3	Barros, M.	2
2005	4.5	Pedagogy of the Oppress.	23.329	Freire, P.	8
2005	1.5	A criticism to the domesticated criticism in the organizational studies.	59	Misoczky, M. C.; Amantino, de A. J.	1 1
2007	1.6	Minority employees engaging with (diversity) management: Na analysis of control, agency, and micro-emancipation.	139	Amantino, de A. J.; Janssens, M.	1 1
2009	4.6	The Emancipeted Spectator.	37	Rancière, J.	1
2010	1.7	Emancipatory management: The contradiction Between Practice and Discourse.	18	Barros, M.	2
2010	2.1	Participation, Entrepreneurship and Self-Management: A New Labor Culture?	0	Lima, J. C.	5
2010	1.8	Praxis Makes Perfect: Recovering the Ethical Promise of Critical Management Studies.	12	Foster, W. M.; Wiebe, Elden	1 1
2010	2.2	Rethinking Emancipation in organization Studies. In the Light of Jacques Rancière's Philosophy.	0	Huault, I.; Perret, V.; Spicer, A.	3 3 6
2013	2.3	Critical Approach in Organizational Studies: Conception of individual from the Emancipatory Perspective.	0	Mozzato, A. R.; Grzybovski, D.	2 1
2013	1.9	Down with Big Brother!' The End of 'Corporate Culturalism'?	21	Fleming, P.	10
2014	1.10	Beyond macro and micro-emancipation: Rethinking Emancipation in organization Studies.	31	Huault, I.; Perret, V.; Spicer, A.	3 3 6
2014	3.2	Emancipation: historicity of the concept and the controversy in the real process of human existence.	2	Ciavatta, M.	4
2014	3.3	Emancipation and/or oppression? Conceptualizing dimensions of criticality in entrepreneurship studies.	15	Verduijn, K.	3
2015	3.4	Dehumanization of the work in the era of Flexploração.	0	Areosa, J.	1
2016	1.11	When performativity fails: Implications for Critical Management Studies.	2	Fleming, P.; Banerjee, S. B.	10 3

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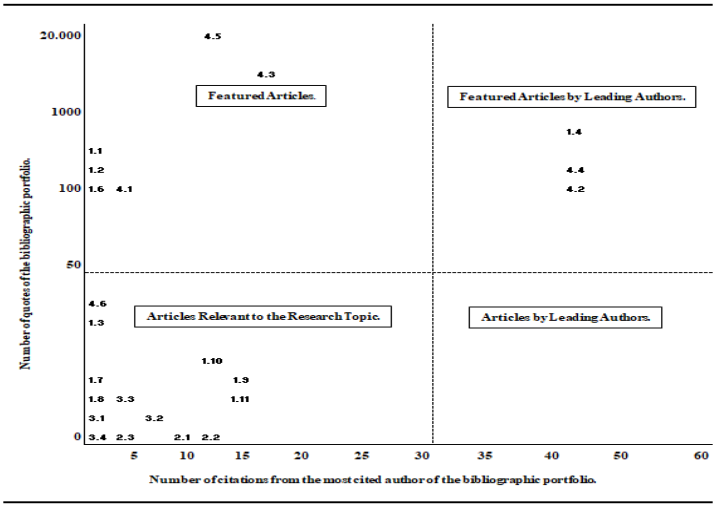


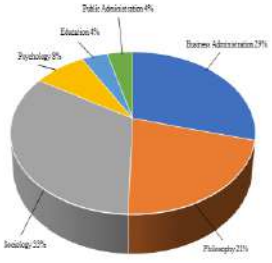
Fig. 6: Correlation of the Portfolio articles' impact and their authors.(Source: By the authors).

The figure highlights the seminal role that works of Freire (23.329 citations), Habermas (19.106 citations), Alvesson and Willmott (1.679 and 775 citations), Alvesson (276 citations), Serva (240 citations), Inglis (204 citations) and Guerreiro Ramos (156 citations) represent to the emancipation studies development. The number of their works' citation leaves no doubt of the importance of these studies for the theoretical development of the theme in general.

More than that, the performed study shows through the graph of the quadrants that Freire's works (2005), which has been written in 1968 and published in Brazil in 1974, [9] , [10] , [14],[11] , Zanoni and Janssens (2007) are considered are considered outstanding works, studying and grounding the theme comprehensively.

However, the study places the works of [1], [2], [3], as shown in the graphic, as featured articles performed by great authors, only more focused on the theme proposed in this work.

Another important aspect refers to the process imposed by the adopted methodology, which during the selection stage through the reading of the abstracts and articles, highlighted the works of [14] and [4], which bring proposals of the theme study, comparing organizations and analyzing their administrative practices. Works that are very close to the study proposed by this thesis but without considering the risk management. This demonstrates its importance for this study initiative. In Figure 7, the study areas that involves the theme.



Article of the Bibliographic Portfolio	Areas
Model of men and management theory.	Philosophy
Organization Theory and Technocratic Concienciousness: Rationality, Ideology, and Quality of Work.	Business Administration
The Theory of Comunicative Action: Life World and System.	Philosophy
On the Idea of Emancipation in Management and Organization Studies.	Sociology
The substantive rationality demonstrated in the management practice.	Business Administration
Empowerment and Emancipation.	Sociology
Cultural Imperalism: A Critical Theory of Interorganizational Change.	Business Administration
Identity Regulation as Organizational Control: Producing the Appropriate Individual.	Psychology
A study comparing emancipatory management in community organization: it compares Bahia (Brazil) an Quebec (Canada).	Sociology
Pedagogy of the Oppress.	Sociology
A criticism to the domesticated criticism in the organizational studies.	Sociology
Minority employees engaging with (diversity) management: Na analysis of control, agency, and micro-emancipation.	Business Administration
The Emancipeted Spectator.	Philosophy
Emancipatory management: The contradiction Between Practice and Discourse.	Sociology
Participation, Entrepreneurship and Self-Management: A New Labor Culture?	Public Administration
Praxis Makes Perfect: Recovering the Ethical Promise of Critical Management Studies.	Business Administration
Rethinking Emancipation in organization Studies. In the Light of Jacques Rancière's Philosophy.	Philosophy
Critical Approach in Organizational Studies: Conception of individual from the Emancipatory Perspective.	Sociology
Down with Big Brother!' The End of 'Corporate Culturalism'?	Business Administration
Beyond macro and micro-emancipation: Rethinking Emancipation in organization Studies.	Philosophy
Emancipation: historicity of the concept and the controversy in the real process of human existence.	Education
Emancipation and/or oppression? Conceptualizing dimensions of criticality in entrepreneurship studies.	Business Administration
Dehumanization of the work in the era of Flexploração.	Sociology
When performativity fails: Implications for Critical Management Studies.	Psychology

Fig. 7: Study Areas. (Source: By the authors)..

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In Figure 7, the articles that compose the Bibliographic Portfolio and the respective areas of knowledge that involve these studies are separated. The areas of Administration and Sociology divide most of the articles and considering the interdisciplinary character of the emancipation theme, these studies end up involving knowledge from other areas. This theme also involves works and authors of Education, Philosophy and Psychology, which are revisited in some works, these areas end up being contemplated, directly or indirectly, through their knowledge, in the discussion of the theme.

IV. CONCLUSION

The research process allowed to select through the Scopus, Web of Science and Scielo databases, a raw file that has 192 items, composed by 65% of articles, 26% of books and 9% of articles published in congresses. The used methodology was able to filter the collected material creating a Referential Chart with 85 articles, which, by its turn, create a Bibliographic Portfolio composed of 24 articles, published between 1972 and 2016. For the systematic search process four research axes identified by the Man, Organization, Management and Risk dimensions were defined. The Man dimension uses as a single keyword the term Emancipation, representing the central and most important element of the research. In the Organization dimension, the keywords were Organization and Organizational, representing the environment where we want to evaluate the emancipation element. The Management dimension was represented by the word "management", representing the driving force that promotes the emancipation of the worker. And the Risk dimension used the keywords Accident, Risk and Safety, representing the second most important element of the research, where one intends to check the possibility of developing the process of emancipation within a risk management.

It is worth to highlight that the search for scientific material, which includes the themes Risk and Emancipation, simultaneously, did not result in any article that was aligned with the theme, which characterizes the novelty of the study. However, the used methodology gathered works that included the emancipation in organizations and the management influence in this process. Among the knowledge areas addressed in the found studies, one may highlight, mainly, Administration and Sociology, which share the most part of the articles, also bringing important contributions of Education, Philosophy and Psychology, clearly demonstrating the interdisciplinary nature of the theme.

The research highlighted the journals Organization – SAGE, System Practice, Journal of Organizational Change Management, Human Relations - SAGE, Journal Business Ethics, Journal Advanced Nursing, Journal of Contemporary Management, with the largest participation of Journal Management Studies, both for the referential Chart and for the Bibliographic Portfolio. Among the collected works, the research brought up Freire's work (2005), written in 1968 and published in Brazil in 1974, [9], [10], [14], [11], Zanoni and Janssens (2007). It was also highlighted the works of [1], [2], [3], which appear 45 and 39 times respectively, in the articles references that compose the Reference Chart. Within the Bibliographic Portfolio, contributing fundamentally, to the thesis in development, which motivates this research, we found the works of [14] and [4] that brings up practical studies of the theme Emancipation in Organizations, comparing and analyzing administrative practices.

In general lines, the study evidenced the novelty of the thesis in development as well as the interdisciplinarity of the theme, through the articles classified by the researched databases, gathered in its Referential Chart and Bibliographic Portfolio.

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Activity of two Exometabolites produced by Escherichia coli on the Synthesis of Pyocyanin

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Abstract *— The secretion of metabolites with antimicrobial activity is one of the strategies employed by bacteria to respond to negative stimuli promoted during interspecies competition. In a long-term stationary phase. Pseudomonas aeruginosa and Escherichia coli can synthesize diffusible exometabolites whose action is to mutually inhibit the exposed cells, guaranteeing the balance of both populations in a certain site. The P. aeruginosa may have an advantage in that it produces pyocyanin. However, the excretion of indole and acetate by E. coli may reduce this advantage. This work aims to detect the influence of different concentrations of these two exometabolites on the synthesis of pyocyanin in two wild isolates of P. aeruginosa. After incubation under shaking for 72 h at 29°C, reduction of up to 50% of the concentration of pyocyanin in the presence of indole was observed. On the other hand, no change was observed in the production of the pigment with the acetate, alone or when in combination with concentrations of less than 0.5 mM indole. It reduced the inhibitory effect of the compound, reflecting an increase in pyocyanin production of more than 20%. The results contribute to help understanding the ecological mechanisms of competition between the two species.*

Keywords *— **Pseudomonas aeruginosa, Natural phenazine, Microbial antagonism, Indole, Anti-Quorum Sensing molecules.***

I. INTRODUCTION

The In natural environments, different bacterial species coexist, forming complex multicellular communities that collectively respond to stimuli from the environment they inhabit, resulting in the stability of their populations [1]. During a long-term stationary phase, competition for space and nutrients is a natural process that occurs in mixed microbial populations, where a given microorganism produces certain diffusible substances whose function is to inhibit the growth of a second microorganism. These substances can be of various natures, for example enzymes, organic acids or phenazine compounds, among them, pyocyanin [2].

Pyocyanin is a bright blue pigment, characteristic of the *P. aeruginosa* species. It is also the main pigment synthesized by fluorescent pseudomonads [3]. In addition, pyocyanin is known as one of the most important virulence factors of *P. aeruginosa*. In addition to the role of a signaling molecule in cell-dependent cell density phenomena [4], it has been reported to participate in events involving resistance to antibiotics [5], inflammatory processes [6] and competition with other microorganisms at a given site [7].

In aqueous media, the relationship between *P. aeruginosa* and *E. coli* reveals certain particularities during a long-term stationary phase. Both organisms can synthesize diffusible exometabolites whose action is to mutually inhibit the exposed cells, ensuring the balance of both populations at a given site [8]. In addition to pyocyanin, other important exometabolites have been identified in *P. aeruginosa*, such as proteases, hemolysins, rhamnolipids and pyoverdine, a green color pigment that also has a siderophore function [9].

In an attempt to overcome the pressures exerted by *P. aeruginosa*, as well as its exponent metabolic advantage, *E. coli* strains can release into the environment, for example, acetate and indole. The first is formed as a by-product in aerobiosis when the absorption rate of the primary carbon source is greater than its conversion to biomass and CO_2 [10]. On the other hand, indole is formed from the metabolism of tryptophan [11] and concentrations of 0.5 to 1 mM can regulate *E. coli* responses to stresses exerted by the environment, including competition with *P. aeruginosa* [12].

The microbial interspecies relationships are a subject with a number of aspects that can be explored. The

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present work aimed to evaluate the influence of exogenous acetate and indole on the inhibition of the synthesis of pyocyanin in two wild strains of *P. aeruginosa*, submitted to direct contact with these metabolites.

II. MATERIAL AND METHODS

2.1 Microorganisms

Two isolates of *Pseudomonas aeruginosa*, TGC02 and TGC04, recovered from a petrol station in the city of Joao Pessoa, Brazil [13] were used. Both isolates exhibited pyocyanin by culturing at 30°C for 72 h in King A broth [14] and cetrimide agar [15].

2.2 Assay of exogenous indole and acetate activity on pyocyanin production

Recently cultured cells of TGC02 and TGC04 were suspended in 0.85% NaCl solution, standardizing the turbidity with tube # 1 of the MacFarland scale. Then, 5 mL of the suspension was transferred to flasks containing 50 mL of King A broth, to which had been added different concentrations of sodium acetate (0.25, 0.5 and 1.0 mM) and indole (1, 2 and 4 mM), totaling 16 conditions, including the control. The flasks were incubated under constant shaking at 150 rpm at 29±1°C for 72h [16]. The test was conducted in triplicate.

2.3 Extraction and quantification of pyocyanin

The assay was conducted according to methodology described by Oliveira et al. [17]. After the incubation period, 10 mL of the contents of the vials was transferred to 3 mL of chloroform. After vigorous vortexing and resting for 1h, 1.5 mL of the blue chloroform phase was acidified with 1 mL of 0.2M HCl, changing the color to red. After 1 h of rest, the concentration of pyocyanin was estimated by measuring the optical density of the acidified solution at $\lambda = 520$ nm (U2M chemistry), based on a standard curve prepared with 98% pure pyocyanin (Merck KGaA, Darmstadt, Germany) ($r = 0.9999$).

III. RESULTS

Both exometabolites promoted changes in the production of pyocyanin for the TGC02 and TGC04 isolates, especially indole. The results are shown in Figure 1. Pyocyanin concentrations are expressed as the mean of the three trials, with a standard deviation of ± 0.10.

In the absence of the inhibitors, the TGC02 and TGC04 isolates produced slightly more than 50 µg/mL pyocyanin. Indole alone, in the concentrations from 0.5mM and higher, was responsible for lower activity on the part of the *P. aeruginosa* isolates from the point of view of pyocyanin production, reducing the synthesis by about 40 and 50%, for TGC02 and TGC04, respectively. In contrast, the indole concentration of 0.25 mM did not promote reduction of the synthesis of pyocyanin for either of the *P. aeruginosa* isolates. This same result was observed under the conditions tested with the acetate, alone. Surprisingly, compared to the control, there was a 15% increase in the production of pyocyanin in the TGC02 isolate in the presence of 1 mM acetate. Under the other conditions, the concentration of pigment was not different from that observed in the control, with the increase of acetate in the medium.

When indole and acetate were associated, both TGC02 and TGC04 also exhibited a reduction in pyocyanin production, as the indole concentration increased. The concentration of the pigment obtained, however, was higher when compared to the results of samples only containing indole.

IV. DISCUSSION

There are two forms of microbial life in nature: planktonic and sessile. The second, more frequent, assures the formation of mixed communities with a high level of organization, whose maintenance in coexistence is guaranteed through several mechanisms, of which the nutrient concentration and chemical signalling stand out [18, 19].

Pseudomonas aeruginosa is an aerobic Gram-negative bacillus, a member of fluorescent pseudomonads [20], characterized by remarkable metabolic versatility, which gives it ubiquity, ensuring persistence in environments with different degrees of selective pressure [21, 22]. About 90-95% of all strains can produce pyocyanin [23], a pigment involved in the production of reactive oxygen species [24]. This is believed to constitute one of the main mechanisms that guarantees the advantage of *P. aeruginosa* against other bacteria [25].

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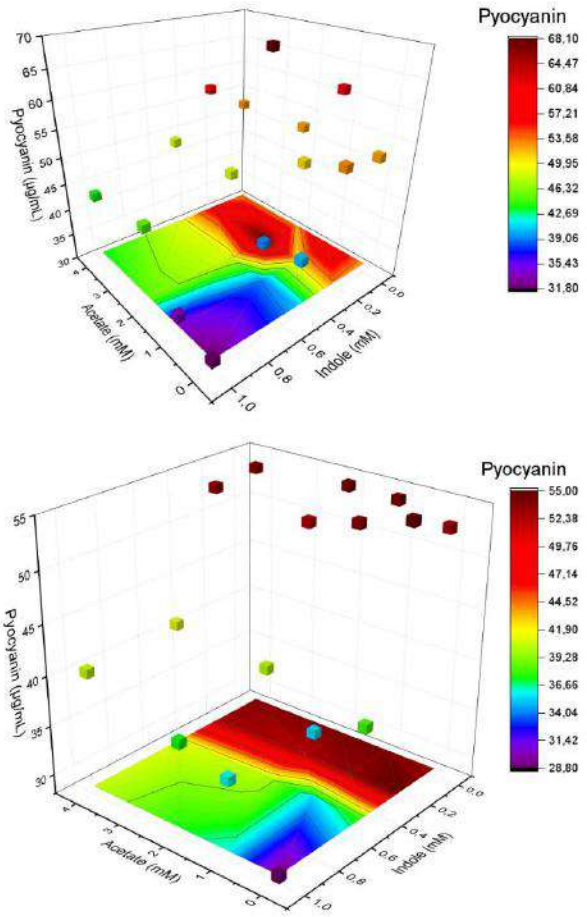

Fig. 1: Influence of indole and acetate on the production of pyocyanin by Pseudomonas aeruginosa TGC02 (A) and TGC04 (B). The colouring of the surface chart demonstrates the level of pyocyanin production: the nearly purple colour indicates a lower rate of production while that closer to red shows a higher production rate of the pigment.

It is known in the scientific community that in an aqueous media, *P. aeruginosa* and *E. coli* can interact [26]. This association sometimes represents disturbances especially to coliforms, although with a biostatic rather than a biocidal effect [2, 27]. In order avoid disturbance in the cells, *E. coli* releases secondary metabolites to keep itself viable in the environment, until it finds favourable conditions for regrowth [11, 28].

Among the exometabolites tested, indole proved to be more inhibitory to the production of pyocyanin by both TGC02 and TGC04 when compared to acetate, possibly due to its toxicity. On the other hand, it is known that acetate may also have a negative effect on organisms coexisting with *E. coli*. Concentrations of about 20 mM of acetate may slow growth or inhibit protein formation in competing organisms, however this concentration does not occur naturally [29].

It is emphasized that acetate reduced the inhibitory effect of indole on the TGC02 and TGC04 isolates when the two molecules were associated, especially under conditions where the indole concentration was 0.25 mM, as observed at acetate 2 mM and indole 0.5 mM, when TGC02 produced 68 µg/mL of pyocyanin, representing an increase of about 20% over the control. This apparent equilibrium suggests that acetate may have been used as an additional carbon source, based on a previous observation of the use of acetate by a *P. putida* strain in the presence of *E. coli* DOT-T1E [28].

E. coli excretes 10 to 30% of the carbon flux from glucose to an acetate in a glucose-containing medium, even when the culture is fully aerated [30]. Acetate can also be consumed by *E. coli* in terms of providing nutritional support to growth under stress conditions, and can be metabolized by two alternative routes: the first, by reversible Pta-AckA and the second, by irreversible, high-affinity acetyl-coA synthetase [31]. It is important to note that, because it also serves as an alternative source of carbon for the production of biomass and energy for *P. aeruginosa*, acetate is an exometabolite less damaging to the cell [32].

It is also important to remember that although there was a higher carbon input via acetate under some conditions, this did not promote significant differences in pyocyanin production when the indole concentration was equal to or greater than 0.5 mM, reinforcing the hypothesis that indole is a potentially more inhibitory molecule. Having information about the amount of indole and acetate produced when *E. coli* is disturbed in its environment can contribute to the elucidation of the population dynamics of the two species in mixed communities.

A previous study reported the reduction of pyocyanin production in three ATCC strains of *P. aeruginosa* when they were cultivated in a mixed culture with *E. coli*, attributing this reduction to the presence of exoproducts without naming them [8]. However, Chu et al. [11] studied the growth of *E. coli* in mixed culture, identifying indole as an anti-quorum sensing molecule for *P. aeruginosa*, which ensured the persistence of *E. coli* in the medium. In addition, Lee et al. [33] demonstrated that indole 1.0 mM inhibited 444 *P. aeruginosa* genes, including those regulating the production of the pyocyanin synthesis intermediates, such as *phz*C2, *phz*D2, *phz*E2 and *phz*F2, which are essential in the conversion of 5-methylphenazine-1-carboxylic acid betaine (PCA), to 1-hydroxy-5-methylphenazine, i.e., pyocyanin [23].

Pyocyanin biosynthesis is mediated by the quorum sensing system (QS) via the PQS system [4]. The QS is a

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density-dependent cell-cell signaling mechanism, used by *P. aeruginosa* to guarantee, among other responses, the stability of its population in a given environment under pressures of different natures [34]. Pyocyanin was described as a physiological signal, assuming the role of regulator of quorum sensing sensors, controlling genes during the stationary phase of *P. aeruginosa* [35]. The participation of pyocyanin as the QS signalling molecule in *P. aeruginosa* was identified as an important factor during formation and stability of biofilms [36, 37]. It is also believed that pyocyanin is required as autoinducer of the expression of certain phenotypic characteristics in *P. aeruginosa*, among then, the biosynthesis of surfactants, thus favouring the degradation of hydrocarbons [38, 39].

Microbial interactions occur with the purpose of promoting the stability of populations in the environment, guaranteeing the recognition of substrates, as well as the transfer of genetic information, resulting in a diversity of phenotypes [40, 41]. In the microbial world, competition is a common and an expected event. However, some evidence suggests that interspecies interactions are weak, since they can be resolved by spatial separation [42]. For microbes, the balance between the populations brings many more advantages than the elimination of a particular population. This may reinforce and justify the reduction in the production of pyocyanin, but not more than by half.

V. CONCLUSION

Under the experimental conditions tested, the presence of indole promoted perturbations in the production of pyocyanin in TGC02 and TGC04 isolates. The presence of acetate contributed to equate this disturbance when the concentrations of exometabolites were lower than 0.5 mM.

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The Detachment of the Homogenizing discourse and lived for Resettled Hydropower plant Irapé: the Landscape of Reification of Logic and the "Development"

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Abstract *— This work intends to present the mechanisms used by the "development" and the experiences of the people compulsorily displaced due to the Irapé HPP in the Jequitinhonha Valley, stigmatized as a "valley of misery". For this purpose, literature review, qualitative research, case study, field work, etc. It was carried in October Also Analyzes the Disproportionate power to suppress rights and lead the population to accept the "rules of the game". The pressures for homogenization que Suppresses the socio-cultural diversities of the "being and doing" of the peasant, the emptying and disqualification of the confrontations that make invisible the social movements. The relativization of the symbolic value of land, inheritance, traditions, way of life and the multiple uses of land and nature, Which are despised by entrepreneurs. In this way, the resolution of conflicts is enabled by reification, Which Merely prioritizes the economic logic, Which Understands the people of the place object to another in the natural landscape.*

Keywords *— **Irapé, affected, speech.***

I. INTRODUCTION

Modern society lives under the umbrella of the capitalist system, whose basic philosophy is to produce and consume continuously. In this regard, Carneiro (2005), notes that part of capitalism's nature, the pursuit of maximizing the accumulation of abstract wealth through the continuous production, to satisfy a consumer market increasingly hungry for new products.

To feed gear production-consumption, constructs capitalists as industries are driven to transform natural resources into products and is essential in this context, the electricity that moves machines, processes, raw materials, lights artificial consumption centers, such as Shopping malls and also provides operation of numerous products available to the market.

Important to mention that not only the industry depends on energy for its operation, but also the products themselves of capitalist industry, available to the consumer market. Thus, there is no way to use electronic devices such as computers, cell phones, etc. microwave oven without, at some point, connect them to a power source, which makes the demand for electricity, is increasingly bigger.

Important to note that, as Zhouri; Oliveira (2005), there is also, in Brazil, demand for electricity to supply the consumption of foreign companies.Since, periphery economies as is the case of our country, serving the capitalistsinterests the central economies harboring intensive industries in energy use, such as the Canadian Novelis Brazil (formerly Alcan) among others, whose purpose is to use the cheap labor from third world countries, and exploit to exhaustion, natural resources scarce in their home countries, in the production of intermediate products with low added value for export.

On the other hand, the production of electricity in Brazil, whose energy mix is predominantly hydroelectric, requires the exclusive use of large areas. Thus, several changes are checked in the sovereign territory involved, since they are flooded many kilometers of fertile land, with suppression of natural and cultural landscapes, fauna and especially imposing expulsion displacement of the local population.

The speech propagated by the managers of hydroelectric projects, government and political leaders are in the sense that the work will progress, development, increase the income of the population, and therefore

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something to be desired by the people. The fallacy is still to ensure that the impacts on the lives of local people will be insignificant, easy adaptability, corrected and mitigated through financial compensation, collective resettlement etc. In the case of Plant Irapé, located in a poor region of Minas Gerais, the Jequitinhonha Valley, the speech focused on the constructed image, the"out" Valley, giving him the pejorative label of "Valley of Misery" strategy that serves to instill a general acceptance that the power plant is the only chance of the Valley exit delay, to develop economically, and provide improved the living conditions of the population.

It is felt that the development discourse is not always accompanied by practical results, emerging from an unbalanced context of disputes over ownership of spaces and natural resources. Two rationales operating in non convergent logic: The interests of farmers in the defense of their rights, as historically use of natural space with various social and collective purposes and thence derive their livelihood from fishing, farming, extraction, etc. Ofopposite side, the hydroelectric entrepreneur who sees from the resources / natural spaces meet the demands of capital, with regard to the availability of energy for industries allocated anywhere in the country. This dominant logic, the use of such resources to the market, it is inevitable and urgent.

The hydropower plants are generating various conflicts, according Zhouri et. al (2005) as a result of impacts suffered by the local population, ranging from the loss of the material basis of its existence as rivers, land etc. as well as the breakdown of family ties, neighborhood, loss of identity, symbolic values and difficulties repossession.

In this sense, this article aims to verify the tuning level between discourse and practice with regard to the project of Irapé hydroelectric plant, trying to analyze the situations and impacts experienced by affected were resettled in Araras farm in Francisco Sá, as well how conflicts triggered in this context.

II. THEORETICAL FRAMEWORK

Gestated in the capitalist mode of production, large industrial projects are synonymous with development for the regions in which they are inserted. Thus, the speeches preceding the works, greatly maximizing its positive aspects and relativize the numerous negative impacts they cause. Incidentally, the word development was so strategically crafted in the capitalist context, which in time came to exercise a certain fascination in people so that, as noted Gómez (2002) It seems to be almost a sin anyone dare to raise questions or to position contrary the stocks that are considered alavancadoras development.

One can not ignore the context in which came the word development not to commit the ingenuity to associate it only the positive aspects touted in speeches conveniently formulated by capitalist core countries to achieve adhesion of the South, its expansionist policies. As we teach Sachs (2000, p.11) "the development provided the essential framework for that mixture of generosity, blackmail and oppression that characterized the south directed policies. "

The developers aim to legitimize the discourse industrial projects. Thus, the rhetoric is all built on the formation of a positive image of the work of Salvationists character for the region, generating jobs and income. Foucault (2005, p.10) warns us that "the speech is not simply that which translates struggles or systems of domination, but that why, for that struggle, the power of which we want to seize".

The reservoir Irapé, consumed 137.16 km², promoting the private appropriation of natural resources in the region that led to the removal of portions of the most fertile lands of the Valley region, this total about 90 square kilometers were native cerrado vegetation. The peasants who depended on the river lowlands faced with a severe change in their modes of social reproduction. The river was also very important for those who made their living from fishing or supplemented their income from this activity. In this sense, the speech that preceded the work represented a strategy to reduce the opposition on what the project would need to take over (water resources).

Santos (. 1999, p 173), although this perspective, reminds us of the following on the experiences after the implementation of hydropower projects:

> When we say that the dams come bring, (..) to a region, the hope of salvation of the economy (..) all these are symbols that allow us to accept the rationality of the object, in fact, on the contrary, can accurately come to destroy our relationship with nature and impose unequal relations.

Fleet (2001) considers the deployment of a hydroelectric power plant substantially changes the environment and these changes are due to interventions on the media (soil, underground water, etc.) and biotic (fauna, flora, etc.) in the project execution process. The social and environmental impacts, given the subjectivity of features, complexity and dinamicidades involved, to be minimally reduced, require non-linear and costly solutions.

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In this perspective, a hydroelectric power plant, when ordering the almost exclusive use of natural resources in the region, suppressing the biosphere hitherto existing, as well as requiring the local population involuntary displacement, the unwinding of the way of life, the loss of family ties and neighborhood will be a necessarily a source of conflict of interests.

On the impacts of a hydroelectric, Zhouri; Oliveira (2007) mention that the populations of local lose from its base material existence (land, rivers, etc.) to the cultural and symbolic references, kinship networks and collective memory.

Zhouri; Oliveira (2007) to discorrerem on what they call "paradigm of adaptation" shows that the realization of a large hydroelectric project becomes unquestionable, and the impacts of the intervention, considered mitigated externalities through financial compensation, thus emerging the reifying character the strategies implemented by the managers of the plant, government and political leaders.

In this way immaterial values of coastal communities, such as: the traditions, the social ties of kinship neighborhood as well as the values assigned to the lands, which are often family heirlooms, are converted into goods or components of the natural landscape, subject to economic valuation, therefore compensable goods. This is the reifying conception that seeks to materialize the possible path of monetization of everything around you.

The affected people are under pressure from all sides so that, in a way, to pass to value new habits, new times, times those not rooted in the past and in diversity, one start founded on the homogenization of socio-cultural diversity, as asserts Zucarelli (2015), streamlined for a "modernized" social being transformed after Irapé. A new beginning that much was lost or emptied, such as identity and social ties, given the fragmentation imposed on the sprawling people from several municipalities, that have nothing to compare the specifics of the living peasant of Jequitinhonha banks, such as the resettlement of Araras farm. Such pressures compromise even the subjective aspects: sense, meaning, cultures collective memories, etc. In summary, in this logic, social being is also understood as another "object in the natural landscape" as inform us Sigaud; Vainer (1986, 2004, cited Zhouri; Oliveira (2007).

Zucarelli (2015), argued that in the process of formalizing the licensing of hydroelectric emprendimiento, there are diverse ways to relativize, soften or adjust things, to justify and not comply with environmental legislation. This is from the streamlined flexibility through mitigation measures, compensatory, conditions that allow the advancement of an unfinished phase to the next phase of the project, terms, agreements, negotiation mechanisms that meet the formal role of democratic participation, but in practices are stratagems of unlimited adequacy policy by the interests of capital / market. More flexible in this context often means suppressing rights.

On the legal mechanisms, tell us Zhouri; Oliveira (2005) that the environmental licensing, in practice, does not provide the riverside communities, the condition of active participation in discussions on the project viability in a broad context, leaving them only secondary opportunities, such as: to discuss compensation values, possible grounds for implementation of resettlement.

At another point, Zhouri et. al (2005) add that the technical language of the documents, becomes a limiting factor in the participation of people impacted by the project, the difficulty or impossibility of understanding of the terms / codes / signs contained in the reports and other documents. Another consequence of this language is that it impose a point of view on the issue, disqualifying and delegitimizing the claims of those affected.

Marques (2005) says that the impact on the lives of people relocated due to construction of hydroelectric plants are large and beyond controversies about a new place of residence or issues related to the amounts of compensation. Trigger to the new place adaptation problems, hindering the process of repossession, due to cultural differences between the resettled and the inhabitants of the new region. It is very common in the new place of residence, people receive treatment through derogatory names like "drowned".

Zhouri; Oliveira (2007) show in their studies, a social or collective identity, established in the communities affected by the project Irapé fruit of different generations interacted in that geographic space, with shared values and the same way of acting and producing sustenance. These authors emphasize in this regard, including on the seizure system of lands and natural resources, known as "land on the cake" when there were areas of collective and family use, that the inheritance did not generate division of land, which is fully maintained to the family.

It is important to note that the local population, affected by Irapé venture can be considered peasant. To support our thinking about this, we turn to Santos (2016) that examined the terms that the inhabitants of the Jequitinhonha Valley understand being representative of their conditions. This perspective is very clear that people do not see themselves only as "achieved". The term

https://dx.doi.org/10.22161/ijaers.6733 ISSN: 2349-6495(P) | 2456-1908(O)

"improper" neither would characterize the situation of these people, as only covers the aspect of the material property of the land, not taking into account the intangible assets that are also lost in the involuntary transfer process, such nomenclature subtracts the perception of related senses violations suffered by achieved.

Ribeiro (1993, p.46), this perspective tells us the following in relation to the nineteenth century: "(...) areas of the Jequitinhonha, at the end of the last century was characterized on the one hand, the presence of a peasant economy as evidenced by the large number of farmers and the small percentage of skilled labor captive (...) "

Also according to Ribeiro (1993), in Jequitinhonha farmers were established in the vicinity of farms generally as aggregates, residents in the land of the farmer, exercising, in return, the activities of the farm and living primarily from his work, in agriculture, whose harvest was still share with the landowner. The author also mentions a kind of autonomous peasant on the owners of large farms once owned their own land and produce in it the support of the family and could still trade surplus in the local market. This kind would, in our view, the most like the families that came involuntarily to resettlement in Araras, since they had their family properties, which grew in the low waters. So much so that, as compensation,

The adoption of the term peasant in Brazil is recent, as tells us Martins (1981), to clarify that the use of this expression in academic and political terms, occurred only in 1960. Until then, according to this author, the workers from rural areas, unpaid for wages, were known by terminology regionalized and even derogatory, as in the case of the term "hillbilly". Who has not at least talk about the character Jeca Tatu, created by Monteiro Lobato, representing a hillbilly considered lazy?

Martin (1981) emphasizes that even after only 60, it verifies that two opposing classes in the field, represented by Squires, which were the owners of large farms, and the rubes, now known as farmers. The strategy of the landowners, to give a sense of usefulness huge areas of unproductive land, state capitalism in expansion, was occupying huge areas with monoculture plantations, which also occurred in the Jequitinhonha Valley, as well observe Zhouri; Oliveira (2005), the emergence, in the 1970s, the eucalyptus monoculture, even on public land.

Side of the peasantry, under the dictates of the hegemonic capitalism, what was perceived was an attempt to change the meaning of the peasant term, under the political and even ideological point of view, trying him impose an entrepreneur occupation under the nomenclatures family farmers or family farmer. In this regard, we find Marques (2002, p.3), as follows:

> (...) however, in the 70s, the concept of small production is now used as an alternative to the peasant for his operational nature and supposedly better represent the reality of a state by the subject field to the disarticulation of their movements social and a set of modernizing stamp policy.

Shanin (2005, p.3) to mention on the economy of the farmers, provides us with important features for delinearmos the peasantry, though, are several forms of consideration of this social class: "(...) is characterized by extensive forms of autonomous occupation (ie family labor), for control of own means of production, subsistence economy and multidimensional occupational qualification (...). "

III. METHODOLOGICAL PROCEDURES

This article, predominantly qualitative nature, aimed at analyzing the gap between theory and practice in regard to the socio-cultural impacts experienced by people affected by hydroelectric plant Irapé, resettled in Araras farm, Francisco Sa, and intended to examine the conflicts triggered.

Thus, there was a case study with field research, through the implementation of semi-structured interviews conducted with the people transferred to the resettlement of Araras.

On field research, Brandão (2007) highlights positive aspects such as experience and contact, in order to understand what needs to be known. Moreover, this type of research, there is the advantage of the presentation of updated data, strongly related to the goal and classified according to the analysis needs.

Regarding the semi-structured interview, it is important to mention that according to Duarte; Furtado (1991), it is processed in the form of a conversation that occurs between two people for one of them to collect information on a particular subject

Of the 26 planned interviews, if effectively implemented 22 of them because four people had sold their plots / tracts, returning to the vicinity of the place of origin, according to testimony from neighbors.

It held also literature, and the works consulted were obtained by searching the banks of Google Acadêmico[1] and Scielo[2] data from the use of expressions related to the theme, such as "socio-cultural or socio-economic impacts arising from the hydroelectric construction "" resettlement arising from hydropower "," identity or kinship ties or religious traditions or after dam

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construction "and" conflicts in hydroelectric projects. " They were analyzed also several works that allowed to know the developmental ideological discourse that precedes the construction of major works, including Hidreléticas Plants

The literature is that which, according to Duarte; Furtado (1991), used lifting techniques and material selection, techniques for reading and for the appointment (scheme summary review, BOOK REPORT, etc.).

IV. RESULTS AND ANALYSIS

The 26 families resettled in Araras, according to field research, come from the municipalities of Cristália, Botumirim and Mogol, left bank of the Rio Jequitinhonha. It is noteworthy that four of these families have sold their homes and returned to the source of municipalities, given the difficulties of adapting to the new place, according to testimony from neighbors. This difficulty of repossession is described by Marques (2005) mentions that the impacts on the lives of people involuntarily relocated, due to the hydroelectric power plant construction, are large, going beyond financial matters as the compensation values.

Another visible impact in Araras resettlement, according to interview data, it was the breaking of family ties and neighborhood. The place of origin 59% of people living near relatives and 41% near neighbors who were regarded as family.

It is important to note that the negative impacts linked to kinship and neighborhood ties breaks are checked at various hydroelectric projects and has become even a situation "somehow" be regardedthe normal ones by entrepreneurs, governments and political authorities. So that in a study of Environmental hydroelectric plant hopper impact, the situation was placed in plain terms and even as a natural phenomenon, as evident from the word that now grifamos, the transcript then extracted Pereira Study (2014):

> [....] it is important to emphasize the strong neighborhood ties and kinship which unite the inhabitants of the area directly affected HPP funnel. With the compulsory displacement of this population, it is common to occur breakdown of these bonds and the loss of historical references, relevant social and cultural (EIA HPP Funnel Leme Consulting VI: II / p.51)

There was, as a result of Irapé enterprise, the loss of an existing social identity in the territory of origin, Zhouri; Oliveira (2007) also found in their studies. According to these authors, in areas of the Upper and Middle Jequitinhonha, the seizure system of lands and natural resources, it was the so-called "land on the cake" in which predominant areas of collective and family use, the inheritance did not generate division of land, keeping - a fully to the family.

Note that the different generations shared, in countries of origin, of a collective identity, sharing similar values and ways of acting and provide for their families, from fishing, planting in low waters, etc.

The change of the physical and social space for Araras shows that it was not possible to reproduce this collective identity until the time of the survey.

The loss of collective identity also reflects the difficulty of maintaining the traditions that are, in fact, the history of a people, as a result of the various interactions of several generations in a given territory.

Resettlement of Araras, 86.4% of respondents said they are unable to attend or play parties in the new place, which was recurrent in ancient sites.

The lack of religious temples in Araras resettlement, points to another negative impact on the lives of the settlers, difficulty in continuing to profess their faith in churches collectively. The nearest places of worship are fifteen kilometers from the resettlement and access conditions are not good.

The issue of access to water in Araras farm resettlement is another matter quite emblematic and reinforces the social suffering that is subject to the new location, since these families lived near the Rio Jequitinhonha, having no problem with the water supply in its various uses. Importantly cultivation in low water, characteristic of the place of origin, it was not possible in the new place, since the water is pumped from wells, in limited quantities, the nearest river is contaminated.

About this, Santos (1999, p. 173), shows us the sad contradiction between discourse and the situation faced by resettled people, despite the existence of documents that establish criteria on the characteristics of the sites to be acquired for resettlement purposes in that water quality is a determining factor:

> When we say that the dams have to bring (..) to a region, the hope of salvation of the economy (..) all these are symbols that allow us to accept the rationality of the object, in fact, on the contrary, you can just come to destroy our relationship with nature and impose unequal relations.

V. CONCLUSION

It appears from the research that families resettled in Araras farm experienced strong commitment

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of kinship, neighborhood, and loss of social identity and losses as the traditions and religious practices, and other losses in the material field, as the difficulty of access the water.

The most troublesome experience in Araras, allows us to infer that there is a gap between the discourse and the situation experienced by people resettled in Araras, since the managers of the enterprise and the government of Minas Gerais, boasted that not only would progress to the region stigmatized as "Valley of Misery" as the impacts on people's lives would be small and properly mitigated.

It is known that it is very complex and costly, and therefore neglected by the project managers, mitigate impacts such as those described by Zhouri et. al (2005) with respect to loss of cultural and symbolic references, kinship networks and collective memory. Even the more concrete issues such as the access to resettlement, water supply did not occur satisfactorily,
so that the water in the new place is pumped from wells to homes in insufficient volume for all activities that depend on it, and the nearest river, green river has contaminated water.

The current mode of production is different because there is a river for fishing, or ebb for planting and this has caused many families they could not play the way of life, returning to the municipalities of origin.

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[1]System that offers specific tools for researchers to seek and find literature.

[2]Scientific Electronic Library Online - electronic library of Brazilian scientific journals.

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Evaluation of Environmental Impacts in Semi-arid Caatingas of Brazil

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Abstract *— The Caatinga is a biome rich in endemic species, both fauna and flora. There is, however, no influence suffered on the impacts, some of them being irreversible. Despite being a fragile biome and requiring care due to vulnerability, the issues related to climatological aspects, this is a very resilient ecosystem. This is not important anthropogenic impact, and this case, approach in the impact of the provocation of the activity of mining, is this case in the environment of illegal environment. In this sense, this article aimed to evaluate socioenvironmental impacts through mining activities, caused by the implementation of the Red Mine in the Curaçá Valley, in the State of Bahia. This research is applied in nature, quantitative, bibliographical and field. The methodology is based on the Tricart (1977) ecodynamic method, on the GTP Theory of Bertrand and Bertrand (2007), on the method of walking of Filgueiras et. al. (1994) and in Bardin Theory (2011). The research findings were the main risk factors for Caatinga surface recovery (PRC).*
Keywords *— **Mining; Degradation; Semi-arid.***

I. INTRODUCTION

Today Bahia is the most sought after location in Brazil by large mining companies. The state has iron, nickel, gold, bauxite and about 40 other minerals. It is the largest national producer of uranium, chromium, salgema, magnesite, talc and barite, ranking second in the production of copper, graphite and silver, and the third largest in gold, ornamental stones and natural gas. Also in Bahia is the Mineração Caraíba S/A warehouse that was discovered in 1874 and, in 1944, the National Department of Mineral Production (DNPM) identified its productive potential.

In 1979, under the name of Caraíbas Metais S/A, the company began operating the mine at Cielo Aberto, and in 1986, with the entry into operation of the Underground Mine, the copper ore was withdrawn simultaneously from both sources (FRÁGUAS, 2013).

According to Fráguas (2013, page 3), in 1988 the former Caraíba Metais, now Mineração Caraíba S/A, started the privatization process and in 1994 entered the National Privatization Program, now known as Mineração Caraíba S/A. "In 2006, the leaching plant began operations to extract copper from the oxidized ore, which has been stored since the beginning of operations."

The mining company is located in the north of Bahia, more precisely in the Pilar District, in the municipality of Jaguarari, with more than 1300 direct employees and almost 2000 in total (FRÁGUAS, 2013).

The present article evaluates the main environmental impacts caused by the ore flow in the Curaçá Valley, presenting causes and consequences, as well as suggesting mitigating aspects to solve the socioenvironmental damages. The methodology used is based on the Ecodynamic Method of Tricart (1977), on the GTP Theory of Bertrand and Bertrand (2007), on the Method of Hiking Filgueiras et. al. (1994) and in Bardin Theory (2011).

The research findings indicate a strong environmental degradation caused by anthropic agents (in this case the mining company), signaling the need to reconstitute the area from the insertion of a Caatinga Recomposition Plan (PRC).

II. STATE OF THE ART OF RESEARCH

2.1 IMPACTS FROM MINERAL EXTRACTION

According to Filho (2011) Mineração Caraíba concentrates (12.1%) of the country's annual copper exploration is 1.1 million tons of sulfide, and 70 thousand tons of concentrate, with an average content of 37% copper. However, anyone who knows the mining company knows that it, even though it has been granted exploitation by the Union, is not in the habit of acting clearly and with respect to the environment.

It attempts to convince residents of areas with mineral deposits to be rewarded with simplistic works and no legitimate value, not making the environmental compensations required by the legislation. In addition, the mining company has not acted in a respectful way in relation to the existing flora, removing the vegetation to open roads for the drainage of its production.

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One of the questions of Fráguas (2013), is about the environmental licensing issues, where according to him:

> A factor that has become important and sometimes limiting to the feasibility of mining projects are the constraints of the TC (commitment terms) assumed in public hearings during the environmental licensing processes, forcing the Mining companies to have a sometimes expressive cost for activities together communities that should be the role of the state or municipalities (FRÁGUAS, 2013, p. 8).

In the municipality of Juazeiro, in the region known as Vale do Curaçá (Mineral Province so named by Mineração Caraíba S/A), the "Red Project" was created (figure 1), an underground mine with an estimated capacity of 3.2 million tons of copper sulphide and started operations in 2016, generating almost 800 jobs (direct and indirect) until the actual production of the ore. Such an enterprise can last more than five years (BLOG CARLOS BRITO, 2015).

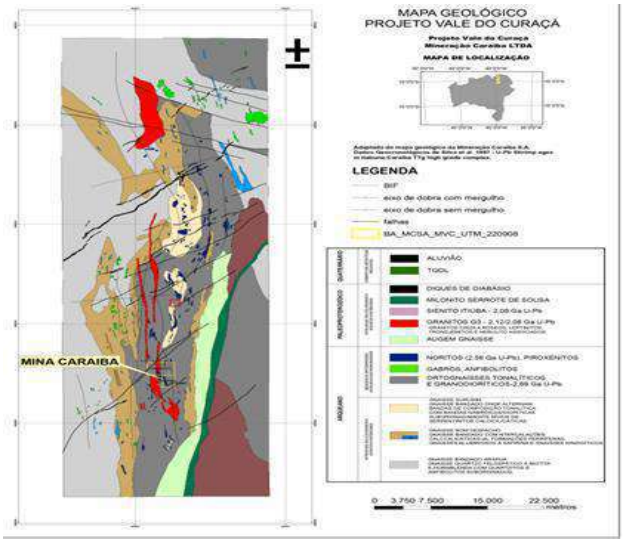

Fig.1: Simplified geological map of the Curaçá Valley
Source: MCSA Geologia (2009)

Copper is the third most used metal in the world, behind iron and aluminum. It is a malleable, recyclable mineral, resistant to corrosion and high temperatures, being used in the generation and transmission of energy, in spinning mills and in practically all electronic equipment, for example, in television and cellular telephones.

However, CBPM points out that the semi-arid region accounts for more than 90% of the production of metallic minerals produced in the state of Bahia, with emphasis on the following municipalities (CBPM, 2013):

i. Jaguarari - the largest copper production in Brazil;

ii. Campo Formoso, Andorinha and Santa Luz - the largest Brazilian production of chromium;

iii. Brumado - greater production of magnesium and talc in Brazil;

iv. Caetité and Maracás - the only uranium and vanadium mines in the largest production in Brazil;

v. Santa Luz and Jacobina - gold mining;

vi. Vitória da Conquista - produces bentonite, sand and clay.

In this sense, the state of Bahia has promising areas for mineral production in the Bahian semi-arid region, highlighting potentials for the exploitation of iron ore, gold, clays, kyanite, zinc, nickel and ornamental rocks.

The IMM (2019) brings a table highlighting the main mineral goods exported in March 2019, their destinations worldwide and their respective dollar values (see figure 3).

Bem mineral	Valor (US$ - Mar /2019)	Acumulado (US$ - Jan a Mar/2019)	Principais Destinos
Ouro	22.875.924	73.441.988	Bélgica, Canadá, Índia, Suiça
Vanádio	19.444.184	98.812.350	Canadá, Coreia do Sul, Estados Unidos, Japão, Holanda
Outros Metais Preciosos	9.786.318	37.818.442	Alemanha, Canadá, Holanda, Suíça
Magnesita	4.388.378	18.075.120	Alemanha, Argentina, Bélgica, Canadá, China, Colômbia, Costa Rica, El Salvador, Equador, Estados Unidos, Índia, Japão, México, Holanda, Reino Unido, Rússia, Turquia, Tailândia, Uruguai, Venezuela. Romênia
Pedras Preciosas	674.358	1.230.314	Alemanha, Arábia Saudita, Bélgica, Chile, Equador, Estados Unidos, França, Índia, Itália, Portugal, Quênia, Suíça
Rocha Ornamental	616.428	1.552.867	Albânia, Alemanha, China, Espanha, França, India, Itália, Polônia, Suíça
Talco	534.902	1.051.966	Argentina, Chile, Colômbia, Estados Unidos, Itália, México, Paraguai, Peru, República Dominicana, Uruguai
Quartzo	206.363	525.553	China, Espanha, Estados Unidos, Itália, Hong Kong, República Tcheca
Manganês	195.317	2.103.198	China, Emirados Árabes, Estados Unidos, Índia
Cromita	96.505	180.100	Alemanha, China
Outros	27.031	69.910	Diversos
Diamante	0	5.570.770	Emirados Árabes, Estados Unidos
Cobre	0	37.383.840	África do Sul, China
Total	**58.845.708**	**277.816.418**	

Fig.3: Main mineral goods exported in March 2019
Source: IMM/SDE (2019)

It can be seen in figure 3 that copper was the last one on the list and its main destination is South Africa and China, accumulating a total of US $ 37,383,849 from January-March, which suggests that the companies that are leaders in the world market for this mineral had in 2018 cumulative profits, despite all the socio-environmental impacts generated.

Therefore, it is known that the state of Bahia has an area of 564,692,669 km², with the largest territorial extension of the Northeast, occupying approximately 37.7% of the region. In this immense area, there are three Brazilian biomes: the Caatinga, the Atlantic Forest and the Cerrado, besides the Coastal Zone, with its ecosystems that are repeated all along the coast - like beaches, dunes, restingas, rupestrian fields, lagoons and mangroves. Thus, Bahia has a great diversity of ecosystems, leading to the reflection of how much has been lost of this natural biodiversity, with mineral

https://dx.doi.org/10.22161/ijaers.6734 *ISSN: 2349-6495(P) | 2456-1908(O)*

exploration in several parts of the state, with the consent of governments and environmental agencies (SDE, 2019).

2.2 DEVELOPMENT OF ORE AND ENVIRONMENTAL DAMAGE

The implementation of the Red Project and the approval of the Municipality of Juazeiro, has been committing countless environmental damages in the Paredão pasture fund area, through the execution of a public road for the production of the Projeto Vermelhos to Pilar (municipality of Jaguarari, where it is the matrix of the mining company), this road that connects BA 210 (Curaçá) to BR 235 (Pinhões).

The mentioned road measures approximately 12 meters of width, being able to transit at least three paired carts. This road was licensed by the Department of Environment and Urban Planning (SEMAURB) of Juazeiro, in the typology "simplified environmental license", published in the Official Gazette (see figure 4).

OFICIAL
Prefeitura Municipal de Juazeiro

PREFEITURA MUNICIPAL DE JUAZEIRO - BAHIA
SECRETARIA DE MEIO AMBIENTE E ORDENAMENTO URBANO

RESOLUÇÃO SEMAURB Nº 144/2018

Concede Licença Ambiental Simplificada em favor da Pessoa Jurídica ***CSSA Construtora São Salvador EIRELI*** *e dá outras providências.*

O SECRETÁRIO DE MEIO AMBIENTE E ORDENAMENTO URBANO DO MUNICÍPIO DE JUAZEIRO, ESTADO DA BAHIA, no uso das atribuições que lhe confere a Lei Complementar nº 020/2016, e tendo em vista as disposições contidas na Lei Municipal 1.873/2005 e Lei 1.703/2003 Código Municipal de Meio Ambiente, regulamentada pelo Decreto Municipal 366/2005, e tendo em visto o que consta no processo administrativo nº **10213/2018**, resolve:

Art. 1º - Conceder a **Licença Ambiental Simplificada,** válida pelo prazo de **03 (três) anos**, ao **CSSA Construtora São Salvador EIRELI**, Pessoa Jurídica de Direito Privado, inscrita no CNPJ sob nº 11.129.119/0001-85, para atividade de **Construção de Estrada**, situado na Av. Anísio Moura Leal, nº 76, A (AV. CEAP), KM 2, Petrolina - PE.

Fig.4 - Official Gazette - Road Licensing

Source: Official Gazette of the Municipality of Juazeiro - Issue 1,264 - Year 6 of July 16, 2018. P. 88-91.

However, in the eyes of the Brazilian legislation, any and all construction works must pass through an Environmental Impact Assessment (EIA) and an Environmental Impact Report (RIMA) that must be made available for access by the interested company. In addition, the municipal government explains in the license document that the road is of "public utility" to the communities, which had to build it (road), the degradation of the soil, the scaring of the fauna, the suppression of flora of the caatinga biome, the destruction of stretches of native vegetation, among other environmental damages.

This requirement is made by CONAMA Resolution No. 01/86 and by Article 2 of CONAMA Resolution No. 237/97. Such studies are necessary to assist in the assessment of the environmental feasibility of the project, so that the environmental agency (in this case, SEMAURB) can issue the Previous License (LP). It is important to emphasize that the LP does not authorize the beginning of construction, it only signals its viability.

The Environmental Impact Assessment (EIA) is the detailed technical study that mainly involves the following questions:

a) Characterization of the enterprise - describes the enterprise to be licensed, considering its installation and operation, and gathers information on how, in the entrepreneur's view, it will work;

b) Environmental Diagnosis - describes the region where the project intends to be installed and its adjacent areas, gathering environmental and socioeconomic data of the area before construction;

c) Assessment of Environmental Impacts - crosses the socio-environmental characteristics of the area and the characteristics of the proposed project, evaluating the effects of the construction and operation of the project;

d) Environmental Prognosis - considers the negative or positive effects on the physical, biotic and anthropic resources associated with the installation or not of the future enterprise.

e) Environmental Impact Monitoring and Monitoring Programs - suggest measures to avoid, mitigate and/or compensate for the negative impacts of the project and enhance the positive ones (obligations of the entrepreneur when he/she receives the Previous License);

All this information and the main conclusions of the EIA should be summarized in the Environmental Impact Report (RIMA), in clear, direct and accessible language for public consultation, which did not occur in the case described here, since until now the Paredão community has did not have access to the EIA and to the RIMA of said road.

Also, the Area of Influence (AI) is one that will somehow be influenced by the implementation of the enterprise, whether in the physical, biotic (fauna and flora) or socioeconomic aspects. In this way, it is possible to identify the AI by defining specific areas of influence for the environmental analyzes, according to the interferences that occur. The Area of Influence can be divided into Directly Affected Area (ADA), Direct Influence Area (AID) and Indirect Influence Area (AII), as shown below.

https://dx.doi.org/10.22161/ijaers.6734 *ISSN: 2349-6495(P) | 2456-1908(O)*

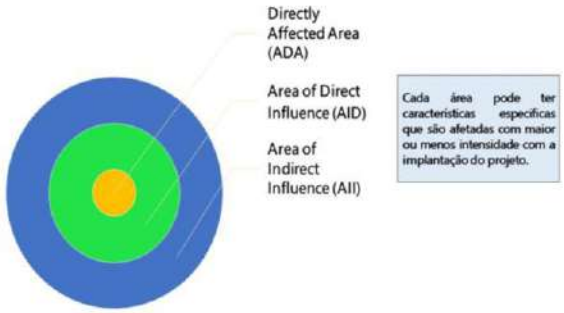

Fig.5 – Sketch of an AI

Source: Elaboration Authors (2019)

Each of these subspaces receives impacts in the construction and operation phases of an enterprise, with direct or indirect causal relations, and hence the name, besides the ADA where the enterprise itself is located, often called the intervention area.

In terms of the applicable legislation, according to Article 2 of CONAMA Resolution 349 - the Area Directly Affected - ADA - is considered the area necessary for the implementation of the enterprise, including its support structures, private access roads that need to be built, expanded or reformed, as well as all other unit operations associated exclusively with the project infrastructure, that is, private use of the project (CONAMA, 2012).

The Direct Influence Area (AID) - is the geographic area directly affected by the impacts arising from the project/project and corresponds to the contiguous and expanded territorial space of the ADA, and as such, should suffer impacts, both positive and negative.

Such impacts must be mitigated, compensated or enhanced (if positive) by the entrepreneur. The impacts and effects are induced by the existence of the enterprise and not because of a specific activity of the same.

Finally, the Indirect Influence Area (IIA) - covers a territory that is affected by the enterprise, but in which the impacts and effects of the enterprise are considered less significant than in the territories of the other two areas of influence (ADA and AID). In this area, the analytical objective is to provide an evaluation of the regional insertion of the enterprise. It is considered a great context of insertion of the area of study itself.

These territorial configurations, in fact, are syntheses of repercussions of impacts that can occur in the physical, biotic, socioeconomic, cultural and institutional environments. More than that, there are situations in which a given area of influence, for example AID, differs for each environment in the local and/or regional environment, drawing its own contours, thus having more than three overlapping areas.

In the case analyzed here, the ADA is the Red community (Figure 6), where the enterprise is situated (the copper mine). However, the Paredão community is located in the Area of Indirect Influence (AII), which, although considered by the legislation as an area less impacted than the ADA, suffers numerous impacts, not only environmental but also socioeconomic impacts.

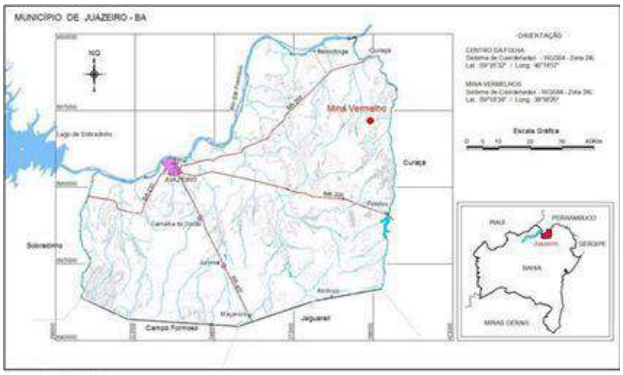

Fig.6 - Map of the Red Mine

Source: INSTITUTO HABILIS (2017)

Still in relation to the Reds Project, the Municipality of Juazeiro, along with SEMAURB (Secretariat that "zela" for the environmental licenses at municipal level), understood that the opening of the road was "public utility" as described in the document published in the DOU.

§ 1º. Todas as coordenadas aqui descritas estão georreferenciadas ao Sistema Geodésico Brasileiro, e encontram-se representadas no Sistema UTM, referenciadas ao Meridiano Central 39° EGr, tendo como o Datum o SIRGAS2000, sendo todos os azimutes e distâncias, áreas e perímetros calculados no plano de projeção UTM.

§ 2º. Respectivas áreas de Servidão Administrativa será em favor do Município de Juazeiro, para fins de ampliação, recuperação e execução de obras da Estrada Vicinal Municipal de ligação entre a BA-210 e a BR-235 e, encontram-se na posse de proprietários diversos.

§ 3º. A Servidão Administrativa ora constituída e declarada está demonstrada conforme áreas representadas nos mapas anexos, que integram este Decreto para todos os fins e efeitos.

Art. 2º. Em decorrência da constituição da presente Servidão Administrativa, ficam declaradas de Utilidade Pública a parte ideal dos imóveis identificados neste Decreto implantação dos serviços públicos de abertura, ampliação e melhoria da estrada vicinal municipal de ligação entre a BA-210 e a BR-235.

Art. 3º. A Servidão Administrativa de que trata este Decreto será registrada no Cartório de Registro de Imóveis desta Comarca, mediante assentimento dos proprietários e possuidores.

Art. 4º. Este Decreto entra em vigor na data da sua publicação.

GABINETE DO PREFEITO MUNICIPAL DE JUAZEIRO, ESTADO DA BAHIA, em 26 de junho de 2018.

Fig.7 - Publication in the DOU - Public Utility Road

Source: DOU - Juazeiro City Hall, Edition 1.251 - 1 Year 6, of June 20, 2018, p. 14-17.

It is public and notorious the misconception that said road is of public utility, since its main objective is the disposal of the copper ore of the Project Red to the matrix of the Caraíba Mining in Pilar, Jaguarari. Thus, it is obviously a private interest, not a public interest, since the understanding of "public utility" means the convenient transfer of private property to the Administration. There is no essential character in this transfer, because it is only

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timely and advantageous for the collective interest. Decree-Law 3.365/41 provides in Article 5 the hypotheses of necessity and public utility without differentiating them, which can only be done according to the criterion of urgency (MEIRELES, 2007).

The most blatant misunderstanding on the part of the municipal public authority was to issue the license for the suppression of native vegetation (according to figure 8) for the construction of this road, not controlling the terrible damages caused to the caatinga biome and its biodiversity.

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RESOLUÇÃO

RESOLUÇÕES

PREFEITURA MUNICIPAL DE JUAZEIRO - BAHIA
SECRETARIA DE MEIO AMBIENTE E ORDENAMENTO URBANO

RESOLUÇÃO SEMAURB Nº 152/2018

Concede Autorização de Supressão de Vegetação Nativa em favor da Pessoa Jurídica CSSA CONSTRUTORA SÃO SALVADOR EIRELI e dá outras providências.

O SECRETÁRIO DE MEIO AMBIENTE E ORDENAMENTO URBANO DO MUNICÍPIO DE JUAZEIRO, ESTADO DA BAHIA, no uso das atribuições que lhe confere a Lei Complementar nº 020/2016, e tendo em vista as disposições contidas na Lei Municipal 1.873/2005 e Lei 1.703/2003 Código Municipal de Meio Ambiente, regulamentada pelo Decreto Municipal 366/2005, e tendo em visto o que consta no processo administrativo nº **10214/2018**, resolve:

Art. 1º - Conceder Autorização de Supressão de Vegetação Nativa, **válida** pelo prazo de **01 (um) ano,** a Empresa **CSSA Construtora São Salvador EIRELI,** Pessoa Jurídica de Direito Privado, inscrita no CNPJ sob nº **11.129.119/0001-85**, para atividade de **Construção de Estrada Pública Municipal**, situado na Estrada Vicinal Rural de Ligação entre a BA 210 e BR 235, Município de Juazeiro-BA.

Fig.8 - Vegetation Suppression License

Source: DOU - Juazeiro City Hall, Edition 1.271 - Year 6 of July 25, 2019, p. 57-74.

Impacts can be viewed with a "naked eye", and any lay people in environmental matters can point out the aforementioned damages caused by the construction of said road, as described later. However, once a simplified environmental license is endorsed, the road is deemed to be of public utility (even if it is of private interest) and that the right to suppression of native vegetation is granted (in one of the most vulnerable biomes such as Caatinga), said company feels protected from any and all legal damages that may be filed by the company, which is harmed and affected by the construction of the rural road.

At that time it is possible to affirm that at the time when the MC S/A accumulates a history of devastation to the Caatinga ecosystem, the environmental authorities of the affected municipalities and the state of Bahia accumulate the impotence to deal with the crimes of this company, since they record facts that it has suffered any penalty or that it has been forced to recompose any affected area.

2.3 ENVIRONMENTAL DAMAGE IN THE PASTE BACKGROUND OF THE COMMUNITY PAREDÃO IN THE SEMIÁRIDO BAIANO

In the Paredão community, it is one of the rural areas that has suffered the impacts punctuated above. Located in the interior of the municipality of Juazeiro, the first expeditions and mineral demarcations also arrived with the "Pignatari", which with government support sought to search areas throughout Bahia to explore copper, gold, or any other mineral. Subsequently, Caraíba Metais (CM), currently, Mineração Caraíba S/A, continued its relentless pursuit.

The Paredão community has been suffering from the environmental impacts of the implementation of the Red Project in the Curaçá Valley, which has the company Mineração Caraíba S/A. At the beginning of the project, all the daily traffic of cars, trucks, buckets and other vehicles was done inside the said community, which began to suffer from the dust promoted by the transport and the high speed of the same, and with the risks of accidents, both with humans and with animals, which during the night period is sheltered near the homes of their owners.

The Community Association of Riacho do Mari/Paredão (ACRM) sought, without success, to dialogue with the company, in an attempt to minimize the risks that were being produced to the community. However, as the company has a habit of respecting only its private interests, it never sought to sit down and dialogue with the ACRM to seek an agreement that would benefit both parties.

In turn, Mineração Caraíba S/A sought support from the municipality, aiming to achieve partnership and irreconcilably intending the simplification of licenses and deadlines, which summarily achieved according to the document inserted in this work.

However, the granting of licenses does not guarantee that the society around the exploration area and the "pasture fund" areas will no longer experience the consequences of socio-environmental damage caused by mineral exploration, on the contrary, it worsens the relationship between man and nature, placing the caatinga as a hostile and inhospitable environment [...] (MARQUES, 2016).

A prominent concept of Grassland Communities is described by Diamantino (2007), where he says:

> One of the most striking features of Fundo de Pasto communities refers to institutional mechanisms for access and use of native lands and pastures created from discursive and customary combinations of rules of use and hospitality reinforced in situations of adversity and pressure exerted on the group, ruling principles of vital utility and shared

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> sociocultural organization (DIAMANTINO, 2007, p.9).

Thus, it is important to mention that the Pasture Fund system is established not by collective intention to define an area of communal use, but by means of common land use regime that develops according to the utility of that portion of the space for survival of the sheep and goat herds and, consequently, of the peasant family itself (MARQUES, 2016). However, in the Paredão community, one of the pasture land areas has suffered several impacts, with the construction of the road (Figure 9) linking BA 210 to BR 236 for the MC S/A copper ore runoff.

Fig.9 -Vicinal Road

Source: Google Earth (2018)

The community has about 4,000 hectares of land, including legal reserves and pasture funds. The whole area is home to the Caatinga ecosystem, with native vegetation and species almost extinct. It also has great diversity of fauna, which has o habitat the dry areas of the white forest. About 12 families live in the community (these are the target of the research), most of them elderly, all descended from the same family tree, which inhabited these lands for more than 200 (two hundred) years.

III. MATERIAL AND METHODS

The present research is classified according to Gil (1999), Andrade (2006), and Cervo et al. (2007), according to their nature, their technical procedures, the approach to the problem and the objectives. Thus, from the point of view of nature, it is an applied research, since it aims to generate knowledge for practical application directed to the solution of specific problems. The approach of the problem is a qualitative research, considering the existence of a dynamic relationship between the real world and the subject, being descriptive and using the inductive method, and the data obtained are analyzed inductively.

With regard to technical procedures, this is a bibliographical one, since it was elaborated from written material already published, consisting mainly of books, e-books, reports and periodicals made available on the Internet. It is also a participant research, where it develops from the interaction between the researcher and the members of the situations investigated, from the direct contact of the researcher with the phenomenon observed to acquire information about the reality of the social actors in their own contexts.

As for the objectives, this research is exploratory, because it involves a bibliographical survey and a dialogue with people who have had practical experiences with the researched problem, and it is also descriptive because it involves the use of standardized techniques of data collection, such as systematic observation, where the facts are observed, recorded, analyzed, classified and interpreted, without the interference of the researcher.

In addition, such research is essentially based on the GTP Theory (Bertrand, Bertrand, 2007) in the Ecodynamic Method (Tricart, 1977), the Walk Method (Filgueiras et al., 1994) and the Discourse Analysis Contents of Bardin (2011).

Field research began in June 2018, with weekly visits in the first two months in loco, for observation, recording, analysis and interpretation of the data. Subsequently, for safety measures visits were sporadic every two months, and were completed in december 2018.

In order to carry out the research, the following materials were used: pen, notepad, Global Positioning System (GPS), camera, community map, and Informed Consent Term (TCLE) of the Riacho do Mari Community Association, authorizing the research.

IV. RESULTS AND DISCUSSIONS

The first impacts of the construction activity of the vicinal road for mineral flow were the suppression of native vegetation causing unprecedented damage. In the results of the research will be observed images that will demonstrate some of the damages caused in the Paredão pasture area due to the opening of the road that, besides Paredão, "cut" innumerable other small localities and areas of pasture belonging to surrounding communities.

https://dx.doi.org/10.22161/ijaers.6734 *ISSN: 2349-6495(P) | 2456-1908(O)*

Fig.10 – Visão da Estrada em Área de Fundo de Pasto do Paredão

Source: Authors (2018)

Figure 10 demonstrates how exaggerated the opening of this road, which in reality is higher than the standard of any highway, whether state or federal, since it measures approximately 12 meters wide.

CONAMA Resolution No. 001 of January 23, 1986, in its article 2 says that:

> It will depend on the elaboration of an environmental impact study and its environmental impact report - RIMA, to be submitted to the approval of the competent state body, and of IBAMA and on a supplementary basis, the licensing of activities modifying the environment, such as: I - Roads with two or more rolling tracks (BRASIL, 1986).

As shown in figure 11, the aforementioned road has a capacity for 4 bearing ranges, which is essential for the EIA-RIMA, with no simplified license, since it has a high impact. Figure 20 will show synthetically other biota damage.

Fig.11 - Mata native of the caatinga biome that was suppressed

Source: Authors (2018)

Figures 11 A, B, C and D show the chaotic situation of the caatinga biome, which had trees that took years to keep alive and resistant to the extreme temperatures in the semiarid, and which were decimated in a few seconds. In A it is possible to see "logs" of wood originating from the catingueira; in B and C wood derived from the fall of umburanas; and, in D pear wood, all species native to the biome. The vegetation that was not cut was knocked down by the root to make room for the road.

A total of 113 small mounds of wood were cut, stacked and stacked on an 18-km stretch of road, within the Paredão pasture. The finding led to the following questions: 1. Will the wood mounds from the suppression be marketed? 2. If so, who has control over them?; 3. Who will benefit from the sale or donation of the same?

It should be emphasized that Article 2 of Resolution No. 001 of CONAMA (1986) states that the licensing of activities that modify the environment, such as "XIV - Economic exploitation of wood or firewood, in areas over 100 hectares or less, when it reaches significant areas in terms of percentage or importance from an environmental point of view "(BRASIL, 1986).

However, in the case in point, the Paredão community did not benefit from the amount of wood heaped on the roadside, which were gradually being driven by strangers or people passing through the area.

In these affected areas, the society-nature relations are present in the communities, and the lands are in common use, considering the maximization of the use implemented by the free grazing of goat breeding sheep and extensive bovinocultura.

The very conditions of adversity in the semi-arid environment gave conditions so that the interdependence between the subjects and the feeling of territoriality were very present in the daily life of the communities, a territoriality that is now threatened by mining.

It is crucial to understand the areas considered "Background of grass" as:

> [...]an experiment in land appropriation typical of Bahian semi-arid, characterized by the

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> production of animals on land in common use, articulated with the use of land and raising goats, sheep or cattle in the communal area, as well as subsistence crops in individual and practical areas of vegetal extractivism. […] (ALCÂNTARA; GERMANI, 2009, pp. 13-14).

There have been countless accidents with animals that cross the road and have their lives cut down by the cars that daily travel at high speed.

Still in the pasture area, 72 catingueiras (*Caesalpinia pyramidalis Tul*) were counted, because of an on-site visit; 08 umbuzeiros (*Spondias tuberosa L.*) felled and/or buried; 22 pinnacle brave (*Jatropha molíssima*) banished; 07 pears (*Aspidosperma pyrifolium*) broken down, according to figure 12 (A, B, C and D).

Fig.12 - Deleted Species
Source: Authors (2018)

In addition, species such an aroeira (Schinus terebinthifolius) and umburana cambão (Bursera leptophloeos), with a considerable stem (with a diameter of up to 1 meter), were also cut to make a profit, to wild capitalism (according to figure 13 A and B). About 23 umberanas were destroyed. The umburana is a typical tree of the Northeast of Brazil, with a variable size of 2 to 6 meters. It has soft and lightwood, much used in crafts. The period of flowering is between September and December, where its leaves and fruits serve as refrigerators for animals in the hinterland.

As Santos says (2010), usually in pasture lands, "common use" areas are surrounded and are close to the foothills and to the water resources, such as rivers and ponds - the refreshments -, ensuring fresh pasture and abundant for the herd that is collectively allocated" (SANTOS, 2010, p.91).

Already aroeira is a deciduous plant, heliófita, selective xerófita, characteristic of dry and rocky terrains; occurs in dense clusters, both in open and very dry formations (caatinga) even in very humid and closed formations. It occurs in the areas of the sertão of Bahia where the rainfall is low (less than 800 mm) and the physiological formation of caatinga or maté acaatingada, always in high lands, being deciduous. It reaches up to 20 meters high in favorable conditions (APN, 2015).

Figura 13 – Madeiras "de Lei" da Caatinga

Source: Authors (2018)

Other species, such as the cacti, known as xique-xique (Pilosocereus gounellei), a species of endemic cactus of the semiarid, and mandacaru (Cereus jamacaru), were also cut off from nature, as figure 14 (A and B).

Fig.14 – Plantas cactáceas da Caatinga
Source: Authors (2018)

The two species of cacti conserve water inside to survive in the dry periods. The small farmer generally uses this species to feed the cattle in times of low rainfall, however, the use of the same occurs in a balanced way, aiming not to decimate the species, since in the drought periods to come, it will need the plant again.

However, it was not only these damages demonstrated to date, the only ones, in the context of the construction of said road, considered a "vicinal road" by the municipal agencies. The following figure (Figure 15 A and B) shows the removal of material (sands) in a stream in the community of Paredão, and the total alteration of the course of the same, aiming at overlapping the road.

https://dx.doi.org/10.22161/ijaers.6734 *ISSN: 2349-6495(P) | 2456-1908(O)*

Fig.15 - Course of a creek altered by the removal of sands

Source: Authors (2018)

Removal of material from backhoes, excavating the existing sands in the course of the stream, called "Mari Creek", and placing the material removed on the road, will consequently alter the flow of the waters of its sub-fluids during the floods, and provoke erosion at the edges of it. To make matters worse, not only the material from the streams, but also from areas completely covered with vegetation was removed, as shown in the following figures (16 A and B).

Fig.16 - Extraction of material for road burial

Source: Authors (2018)

All the excavated material leaves "open skies" where the soil remains bare and the particulate material is left in place when it is not removed and intended for road works. The countless open craters, in addition to causing soil/subsoil erosion, fill with water in the rainy season, and cause small and medium-sized jams and animal deaths, causing even more damage to small local farmers.

Altogether there were 20,945 hectares of suppressed vegetation, an incalculable damage, and impossible to be valued environmentally, given the rich flora lost. What was not visualized by the researchers in any consulted document were the constraints listed by the environmental agency of the municipality of Juazeiro, regarding the environmental compensation concerning the damage caused to the caatinga biome.

The company that causes all the impacts demonstrated (Mineração Caraíba S/A) does not show concern for the reparation of environmental damage, but rather, to compensate for environmental damages with social actions, which differs from what the legislation says. It is valid to clarify that one thing is environmental compensation, another is social compensation, or social compensation.

After verifying the environmental damage caused by the implementation of the road under discussion, the Riacho do Mari Community Association implemented a formal invitation to the legal representative of Mineração Caraíba S/A requesting plausible justifications regarding the absence of dialogue with the Paredão community, victim of the Red Mines Project.

Two meetings were held with representatives of the company, where it was questioned: 1. The reasons why the ACRM was not consulted or informed of the possible socio-environmental damages that would be suffered by the construction of the road; 2. Why did the company not formally inform the objective of aerial monitoring carried out on the community, from aerophotogrammetry with probes? 3. Why was the company looking for individual owners for "exchange of favors" and/or social, non-environmental, and collective compensation?

These and other inquiries were not appreciated by the company, which decided to no longer dialogue with the representatives of the Community Association, implying that it had no intention of bearing the environmental consequences, much less, to carry out a PRC Caatinga) in the Paredão pasture area.

By refusing to continue dialogue with the residents, legally represented by the association, what position should the Paredão community take? 1. Seek dialogue (only formal - legal and via association/representatives); 2. To leave aside the exchanges of individual favors (environment is patrimony and the people who inhabit it have a duty to care); 3. To revoke any and all informal authorization by signing documents of one or the grantees (the territory that is surrounded is of each owner, however, what is not surrounded is common to all, and of collective use, thus characterizing area of grass background); 4. Avoid accepting "individualized improvements", so as not to strengthen the spirit of competitiveness and territorial disagreements; 5. Finally, understand that environmental damage cannot be "compensated only by social actions", but rather, should follow environmental legislation.

In this sense, activities and undertakings that use environmental resources, as well as those capable of causing environmental degradation, depend on prior environmental licensing, in accordance with the provisions of Law 10,431 of December 20, 2006 and its regulations. The exploitation of deposits (rock, sand and special soils) should be considered in the analysis of the

https://dx.doi.org/10.22161/ijaers.6734 *ISSN: 2349-6495(P) | 2456-1908(O)*

road or highway project and when not contemplated in said project will be subject to specific licensing.

It is worth mentioning that the main socioenvironmental damages caused to the population of Paredão and its surroundings were:

1. To health (dust / soot);
2. Security (proximity to strangers who travel inside the inhabitants' lands);
3. Malaise of the population (due to dissatisfaction and lack of respect for a centennial community in the region);
4. As atividades sociais e econômicas estão prejudicadas (pecuária – caprinos, ovinos e bovinos afugentados);
5. To biota (accidents involving domestic and domestic animals);
6. Birds scared by the noise and movement of cars;
7. The aesthetic and sanitary conditions of the environment (in calamity - vegetation covered by dust, without photosynthesis, without evapotranspiration) as it is possible to see in figure 26;
8. Risks of erosion and silting during and after the operation;
9. The quality of environmental resources is totally compromised.

Therefore, an Environmental Impact Assessment (EIA) is indispensable, which is defined as a set of procedures capable of ensuring, from the beginning of the process, a systematic examination of the environmental impacts of the project and its possible alternatives, as well as, that the results thereof are presented in a manner appropriate to the public authority and society (CUNHA; GUERRA, 2009).

Fig.26 - State of the tree due to the dust of the car flow
Source: Authors (2018)

In this sense, art. 20, inc. IX, of the Federal Constitution, affirms that mineral resources are Union assets, and that research and development of such resources can only be made through its authorization or concession (article 176, paragraph 1), being common competence of the Union, States, Federal District and Municipalities, to register, monitor and supervise the concessions of rights of research and exploitation of mineral resources in their territories (article 23, XI, CF).

Based on this, the Mining Code (Decree-Law No. 227 of February 28, 1967), in relation to the environment, provides in its art. 47, that it is incumbent on the mining company to respond for damages and losses to third parties, resulting directly or indirectly from mining (inc. VIII), and to avoid pollution of the air or water that may result from mining work).

Therefore, it is incumbent upon the municipality of Juazeiro, which granted the license for the construction of the road, to follow up and inspect the damages, aiming at the implementation of a PRAD that will mitigate all damages caused in the focus area of this study. To the community harmed by the environmental damages practiced by the mining company, it is the role of understanding that it is everyone's duty to take care of the environment, for the healthy quality of life.

V. FINAL CONSIDERATIONS

This research, aiming to meet the objectives and based on the adopted methodology, comprised the ecodynamics of the studied landscape in the Paredão Community in the north of the State of Bahia, identifying the processes of environmental degradation provoked by the mineral exploration, besides analyzing the levels of stability of the system environmental, discussing forms of conservation of this biome, which is a representative of the climatic characteristics of the Brazilian semi-arid.

Regarding the observations and analyzes made, it was verified that the studied area is highly degraded, considering the environmental impacts present in the investigated geosystem, based on the precepts of Tricart (1997), where, in turn, it was verified that the research area is classified in the stable, intergrades and highly unstable areas and, because of this, it is necessary an urgent awareness regarding the management and territorial planning of the area.

Finally, this research does not have a conclusive character and it is not intended to exhaust all the debate on the subject in focus, considering the relevance of this discussion in the present days and in the scope of the management and organization of the environmental territories, taking into account that ecosystems, especially those of caatinga, are changeable both by their natural dynamics and by the social dynamics that surround it. Therefore, research and debate continue beyond the end of this article.

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Lean Production System Applied to a Liquid Fertilizer Industry

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Abstract *— The reduction of production costs is currently a subject much sought after by companies. The Toyota Production System was the first program to be produced through a demand that was able to raise the quality level of the products, working with zero inventory, generating greater sustainability in the Japanese automotive business. The technology industry in plant nutrition has been growing in recent years in Brazil, with more than 450 companies in the segment and producing a turnover in the order of R$5 billion reals. The objective of this work was to apply the methodology of lean manufacturing in a liquid fertilizer factory. After application, the production time was reduced by 33% and the productive capacity was doubled.*

Keywords *— **Lean manufacturing, fertilizers, costs reduction, improvement process, Toyota Production System.***

I. INTRODUCTION

The implementation of techniques that provide higher productions with lower costs is of paramount importance for the survival of the business. The argument of lean production was adopted by Japanese organizations in the 1940, and generated new procedures for production excellence, which brought significant results: reduction of unit costs, variety of products, quality improvement and multipurpose employees. Several studies have shown that the lean production model introduced by Toyota is the successor to the traditional Fordist model of mass production, which can be applied in any business environment (FAVONI *et al*, 2013).

Lean manufacturing is one of the most widely adopted methodologies in the largest companies in the United States. In addition to increasing productivity, it can also make organizations more competitive on a ever-growing global market (ABDULMALEK & Page 5 In the academic environment, it has been identified that the total or partial implementation of some concepts or techniques of lean production, such as: Map of Value Flow, Standardized Work, Total Preventive Maintenance, Rapid Tool Change, Total Quality, Kaizen, among others, ensured better results and greater savings in production processes, as well as operational gains and business performance (FAVONI et al, 2013).

The application of LM consists in the union of continuous actions that aim to adequately specify the profit from the perspective of the final customer, excluding activities that generate waste and organizing the ones that generate value to happen in a flow driven by demand (SCHELLER, MIGUEL, 2014). For a better structuring of the scope of lean production, the use of the Kaizen methodology allows for a greater operational gain, which results in financial benefits (GONÇALES FILHO; PIRES, 2017).

Since the beginning of lean manufacturing practices, the program has usually been of interest to entrepreneurs and researchers. However, companies were not always successful in implementing lean production. Some essential points, such as the lack of guidance and planning, omitting the fact that LM is a long-term task, are highlighted by several authors, which is generally condensed in the absence of a strategic perspective for its implementation (MEDEIROS et al, 2016).

Initially developed and deployed in the automotive sector, many of the LM tools have been transplanted to other segments, such as the electronics and consumer goods industry (ABDULMALEK and RAJGOPAL, 2006). For the footwear sector, it was not different since it presents a manufacturing model and industrial environment consistent with the practice of lean production. (SANTOS et al, 2017).

The plant nutrition technology industry is a niche not yet explored by lean production systems. However, it represents a great participation in the development of the country having 459 companies in the segment that generated more than 17 thousand jobs and a turnover in the order of US$ 1,4 billion. In addition to US$ 78 million invested in R&D in 2016 (ABISOLO, 2017).

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With the market rising with a growth rate of more than 26% between 2014 and 2016, the implementation of lean manufacturing in the production of special fertilizers can be a growth factor for companies of all levels. Therefore, the continuous improvement program based on the Toyota Production System, and carried out through tools such as Kaizen, can provide the industry with: reduction of waste and the ergonomic risk of employees, increased productivity and business competitiveness.

In this context, the objective of the present work is to apply the methodologies of Lean Manufacturing through the tools Brainstorming, diagram of cause and effect, chronoanalysis and 5W2H in a factory of liquid fertilizers that carry out hot process, in which there was a high investment for the increase of productive capacity. Nonetheless, with no real return, where current practices did not meet the expectation of volume expansion expected by the company's management.

The scenario before the investment had a reactor of 2.2 m³ coupled to a cooling tower that conditioned it to do 3 batchings per day, or 6.6 m³. With the high market demand, the company's board of directors invested in a 5 m³ equipment, expecting to produce 2 daily batches, 51% more than the previous model. However, without having modified the cooling system, the high temperature generated in the manufacturing process of liquid fertilizers couldn't be controlled efficiently causing a production 50% smaller than expected. Consequently, without financial support to acquire a new system, lean manufacturing was the best alternative to solve the problem.

II. LIQUID FERTILIZERS

For a production of fluid fertilizers, it is possible to highlight the processes that are most used for the manufacturing of solutions or concentrated suspensions, being themselves the mixing process (hot-mix) and the cold-mixing process.).

O-hot-mix is what known as a source of energy, like the energy of a heat source, this being an exothermic reaction, exemplified in Fig. 1 (BICHARA, 1990).

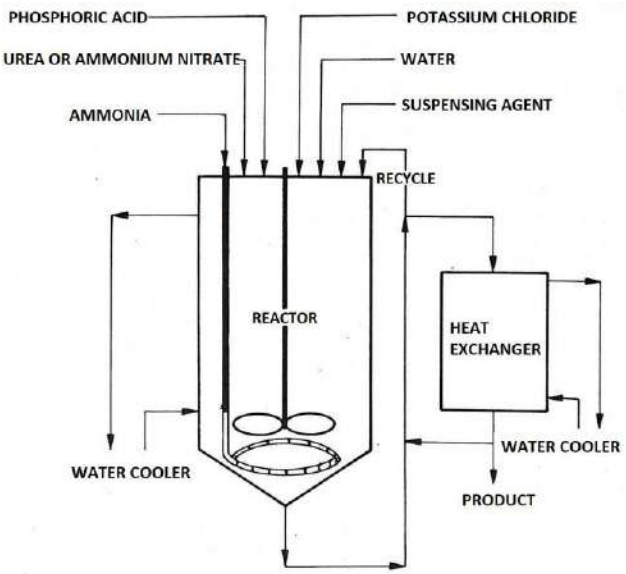

Fig. 1: hot-mix process.

The cold-mix, however, does not generate energy in the form of heat, contextualizing itself only in the mixture of components without exothermic reactions.

III. MATERIALS AND METHODS

3.1 Brainstorming

Brainstorming is a method of group work that assists in the emergence of new ideas about a certain subject (or problem). In addition, the tool can also stimulate the team's creativity, which generates a number of solutions to the issues in question.

The brainstorming structuring model consists of 5 main steps: presentation of the problem, free presentation of ideas, writing of ideas, reformulation of ideas, and evaluation of proposals.

Beyond this path, it is important to emphasize that a leader should be chosen to moderate the meeting and that the environment should be light, without excessive control by the coordinator (POSSARLE, 2014).

3.2 Cause and Effect Diagram (CED)

The DCE consists of a fishbone style chart, where the central axis (arrow) points to the consequence of the causes, which are represented by the ramifications of that axis. Commonly, the elements of the causes are: labor, environment, machinery, method, materials, and measure.

For elaboration, the following steps should be followed: definition of the problem to be analyzed, a survey of all causes and, finally, to present these data through the suggested model for this tool (COLENGHI, 2003).

Once you have the problem at hand, brainstorming is necessary, as it will ensure accuracy in determining the

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causes. Along with others, organize them in their respective categories.

3.3 Study of AV and NVA times and activities

Time study is one of the most used methods in factories to measure work. This tool helps to measure individual efficiency, with the objective of establishing standards for production and greater control of industrial costs.

The application of this tool can be done through the letter of AV and NVA. An AV is an activity that adds value, that is, an operation that the final customer would pay the company for it. Therefore, NVA, defined as activity that does not add value, would be the one that the end customer believes is costly.

In the industry there is still the VSA activity, which would be the activity that has a semi-aggregate value. In this case, we would consider a VSA a task that can become VA by investing in machines and equipment that would reduce process time.

The presentation of this parameter can be performed through a chart or graph control, demonstrating the percentage or numerically the times of VA, NVA and VSA. This allows a strategic view of production and can serve as a basis for taking actions (MARTINS, 2005).

3.4 5W2H

This tool is a document that, in an objective way, defines actions and responsibilities of those who will perform, through questions (5W2H) that has the ability to guide the activities that should be implemented.

The 5W questions are: what, why, where, when, who, who, in Portuguese, represent: what, why, where, when, and who. And at 2H: how, and how much, what, the same way, how and how much it will cost (POSSARLE, 2014).

This method can be presented through a table, with the questions to be answered, actions to be taken, responsible for it, area in which they will be executed, when and how they will be executed and what the cost of this action will be.

3.5 Benefit / Cost Ratio

The benefit / cost ratio is an indicator to verify how much the company has obtained for each R$ 1 invested. This is will calculated by adding up all the financial returns that the company will achieve in 1 year divided by the sum of the investments made.

IV. RESULTS AND DISCUSSION

After the execution of the brainstorming process, a cause analysis was carried out through the cause and effect diagram, determining the root problem, being the low daily production, which is caused by the high time to formulate the product according to the activities described in Fig. 2.

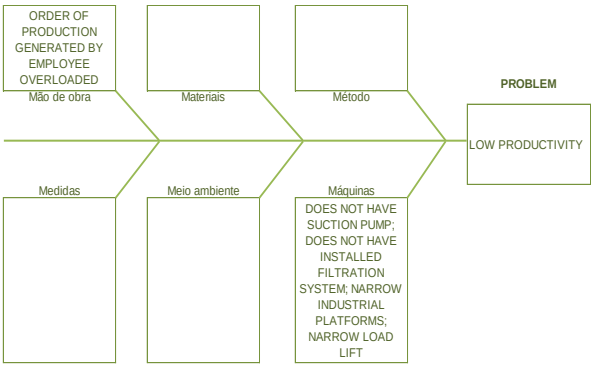

Fig. 2: Cause and Effect Diagram

For this time study, we used the tool applied cronoanálise determining NVA, and obtained the result shown in Figure 3.

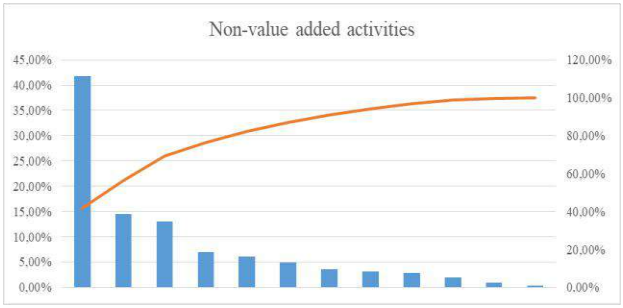

Fig. 3: Pareto chart for non-value-added activities

In this context, it is possible to verify that the activities that will take time for the formulation of the product are: filtration of the finished product and search and placement of sacks of raw materials. Figure 4 shows the activity mp1 positioning in the cargo elevator, which was performed manually by moving 25 kg bags, totaling 3 tons, which represented 15% of the NVA.

Fig. 4: sacks positioning mp1.

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Table 1 describes all the activities of the product formulation process in question before the improvements implemented with their execution times. Thus demonstrating that the production stage is 63.4% of activities with value added (VA column), and a total percentage of 21.5% for no added value, (NVA column). In the industry and lean manufacturing projects, it is adopted a value of 88% to 12% for VA and NVA. The average times of standard deviation was 0.25.

Tab. 1: time formulation process before improvement

Sector	Activity description	activity time (min)	Before improvement		
			VA	VSA	NVA
Production	Making of Production Order	4.83			4.83
Production	Water supply	17.32	17.32		
Production	Installation of the water transfer pump	5.50			5.50
Production	Search reuse water container	0.50			0.50
Production	Pump Assembly Transfer MP	4.33			4.33
Production	MP Search	22,10			22,10
Production	MP weighing	9.26			9.26
Production	Addition of water to the solution mp1	10.66	10.66		
Production	Addition of water to the solution mp2	6.46	6.46		
Production	Search tools	1.50			1.50
Production	mp3 addition	15.62	15.62		
Production	sacks positioning of mp1	20.03			20.03
Production	mp1 Adding to the tank for preparing the solution	30.05	30.05		
Production	mp4 pumping	25.01	25.01		
Production	Mont. the siste. adding the solution to the reactor mp1	10.63			10.63
Production	MP2 adding to the solution preparation	7.00	7.00		
Production	Addition of the solution mp2 the reactor	115.75	115.75		
Production	Weighing the MP5	2.96			2.96
Production	Addition solution MP2 and MP5	6.32	6.32		
Production	Product cooling	30.00	30.00		
Production	Mount PA transfer pump	7.43			7.43
Production	Filtration and PA transfer	64.00		64.00	

The total measurement time was 6 hours for the formulation of a volume of 5 m³. Although the sum of the times has a value close to 7 hours of work, it is important to note that some activities occur simultaneously. Considering a shift of 8h45min, which is conducted by the company, the production is defined in that volume. So it was defined an action plan based on 5W2H methodology, where the goal was to reduce the times of the three items with greater delays in the manufacturing sector so that it is possible to produce at least 10 cubic meters per day, according to Table 2.

Tab. 2: Action plan

What?	Who?	At where?	When?	Because?	As?	How much?
Increase the lift platform	plant engineer	Production	Aug / 18	To facilitate the positioning of the sacks via forklift	Contact service provider	R $ 15,250.00
Adiquirir filter and pump with proportional flow the need	plant engineer	Production	Aug / 18	All in process	Contact pumps and filters suppliers	R $ 19,520.00
Redesigning the platform	plant engineer	Production	Aug / 18	To facilitate the positioning of the sacks via forklift	Contact service provider	Included in item 1
Perform production planning	Production manager	Production	Aug / 18	Plan a day before what will be produced the next day	Conduct training planning and production control	R $ 800.00

After the completion of the improvements, then given another the deadline, another cronoanálise was done with the results being presented in Table 3. The reduction of activity by 50% (22 to 11) by automation of some processes and also to reduce the time from other movements, caused a lean and without waste environment, focused exclusively on producing. It is observed that, with the changed process, the activities represent 84% VA (VA column), VSA, 14% (VSA column) and finally NVA (NVA column), only 2%.

Tab. 3: time formulation process improvement after

Sector	Activity description	activity time (min)	After improvement		
			GO	VSA	NVA
Production	adding mp1	15.33	15.33		
Production	Search materials	1.43			1.43
Production	rest of weighing mp1	1.49	1.49		
Production	preparation mP2	22.73	22.73		
Production	adding mp3	27.0	27.00		
Production	mp3 line cleaning	5.00			5.00
Production	Cooling the primary mixture	22.0		22.00	
Production	adding mp4	9.0	9.00		
Production	adding mP2	110.0	110.00		
Production	Cooling final product	44.0	44.00		
Production	Filtration and pumping	15.0		15.00	

Figure 5 shows the activity after new improved positioning mp1, where the pallet is placed feedstock directly via forklift in the cargo elevator, unlike what is shown in Figure 7, where the position was manual.

Fig. 5: sacks positioning mp1.

https://dx.doi.org/10.22161/ijaers.6735 *ISSN: 2349-6495(P) | 2456-1908(O)*

Figure 6 shows the comparison between the AC and NVA activities as a function of time (minutes), the formulation process before and after improvement.

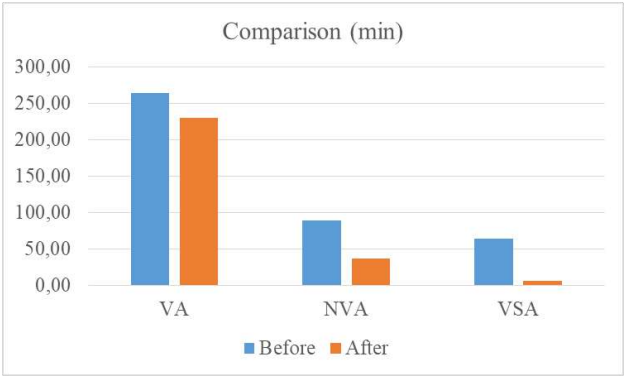

Fig.6: Graph comparison between VA and NVA VSA before and after the improvements

Thus, the total time for product formulation was increased to 4 hours, which allows the production of 10m³ per day, in turn 8h45min. The evaluation of the benefit / cost can be performed taking into account that 1 liter of product that generates an average income of R $ 3.00, a production 5m³ more than was installed per day, 20 days a month and 12 months a year, resulting in a return of R $ 101.20 for every $ 1.00 invested, as the following equation:

$$\frac{B}{C} = \frac{\left(average\ revenue\ \frac{product}{L} * production\ increase\right) * \left(\frac{days\ worked}{month}\right) * \left(\frac{month}{year}\right)}{project\ cost}$$

$$\frac{B}{C} = \frac{\left(\frac{R\$3,00}{L} * 5000L\right) * \left(20\frac{days}{month}\right) * (12\ month/year)}{R\$35.570,00}$$

$$\frac{B}{C} = \frac{R\$3.600.000,00}{R\$35.570,00} = R\$101,2\ or\ US\$25,00$$

V. CONCLUSION

The present study showed lean manufacturing tools applied to a liquid fertilizer industry, which, until then, it comes as an innovation since it was not found in the literature reports of applying such a tool in this market segment.

Given the above, it is concluded that the lean manufacturing in plant nutrition technology industries is extremely feasible because culminated in the production achieving the goal of 10 m³ / day, reduction of non-value-added activities in 92.8% reduction production time by 33%, and consequently, in the cost / benefit analysis yielded a return of R$ 101.20 for every R$1.00 invested. You might even notice a better ergonomic working condition, since it has reduced the absolute number of activities, especially those weight transportation demanded by the employees.

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Blockchain Technology applied to Education

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Abstract *— The purpose of the present work is offer an implementation of a private blockchain infrastructure for data storage, specifically the certificates of completion or participation issued by the Federal University of Tocantins, Campus Palmas-TO, Brazil, aiming to avoid their falsification by means of validation using hashing. Some institutions, such as the Massachusetts Institute of Technology and Holberton School in San Francisco, use Bitcoin's public blockchain to maintain and validate their certificates, but paying fees for each operation. The blockchain implementation adopted for this project is Multichain, a solution that, because it is open source, reduces deployment costs, facilitates its installation and maintenance of its infrastructure, and doesn't request the payment of any fees for information storage. Because of its security features and transparency in data storage, Blockchain has been used in a number of technologies, such as the Bitcoin cryptocurrency, smart contracts, shared economy, corporate governance, intellectual property protection, Internet of Things (IoT), management of identity, among others, and also in education, focus of this work.*

Keywords *— **education, technology, blockchain, cryptography.***

I. INTRODUCTION

Blockchain is a distributed database technology that allows maintain a growing list of records, called blocks. Each block contains a creation date and time information and a link that points to a previous block. A blockchain is typically managed by a peer-to-peer network that uses a specific protocol to validate new blocks collectively (ANTONOPOULOS, 2010). By design definitions, blockchains are inherently resistant to unauthorized modification of their data. Once recorded, the data in any block can not be changed retroactively without changing all subsequent blocks and validating the entire interconnected block network.

Functionally, a blockchain can serve as an open and distributed ledger that can record transactions between two parties efficiently and verifiably. The ledger can also be programmed to trigger transactions automatically (WATTENHOFFER, 2016). The first blockchain was conceptualized by Satoshi Nakamoto in 2008 and implemented in the following years as the main component of the Bitcoin, where it serves as a public ledger for all transactions related to this cryptocurrency (NAKAMOTO, 2008).

Blockchain solutions applied to education are present in institutions such as the Massachusetts Institute of Technology and the Holberton School in San Francisco, where the storage and delivery of certificates issued are made using the public blockchain of Bitcoin, by means of payment of a small amount to each certificate generated, as a measure to avoid forgery of these documents. In this work, a private blockchain (Multichain) is used as a repository of the certificates issued by the Federal University of Tocantins (Brazil). Multichain is an open source version of blockchain, becoming a more economical alternative for the institutions that adopt it, generating reliability, security and transparency in the storage of its digital assets.

II. MULTICHAIN BLOCKCHAIN AS A SAFE REPOSITORY FOR CERTIFICATES

Private blockchains are inherently faster than public ones, since in private versions real decentralization is not required and its participants do not need to mine blocks of data, but instead only validate transactions (GUEGAN, 2017). In any case, it should be noted that private blockchains have their applicability restricted to certain situations, and, in the same way, the public ones (GARZIK, 2015).

Holberton School in San Francisco, a software development school that offers project-based education as an alternative to college courses, has used Blockchain to store and deliver its issued certificates. This strategy is seen as a measure to prevent the use of counterfeit certificates. Encryption and two-factor authentication are used to create, sign, and add certificates to the blockchain database. The school still gives paper copies of its certificates to its students, but a Decentralized Clearing Number (DCN) for certificates is generated by the system and allows authentication by employers (HOLBERTON SCHOOL, 2015).

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The Massachusetts Institute of Technology (MIT) has also adopted Blockchain to issue its certificates through a project called *Blockchain certificates* (MIT MEDIA LAB, 2016). The project consists of a set of tools that allow storaging and management of digital credentials. An open source initiative developed by the same institute is available for use by any interested party, including for commercial purposes, at http://www.blockcerts.org. The Blockcerts community provides open-sourcing, ready-made software libraries, tools and applications that enable the implementation of decentralized, standardized and secure computing ecosystems through Blockchain and related technologies. Some examples of institutions using certificates created and maintained with tools from the Blockcerts community are: MIT itself (certifying its students), the Learning Machine company (which generates certificates for its employees), and the Mexico City Laboratory, which certifies participants in their workshops (BLOCKCERTS, 2016).

Another educational institution that adopted certificates stored and managed in blockchains was the University of Nicosia, which reports that no other technology, other than Blockchain, was used for the project, so that any individual can authenticate certificates issued by the university without contact with the institution, and the records, because they are distributed, will remain available even if the institution website is out or the university no longer exist (UNIVERSITY OF NICOSIA, 2016).

Blockchain technology is a kind of distributed database designed to process and store transactions. And while most of today's blockchain implementations are used in financial operations (TOKENMARKET, 2018), such infrastructures serve to store various digital assets, such as timestamps of documents and files.

In terms of access privileges, blockchains can be classified in public and private. A public blockchain is one in which there are no restrictions on reading data from blockchain or even for inclusion of transactions in your infrastructure. One of the most famous examples of public implementation of blockchain is the Bitcoin cryptocurrency. In contrast, private blockchains require, through access control, certain privileges for specific users, both to read the data in the blockchain and to include new data, ie transactions (GARZIK, 2015).

Another classification applicable to blockchains is the permission to validate blocks that will be inserted in the network. When the blockchain is configured so that only certain users have block validation privileges, this blockchain is called permissioned, that is, it has permission rules. On the other hand, when block validation can be done by any user of the network, there is a permissionless blockchain, that is a network where anyone interested can join and mine data. Again Bitcoin figures as a notorious example of permissionless blockchain (GARZIK, 2015).

A performance difference between permissionless and permissioned blockchains is that the first ones use algorithm-based mining, such as Proof of Work (PoW), which requires miners computational power and slows it down than permissioned blockchains. Private blockchains do not need mining based on computational power to reach the consensus of the transactions generated by their users, since they are all previously registered in the system and for this reason, known and with guaranteed mining powers (ANTONOPOULOS, 2016). Some consensus algorithms commonly used in permissioned blockchains are RAFT, Paxos and PBFT.

Other relevant issues to consider when choosing which type of blockchain to use are data privacy, the entity responsible for the network, scalability and access control. In public blockchains data are accessible by any interested party, and if this is not desired the ideal is the adoption of a private blockchain. However, when choosing it, there must necessarily be a centralizing entity, which will maintain the network and take the decentralized operation, characteristic typically belonging to public blockchains. As far as scalability is concerned, permissioned blockchains are better scalable in relation to permissionless because they do not need incrementally computational power to process their transactions. Finally, if the goal is refined access control, again the best choice would be for private and permissioned blockchains, which assign user-level privileges to read and write data, and at the level of miners, for validation of blocks (ANNAMALAI, 2016). For the project of this work the choice for blockchain private and permissioned is the open source solution Multichain (www.multichain.com).

Multichain is an open source platform for creating private blockchains. The user is allowed to define parameters of the blockchain to be created, and the technology, in turn, allows the storage of several types of digital contents, called assets. The platform is available for download and installation on Windows and Linux machines, and its source code can be accessed at Github, specifically at https://github.com/MultiChain/multichain. Multichain extends Bitcoin's Application Programming Interfaces (APIs) and has a similar protocol and transaction format. A Multichain client node can act as a node for the Bitcoin and Bitcoin test networks.

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For blocks created using Multichain, the protocol allows creators to determine which permissions a new entrant will have without needing to receive them directly from one of the network administrators. When blockchain is started, its creators determine the powers of the administrators, as well as whether any interested party can connect, without restriction, to the network. Administrators can also dynamically control permissions for specific users of the blockchain while it is running. These permissions include sending, receiving, and creating actions (assets), as well as creating blocks. Subsequent decisions to change permissions are made by consensus among administrators. The proportion of administrators who must accept user privilege modification is set before the blockchain goes live.

Because of its private blockchain behavior, Multichain solves data mining and privacy issues through integrated access control to the solution itself. The solution is: a) ensure that any activity in the blockchain is visible only to authorized participants, b) permit privileges and definitions of which transactions are allowed on the network, and c) allow mining to occur without Proof of Work (PoW) and therefore, computational and energy resources do not need to be allocated. In addition, Multichain allows multiple blockchains to be deployed on the same server and multiple servers work together to maintain the network.

Another aspect taken into consideration for the choice of Multichain as a solution to be adopted for this project is that it derives (via fork) from the Bitcoin blockchain official code, and therefore its maintenance and updating are practically transparent to the community of developers, resulting in better scalability and greater compatibility with existing standards and infrastructures.

The first step in using Multichain is to install it on any available server computer, from the Internet address https://www.multichain.com/download-install/, respecting the requirements below:

- Linux: 64-bit; Compatible distributions: Ubuntu 12.04+, CentOS 6.2+, Debian 7+, Fedora 15+, RHEL 6.2+.
- Windows: 64-bit; Supported versions: 7, 8, 10, Server 2008 and later.
- Mac: 64-bit; Compatible Version: OS X 10.12.
- 512 MB of RAM or higher.
- 1 GIGA of disk space or higher.

For this work, it is assumed that the server computer to be used for installation and configuration of Multichain technology it is a Linux Mint 64 bit, version 18.3 codenamed "Sylvia", with 16 GIGA of RAM and 1 TERA of space in disk. In Figure 11 there is the sequence of steps to be performed for installation and use of Multichain.

The installation of Multichain is done in a traditional way for Linux environments. First it is necessary to download the desired package, extract it and copy the binaries from Multichain to the /usr/local/bin directory. After installation is necessary create one or more blockchains by running the utility "multichain-util" (followed by its parameters). When this command is executed, the message "Blockchain parameter set was successfully generated. It possible edit it in <path>/.multchain/chain1/params.dat before running multichaind for the first time", signaling that the new blockchain was created successfully and indicating the path to your configuration file (params.dat) which can be modified with the use of a traditional text editor such as Vim. Params.dat is a properties file that has several keys followed by their values.

Once the blockchains have been created, they can be started with the *multichaind* utility (followed by their parameters). If high network availability is a goal, other servers may be added to the blockchain. This procedure is done by generating a wallet number (which will identify the new server in the network), with the authorization of the new wallet of the blockchain main server, and finally with the connection of the new server to the network.

Multichain technology allows user commands to be sent at their own prompt through an interactive mode, available through the *multichain-cli* utility. The following listing demonstrates some executable commands of Multichain, also, in interactive mode, that aim to facilitate its use:

- getblockchainparams: Displays a list of blockchain parameters (from the params.dat file).
- getpeerinfo: Displays a list of clients connected to the blockchain.
- grant: Gives permissions to node addresses.
- revoke: Revokes permissions from node addresses.
- listpermissions: Displays a list of permissions that have been explicitly granted to node addresses.
- liststreams: Displays a list containing all the streams in the blockchain.
- listblocks: Displays a list of the blocks in the blockchain.
- getnetworkinfo: Displays a list containing network information, such as the port to which the node is connected, as well as its IP address.

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- getinfo: Displays general information about the node where the command was executed and about the running blockchain.
- help: Displays a list of commands available to the user.

Streams in Multichain allow the blockchain to be used as a repository of files, providing timestamping, notarization, and immutability. A Multichain blockchain can contain numerous streams, where the data stored in them will be stored, therefore, on all the nodes that hold the network. Each stream in Multichain is an ordered list of items, where each item has the following characteristics:

- One or more publishers who have signed the item.
- A key with a size between 0 and 256 bytes.
- Information about item and block transactions.

The creation of streams respects the access control built into Multichain. It is possible, for example, create streams that only accept information sent by users with write privileges. It is frightened that stream names are case-sensitive and can not be repeated in the same blockchain. In Multichain, uploading files to a stream is called *publishing* (items), and *subscribe* is the operation that results in access to the stream and, consequently, to your items.

In the case of the certificates issued by the Federal University of Tocantins (Brazil), the hash of the certificates will be recorded in streams of the same chain, using the algorithm SHA256. Subsequently, if any interested party wishes to confer the authenticity of the certificates, it may do so through the following operations: generate a hash of the certificate to be validated and compare the hash generated with the hash in the blockchain.

III. CONCLUSION

Blockchain is one of the most advanced technologies of the present time, mainly known for being a digital mesh behind the famous Bitcoin cryptocurrency. Blockchain works as a safe database of records, shared by users and devices from all over the globe, connected together in a large distributed network.

In this work was explained the creation of a private blockchain for use at the Federal University of Tocantins (Brazil) with the primary objective of storing the certificates issued by this institution, as well as their hashes, so that any public can validate both in order to avoid the possibility of forgery.

In United States, MIT - Massachusetts Institute of Technology and Holberton School in San Francisco have similar projects and pay fees to store their records in the public Bitcoin Blockchain. This project offers a solution based on private and permissioned blockchain using an open source solution, ensuring the scalability, compatibility and low cost implementation for the Federal University of Tocantins (Brazil).

Public blockchain implementations generally are decentralized, while the private versions have an owner deciding which users and devices are allowed to join the network under predefined access privileges. Furthermore, the solution explained in this paper doesn't use Proof of Work (PoW), what means that isn't necessary allocation of computational assets and high spending of electrical energy for the mining process, resulting in efficiency in the use of resources.

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Application of an Assessment Model for Potential Products with recognised Indication of Origin in the Production Chain of Wooden Truck Bodies in Itabaiana, Brazil

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Abstract*— *The present article is aimed at showing the result of applying a model developed for assessing potential products with recognised indication of origin (Indicação de Procedência – IP, in Portuguese) registrations in Brazil. This model was applied on the production chain of wooden truck bodies in the municipality of Itabaiana, in the Brazilian State of Sergipe. This model is based on Bibliographic, Documentary and Delphi research methods. Its application consists of 3 (three) steps: 1 – Product Characterisation (CP), 2 – Preliminary Investigation with specialists (IPE) and 3 – Definitive Documentary Research (IDD). The product studied exhibited a historical, cultural and economic connection with the producing region, besides an 8.3 average degree of agreement, measured using the phrase completion scale proposed in the model, based on the opinion of specialists; thus, confirming the medium-to-high potential for applying for the IP registration through the competent body in Brazil.

Keywords*— *indication of origin, potential products, truck body, Itabaiana, assessment.

I. INTRODUCTION

An indication of origin (*Indicação de Procedência* – IP, in Portuguese) is defined in the Brazilian Industrial Property Law (*Lei de Propriedade Industrial* – LPI, in Portuguese), in article 177, as a type of geographical indication (GI) showing the geographical name of a country, city, region or location of its territory which has become known as the centre for extraction, production or provision of a specific service [1]. The Brazilian government currently recognises and establishes the growing importance of such GIs, either with an indication of origin (IP) or a denomination of origin (DO), to the country's economy through Normative Instruction (IN) 95/2018 from the National Institute of Industrial Property (INPI). Therefore, the search for potential products to be granted these labels is of paramount importance to the regional development in Brazil.

In Brazil, more IPs are usually granted when compared to DOs, as the registration process of the latter is more complex, requiring more thorough technical studies. The greater flexibility of the registration process of IPs is seen as a great opportunity for rapid expansion, with more special attention needed for this type of GI.

When mapping potential products to be granted indications of origin, a historical-cultural survey is carried out to identify information and corroborating elements of the region's notoriety as a producer or service provider. This survey serves as a form of recognition of a local reputation or a relationship between the product and its origin. Thus, it is strictly important to search for concrete evidences of this recognition, in order to effectively follow the application for recognition through the competent entities [2].

In this context, the present work investigated the potential for IP labels of wooden truck bodies produced in the city of Itabaiana, in the Brazilian State of Sergipe. According to the Brazilian Institute of Geography and Statistics (IBGE), this municipality is located in the central Agreste region of the State of Sergipe, with an area of 337,295 km^2, and a population of approximately 95,196 inhabitants and a GDP (Gross Domestic Product) *per capita* of R$ 15,449.45 [3].

The city is notorious for the high number of existing trucks, approximately 3,293; a figure only overtaken by the capital city of Sergipe, Aracaju, which has 5,941 trucks registered. Approximately 16% of the fleet of the State of Sergipe, which consists of 75 municipalities, is registered in Itabaiana [3].

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The research was carried out by applying model for assessing products with a recognised IP, based on Bibliographic, Documentary and Delphi researches.

II. METHODOLOGY

The method used for assessing the potential of the product wooden truck body with a recognised IP adopts the following basic concepts: **Product Grant, Legal and Institutional Requirements, and Proof of Indication of Origin,** as shown in Fig. 1.

Fig 1. Basic concepts for the IP model and background literature.

Basic Concepts	General Definition	Background Literature
Attributes	General characteristics of products that justify the assessment.	Cerdan [4], Dullius [5], Ma et al [6], Zheng et al [7].
Legal and Institutional Requirements	Aspects of the legislation applied to the IP and for institutional support, i.e., governments, companies or entities interested on IP registration.	Lei nº 9.279/96[1], IN 95/2018 [8], Valente [9], Silva et al [2].
Proof of IP	Collection of corroborating documents required for IP registration through the competent entity.	IN 95/2018 [8], Valente et al [9], Silva et al [2].

Source: Prepared by the authors (2018).

The procedures for collection/measuring highlight the basic concepts previously shown and operationalise the IP assessment model. The procedures are divided into 3 steps:

1 – Product Characterisation (CP),

2 - Preliminary Investigation with specialists (IPE) and

3 – Definitive Documentary Research (IDD).

Step 1 – **Product Characterisation (CP)** is related to the product's **Attributes**, with bibliographic and documentary researches being used to characterise the product. This step is aimed at getting the researcher in touch with what has already been produced and registered regarding the subject of research. Through these researches, it is possible to identify whether the product presents a regional economic representativity, a target audience, sales and visibility that support moving to the following steps of the model.

Subsequently, Step 2 – **Preliminary Investigation with specialists (IE)** – consists in verifying, through experts' opinion, the **Legal and Institutional Requirements** associated to the product being assessed. This verification is carried out by applying the Delphi method, characterised as a method which seeks consensus among experts regarding future events. The Delphi survey method is based on the principle of collective judgment which, when well-structured, exhibits more accurate results than in an individual judgement. However, it is important to point out that three conditions are necessary to ensure the authenticity of the method: (a) the anonymity of the participants must be safeguarded in order to avoid previous biases and potential constraints as a result of change in opinion throughout the process; (b) regular feedback of the responses, so that experts can revise and strengthen their views, based on the group's opinion; and (c) statistical treatment of the data is also required, so that the team responsible may follow the development of the responses towards a consensus [10].

The criteria used to measure consensus is in the form of simple statistics. The relationship between the 1st and 3rd quartiles and the median or interval between alternatives is usually considered [10]. Consensus is reached if the distance between the 1st and 3rd quartiles and the median is below 25% of the maximum interval between alternatives [11]. Consensus can also be measured by the coefficient of variation. In this case, consensus is reached when this coefficient is lower than 30% [12].

The choice of experts to express their opinion regarding each product to be assessed is determined by the work experience criteria, which should be of at least 10 years.

In order to register the opinion of experts, the model has a questionnaire with a measuring scale, containing 10 questions, based on the literature and on the Brazilian legislation, as well as the **Legal and Institutional Requirements** for recognising an IP. The questionnaire is centred on 5 (five) categories based on the literature and on the IP legislation, namely: **Region with Recognised Product, Historical-cultural connection of the product with the region, Product description, Involvement of produces, State participation.** These categories have the same weighting coefficient, as they all gather the requirements for the concession of an IP. Each of these items is measured by the *phrase completion* scale, proposed by Hodge & Gillspie [13], which allows to

https://dx.doi.org/10.22161/ijaers.6737 *ISSN: 2349-6495(P) | 2456-1908(O)*

quantify the potential for an IP based on the opinion of experts. In this scale, the intensity of the items varies between 0 to 10, with 11 points. It is admitted that the mid-point is associated to a certain intensity which is not verified, for instance, in the *Likert scale*. In addition, point 0 allows the respondent not to give an opinion, if desired so. The tests carried out by Hodge & Gillspie [14] indicated that the scale is adequately consistent.

The model establishes at least 2 (two) application rounds, up to a maximum 3 (three) rounds, to the questionnaire, as described by the Delphi method [10].

At the end of the first round, the data collected are statistically treated using the SPSS Statistics software, Version 22.0, with the results being presented to the respondents before the second round. In addition, the median, quartiles or coefficients of variation are also defined in order to establish whether consensus has already been reached, according to the Delphi method. If necessary, the questionnaire can be changed according to the field research. Subsequently, the respondents take part in the second round, answering the questionnaire once again, until statistical consensus has been evidenced. The third round is only applied if statistical consensus is not reached in the second round.

The result of the second step of the assessment model considers the results of the coefficient of variation being within the parameters of statistical consensus established by the Delphi method, with the result of the potential of the product being recognised with an IP expressed by the average score of the responses from the experts. The classification of this potential to an IP is given according to Figure 1, which follows the principles of the phrase completion scale, developed by Hodge & Gillspie [8] that is: 0 (zero) corresponds to no potential; 5 (five) corresponds to average or below average potential. Values between 1 (one) and 4 (four) are considered below average. In turn, values between 6 (six) and 9 (nine) are seen as medium-to-high potential. The move towards Step 3 of the assessment model is only possible if the product exhibits a potential between medium to high. Fig. 2 presents the scale used for measuring the potential for an IP.

No Potential			Below Average		Average		Medium to high			Maximum
0	1	2	3	4	5	6	7	8	9	10

Fig. 2. Scale for measuring the potential of a recognised IP.
Source: Adapted from Hodge & Gillspie (2003).

Finally, Step 3 consists of a **Definitive Documentary Research (IDD)**, which is associated to the basic concept of **Proof of IP**. In this step, the model recommends the use of Bibliographic and Documentary researches to corroborate a possible registration request to the competent entity. This is performed with a historical-cultural survey, aimed at gathering elements, from a study on the facts, events and previous developments, for identifying the diversity of the region and to understand how its reputation was built. These elements can be collected from written sources, such as the following: statistic data, documents, management reports, association acts, technical works, specialised journals, novels, biographies, artworks, theses, dissertations and studies from historians, geographers, economists and agronomists. Oral records, also constitute these elements, namely interviews with local agents, such as residents, producers, wholesalers, previous and present municipal as well as regional authorities. Visits to the production sites also enable to understand the lifestyle in the region and to find images of typical regional products.

At the end of these steps the result is expressed as a product that has been assessed on IP recognition throughout all the spheres required to represent its potential for protection in Brazil.

III. RESULTS AND DISCUSSION

Step 1 consists of the **Product Characterisation (CP)**, which was applied aimed at identifying the regional economic representativity and visibility that support the move towards the following steps of the assessment model. With this in mind, bibliographic and documentary data was collected from the libraries of the main Universities of the State of Sergipe, as well as from *Google Scholar* pages. This collection of data enabled to establish a relationship between the city of Itabaiana and the product wooden truck body.

According to Santana [15], this relationship is based on historical roots that exceed 60 years. Due to the truck activity in the region, Itabaiana relies on a local industry focused on the production of wooden truck bodies, as illustrated in Fig. 3, which also contributed to the city's recognition as the national truck capital [16].

In 2014, the Brazilian president sanctioned Law n. 13.044/14 from 19/11/2014, with art. 1 declaring the municipality of Itabaiana, in the State of Sergipe, as the national truck capital [11].

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Fig. 3. Layout of a factory in the municipality of Itabaiana.
Source: Photographic record by the author during data collection, 2018.

According to Santana [15], the municipality has eleven factories from the wooden truck body sector, all with an operating licence. The authors state that the entrepreneurs hold a high degree of family relationship between them. It is also important to highlight that the former staff of the pioneering companies started their own businesses, given the experience acquired from the production process.

In a study carried out by Firmino [16], three large truck body factories were identified as giving a certain degree of importance to this segment in the region. The three companies combined employed 143 staff members, at the time of the research, with a monthly cost of R$ 280,000.00 with feedstock, R$ 169,000,00 with wages, with one of them reportedly spending R$ 18,000,00 on taxes.

The feedstock used for manufacturing is wood, iron, screws and paint. These materials were purchased in the Brazilian states of Pará, Amapá, Espírito Santo and São Paulo. Finally, the product is sold throughout the Northeastern region of Brazil, as well as in other regions, such as in the North and Southeast, as shown in Fig. 4, when considering the example of one of the biggest factories in the region [16].

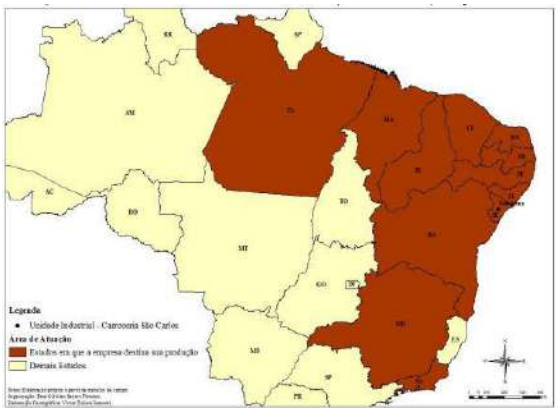

Fig 4. Destination states from the production of one of the truck body factories
Source: Adapted from Firmino, 2017.

The results of this data collection demonstrated the importance of the product to the region, considering the criterion established by the IP assessment model. From this result, Step 2 was performed.

In Step 2 – **Preliminary Investigation with Specialists (IPE)**, 5 employees that have worked in the wooden truck body production sector, in the municipality of Itabaiana, for at least 10 years were selected. This time of work takes into account their expertise, in order to contribute with their opinion regarding a future scenario for verifying the potential for IP recognition of the given product. The scenario presented was: "the region of Itabaiana obtaining the indication of origin registration for the product wooden truck body".

These professionals shared their opinion by answering, in a first round, to 10 questions in the form of an intensity scale. Besides the responses to these questions, age, gender, time of work with the product and opinion regarding the structure and understanding of the questionnaire were collected.

As this step is based on the Delphi method, in order to ensure scientific validity, the anonymity of the respondents was safeguarded, having used the SPSS Statistics software, version 22.0, with the results being shown below. In addition, the feedback was given before the second round of questions was performed.

Results from the First Round

Table 1 presents the characteristics of the respondents, focused on the average age of the respondents and their average time of work with the product. It can be observed that all the respondents had at least 10 years of work experience with the product, complying with the requirement of the model developed.

Table. 1: Characterisation of the respondents.

	Age	Time of Work	Gender
	56	25	Male
	42	33	Female
	42	10	Male
	46	32	Female
	29	10	Male
Average	43	22	

Source: Prepared by the author, based on data from SPSS Statistics, 2018.

Table 2 contains the overall results of the consensus between experts, the overall coefficient of variation (CV) of the study presented a value of 9.90%, being within the acceptable parameter considered in the literature, i.e., below 30%.

Table. 2: Consensus of round 1.

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Average	Standard Deviation	Coefficient of variation
8.22	0.8136	9.90%

Source: Prepared by the author, based on data from SPSS Statistics, 2018.

Regarding the average measure of the responses of this step, considered the main indicator to measure the potential for IP, a value of 8.22 was obtained, characterised as a **medium-to-high potential** within the measuring scale.

Subsequently, the second round was performed, with the results from the first round being shown to the participants, who were asked to answer the questionnaire once again. Despite reaching a consensus in the first round, in order to ensure the validity of the Delphi method, the second round is mandatory. Accordingly, the participants received the responses from the group, having the opportunity to position themselves.

Results from the Second Round

The second round presented a better coefficient of variation, increasing consensus among the experts. The overall coefficient of variation, the measure of consensus, presented the value of 8.93%, while the average score of the responses increased to 8.3, according to Table 3.

Table. 3: Consensus of round 2.

Average	Standard Deviation	Coefficient of variation
8.3	0.7416	8.93%

Source: Prepared by the authors, based on the data from SPSS Statistics, 2018.

The average score of 8.3 is considered the result and indicator for the potential of the product wooden truck body produced in the city of Itabaiana for IP recognition, in the opinion of the experts. This result confirms the **medium-to-high** potential of the product, according to the scale proposed in the IP assessment model.

Having obtained the result of medium-to-high, Step 3 was executed – the **Definitive Documentary Investigation (IDD)**, by gathering the elements capable of subsidising the request for IP registration, as a result of bibliographic and documentary researches in libraries of the city of Itabaiana and universities from the state of Sergipe, as well as visits to the production sites of the product studied. The evidences collected are described in publications, as shown in Fig. 5.

Publication	Author(s)	Origin	Approach	Year
Great Itabaiana and the Saga of the truck drivers (Itabaiana Grande e a Saga dos caminhoneiros, in Portuguese)	Carlos Mendonça	Itabaiana/Se	A book that tells the story of the city of Itabaiana and its connection with the truck, citing the factories of wooden truck bodies	2012
Itabaiana, our place: four centuries afterwards (Itabaiana, nosso lugar: quatro séculos depois, in Portuguese)	José de Almeida Bispo	Itabaiana/Se	A book that tells the story of the city of Itabaiana and its connection with the truck, citing the factories of wooden truck bodies	2013
Characterising the type of management in truck body factories in Itabaiana according to the Filion model (1999) (Caracterizando o tipo de gestão nas fábricas de carroceria de Itabaiana segundo o modelo de Filion (1999), in Portuguese)	Alan dos Santos Ferreira	Federal University of Sergipe	Characterises the type of management in factories of wooden truck bodies in the city of Itabaiana/Se	2013

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Federal Law n. 13.044/14 from 19/11/2014	President of the Federative Republic of Brazil	Federal Government	Article 1 declares the municipality of Itabaiana, in the Brazilian State of Sergipe, as the national truck capital	2014
Characterisation of a Local Productive Arrangement: the case of the factories of wooden truck bodies in the city of Itabaiana (Caracterização de um arranjo produtivo Local: O caso das fábricas de carrocerias de madeira da cidade de Itabaiana/Se, in Portuguese)	Joanisson dos Reis Santana	Federal University of Sergipe	Outlines the activity profile of the city of Itabaiana, mapping the truck body factories, identifying the characteristics of the Local productive Arrangement	2014

Figure 5. Evidences of the relationship between the product and the city of Itabaiana/Se.
Source: prepared by the authors based on selected documents, 2018.

Following the application of all the steps of the model, it is possible to state that the product wooden truck bodies, produced in the Brazilian city of Itabaiana, presents a medium-to-high potential for applying to IP registration through the Brazilian competent body, the INPI, enabling the use of the sources described in Fig 5. as a to support this process.

IV. CONCLUSION

Geographical Indications (GI) have contributed to the development of the regions and for strengthening the protection of intellectual properties worldwide. However, in Brazil, this label still lacks significant advances when compared to other countries, mainly in terms of support from public authorities.

The academy and research entities have striven to contribute to the growth of Geographical Indications in Brazil, seeking potential products around the country, and encouraging producers to include GIs.

An Indication of Origin (IP) represents an opportunity for rapid growth in Brazil, given the high number of popular products produced in certain regions, as well as due to the simpler and quicker registration process of this type of GI when compared to the registration process of the Denomination of Origin (DO), which requires more specific technical studies.

The product wooden truck body from the city of Itabaiana has shown evidences of its connection with the territory. Finally, the assessment model presented in this work demonstrates the possibility of replication with any other type of product to be studied.

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Guarani Aquifer System: Water Quality, Hydrogeochemistry and Legal Implications: A Review

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Abstract *— The Guarani aquifer system is the most important underground water resource in South America. Knowing in detail the characteristics of the aquifer facilitates the management of this resource. Therefore, this paper aims to review the literature on Guarani Aquifer System from the perspective of Water Quality, Hydrogeochemistry and Legal Implications.*
Keywords *— **Guarani, Aquifer, Water Quality, Hydrogeochemistry, Legal Implications***

I. STATE OF ART

There are several large aquifer systems around the world. One of the most important is the Guarani Aquifer System (GAS), located in the Paraná sedimentary basin in South America with a surface area of 1.1 million Km² [1]. The geological and hydrogeological structure of the GAS is well known in Brazil, Paraguay, Uruguay and Argentina [2] as depicted in Fig. 1.

The Paraná sedimentary basin is intercratonic, where the sedimentary sequence covers since the Silurian–Devonian up to the Cretaceous periods [3]. The Guarani aquifer has an average thickness of 300–400m, and is composed of silty and shaly sandstones of fluvial–lacustrine origin and variegated quartzitic sandstones accumulated by eolian processes under desertic conditions [4].

Climatic classification for the region following Koeppen indicates a humid subtropical climate with summer rains, showing a variation to tropical climate with dry winter. The mean annual precipitation is about 1300–1400 mm, while the mean temperature in the region is 20.5ºC [5].

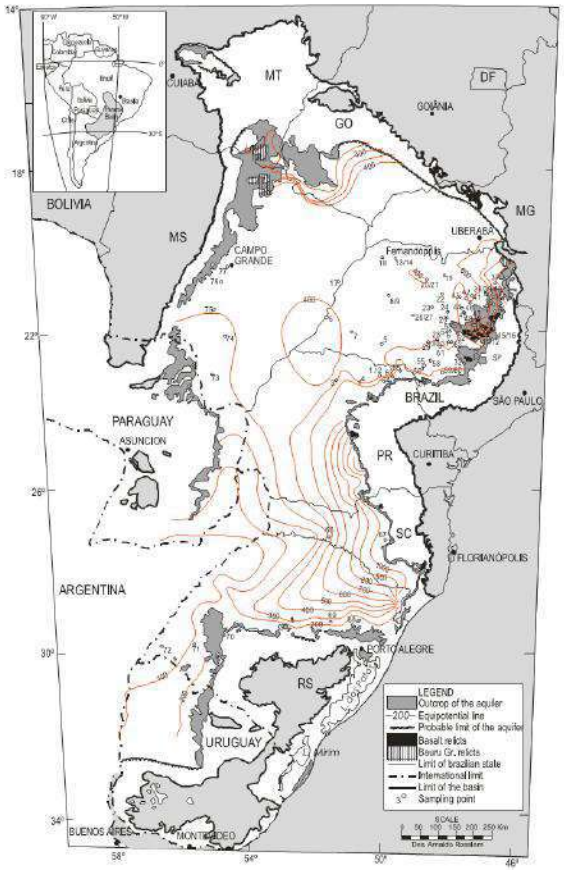

Fig. 1: The outcrop of the Guarani aquifer at the Paraná sedimentary basin [3, 6].

II. WATER QUALITY, HYDROGEOCHEMISTRY AND LEGAL IMPLICATIONS

The main hydrochemical facies are sodium-(bi)carbonate, calcium-(bi)carbonate, potassium-

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(bi)carbonate, sodium/calcium/magnesium/potassium-(bi)carbonate, sodium-(bi)carbonate/chloride/ sulfate, sodium chloride, and sodium-sulfate, as shown in Fig. 2 [8].

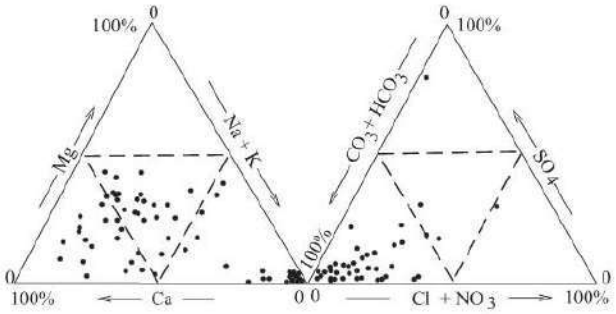

Fig. 2: The data for major cations and anions in groundwaters from Guarani aquifer plotted on a partial Piper diagram [3, 8].

Concentrations exceeding the maximum allowable for fluoride, sulfate, and sodium were identified in some wells, but their waters are not used for human consumption, only for recreation purposes [3].

The groundwaters show a hydrochemical evolution along the major flow paths from the recharge areas toward the confined zone in the center of Paraná Basin that progresses from Ca–HCO_3 water to Ca–HCO_3–Cl–SO_4 water. Chloride and SO_4 in high concentrations are probably related to mixing of Guarani waters with groundwaters originating in underling aquifers units, as supported by the ratios of Na+/Cl- and SO_4^{2-}/Cl^- from the groundwaters of both units (GAS and underling aquifers) [9].

The Guarani aquifer show a isotopic concentration of the natural dissolved radionuclides ^{36}Cl, ^{40}K, ^{238}U, ^{234}U, ^{226}Ra, ^{222}Rn, ^{210}Po, ^{210}Pb, ^{232}Th, ^{228}Th, and ^{228}Ra. Most of the gross alpha radioactivity values were below the critical level of detection corresponding to 1 mBq/L [10].

Atoms ^{222}Rn escape from the rocks and soils into the surrounding fluid phases, such as groundwater and air. ^{222}Rn decays to stable lead according to the sequence: ^{222}Rn (3.84 d, α) → ^{218}Po (3.05 min, α) → ^{214}Pb (26.8 min, β-) → ^{214}Bi (19.7 min, β-) / ^{214}Po (0.16 ms, α) → ^{210}Pb (22.3 a, β-) → ^{210}Bi (5 d, β-) → ^{210}Po (138.4 d, α) → ^{206}Pb (Fig. 3). Since ^{222}Rn data in marine environments are very promising for various applications, like groundwater discharge, earthquake brakes, rainfall, etc [3].

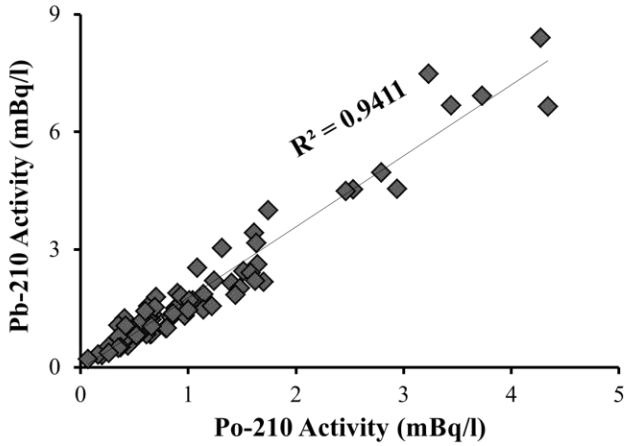

Fig. 3: Isotopic activity in groundwaters from Guarani aquifer plotted ^{210}Pb vs. ^{210}Po graph. Adapted from [4].

Much attention has been paid to Rn in waters, since it is considered a constituent that may be responsible for fatal cancers when continuously ingested in drinking water. Because it is a colorless, odorless, tasteless and chemically inert gas, its measurement is difficult, being mainly based on the detection of alpha particles emitted. The importance of Rn monitoring in water-supply systems has been recognized for most industrialized countries, whereas a similar situation has not been achieved in other parts of the world [11].

Another important radionuclide is ^{36}Cl (half-life of 301,000 years) produced naturally in the atmosphere and lithosphere via various reactions. In the atmosphere, production is predominantly by cosmic-ray spallation of argon, though detonation of thermonuclear devices in the marine environment in the 1950's and 1960's generated considerable quantities via neutron capture of stable ^{35}Cl in seawater [12]. The utilization of ^{36}Cl helps understanding groundwater dynamics such as for indicative of the water recharge (Tables 1 and 2).

Table 1 – Chloride ratios in the bulk composition of rainwater at the locations sampled in São Paulo State, Brazil [12].

Parameter unit	Distance to Rio Claro (km)	Na/Cl meq/l	K/Cl meq/l	Ca/Cl meq/l	Mg/Cl meq/l
Rio Claro	0	1.05	0.21	1.78	0.32
São Pedro	50	1.14	0.97	4.45	1.11
Botucatu	140	0.87	0.61	3.59	0.80
Águas de Santa Bárbara	210	0.80	0.42	3.49	0.63
Assis	330	0.97	0.44	3.93	0.87
Presidente Prudente	440	0.85	0.22	3.05	0.81

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Table 2 – Chloride ratios in the bulk composition of rainwater at the locations sampled in São Paulo State, Brazil [12].

Parameter unit	Distance to Rio Claro (km)	SO_4/Cl meq/l	HCO_3/Cl meq/l	NO_3/Cl meq/l	PO_4/Cl meq/l
Rio Claro	0	<0.03	1.35	0.04	<0.09
São Pedro	50	<0.04	4.60	0.08	<0.11
Botucatu	140	<0.10	3.14	<0.08	<0.30
Águas de Santa Bárbara	210	<0.03	2.71	0.08	<0.10
Assis	330	<0.13	4.30	0.11	<0.41
Presidente Prudente	440	<0.06	1.00	0.09	<0.19

III. CONCLUSION

Based on the data presented, it is considered necessary to effectively manage subsurface water resources of the Guarani aquifer system, especially the public bodies. It is possible to state that water will be available for future generations, if used in a sustainable way.

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Application of mathematical models to breakthrough curves of methylene blue removal using agricultural waste of sorghum (AWS)

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Abstract**—** *In this work, the feasibility of using agricultural waste of sorghum (AWS) in the removal of methylene blue (MB) colorant was evaluated. The experiments were carried out using fixed-bed column in a continuous system and the breakthrough curves were adjusted to the mathematical models of Adams and Bohart, Yoon and Nelson, Thomas and Doses-Response by programming them in the MATLAB R2007a software. With the realization of this study, the high biosorbent adsorption capacity has been demonstrated, as well as the high operating efficiency in column filled with AWS in the elimination of methylene blue colorant.*
Keywords**—** M***ethylene blue (MB), Biosorption, Fixed-bed column, Mathematical model, Agricultural waste of sorghum (AWS).***

I. INTRODUCTION

The public perception of water quality is really influenced by color as it is the first pollutant to be recognized in wastewater even at concentrations less than 1 $mg*g^{-1}$ [1, 2]. Although the amount of colorants produced worldwide is not known exactly [3], about 40000 colorants and pigments have been listed, defining 7000 different chemical structures. Methylene blue is a colorant widely used in the textile industry for sheep wool staining and for cotton and silk fibers, it is a cationic colorant and is known for its high adsorption in solid foods [4]. This colorant is not considered highly toxic, but it can have several harmful effects. It causes burns in the eyes and can cause eye diseases in humans and animals. Inhalation causes breathing difficulties and by ingestion causes burning sensation and nausea, vomiting, excessive sweating, symptoms of gastritis and mental confusion [5]. In the textile industry, considerable work has been carried out in relation to the elimination of color in waste water through chemical coagulation, oxidation and adsorption [6], other less conventional treatments such as biosorption have a large worldwide acceptance due to its high effectiveness and low implementation cost. Biosorption can be defined as the removal of organic and inorganic substances from an aqueous solution through the use of biological materials such as biomass, animal matter, agricultural by-products, forestry, crustaceans and / or waste [7]. Agricultural or agro-industrial residues are lignocellulosic materials whose disposal usually causes additional costs for the producing industry; and because of their high availability, low cost and physicochemical characteristics, they can also be considered as potential biosorbent [8]. Agricultural by-products are available in large quantities and constitute one of the most renewable sources of resources a worldwide [9, 10]. The greatest disadvantage of lignocellulosic adsorbents is their degradability, and that their use in adsorption columns is limited because the characteristics of the particles introduce hydrodynamic limitations and dirty or clog the columns [7]. The fixed-bed column system consists of a column where the biosorbent is deposited in its interior as a bed, which normally does not move; the liquid crosses the column in an ascending or descending direction.

II. MATERIALS AND METHODS

2.1. MATHEMATICAL MODELS

The design and optimization of a fixed-bed column requires knowledge of the relationship between equilibrium and mass transfer within the sorbent particles, in addition to the properties of the fluid in the column. Mathematical models, based on the principle of conservation of the mass, play a fundamental role in the

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change of scale, that is, in the passage of the laboratory on an industrial scale. These models can help to not only analyze and interpret experimental data, but also to predict the response of systems when operating conditions change. The operating time and the shape of the curve are very important characteristics to determine the response of a biosorption column.

2.2. EQUATIONS USED TO QUANTIFY THE EFFICIENCY OF THE ADSORPTION COLUMN

The operation of the adsorption column is described by the concept of breakthrough curve. The breakthrough curve, shows the behavior of a fixed-bed column from the point of view of the amount of colorant that can be retained, and usually, is expressed in terms of a normalized concentration defined as the quotient between the colorant concentrations in the liquid at the outlet and at the entrance of the column $\frac{C_i}{C_0}$, as a function of time or volume of effluent, for a fixed-bed height.

Effluent volume is calculated from equation (1):

$$V_{ef} = Q * t_{total} \ldots\ldots (1)$$

where t_{total}, total time (min) and Q, flow through the column, $\left(\frac{ml}{min}\right)$.

The area under the breakthrough curve, between the appropriate limits, represents the total amount of adsorbate retained (or maximum adsorption capacity of the column), q_{total} in mg, for a determinate concentration of the feed and is determined from integration using the equation (2):

$$q_{total} = \frac{Q}{1000}\int_{t=0}^{t=t_{total}} CR\,dt \ldots\ldots (2)$$

CR, is the concentration of adsorbate retained, mg / l

The total amount of adsorbate passing through the column, m_{total} in mg, is calculated from expression (3).

$$m_{total} = \frac{C_i * Q * t_{total}}{1000} \ldots\ldots (3)$$

Therefore, the total percentage of adsorbate retained during the operation of the column is obtained from the expression (4).

$$\%Retention = \frac{q_{total}}{m_{total}} * 100 \ldots\ldots (4)$$

Column equilibrium studies require knowledge of the biosorption capacity, q_e (mg of adsorbed adsorbate / g of sorbent), and the concentration of adsorbate that remains in solution when equilibrium is reached, C_e (mg/l) and can be determined for the expressions (5) and (6),

$$q_e = \frac{q_{total}}{m} \ldots\ldots (5)$$

$$C_e = \frac{m_{total} - q_{total}}{V_{ef}} \ldots\ldots (6)$$

where m is the mass of sorbent used in the column, (g).

2.3. KINETIC MODELS

The kinetic models of the biosorption processes allow to determine the speed at which the coloring are removed from the aqueous phase, as well as a set of variables that indicate the efficiency of the system. In this work, four models were used for kinetic studies. These models are: Adams and Bohart, Thomas, Yoon and Nelson and Dosage-Response.

2.4. ADAMS AND BOHART MODEL

This model assumes that the sorption velocity is proportional to the residual capacity of the solid and the concentration of the retained species and is used to describe the initial part of the breakthrough curve. The equation that describes this model is equation (7) [11].

$$\ln\left(\frac{C_i}{C_0}\right) = K_{AB} * C_0 * t - \frac{K_{AB} * N_0 * Z}{v} \ldots\ldots (7)$$

where K_{AB} is the kinetic constant (l/mg min), v is the linear flow rate (ml/min), Z is the bed depth of column (cm), N_0 is the saturation concentration (mg/l), t is the time (min), C_0 and C_i are, respectively, the adsorbate concentration at the entrance and at the exit of the column.

Parameters describing the characteristic operations of the columns (K_{AB} and N_0) were calculated using linear regression analysis according to Equation (7). From a linear plot of $\ln\left(\frac{C_i}{C_0}\right)$ against time (t), values of K_{AB} and N_0 were determined from the intercept and slope of the plot.

2.5. THOMAS MODEL

The Thomas model [12] is one of the most general and used to describe the behavior of the biosorption process in fixed bed columns. This model is described by equation (8):

$$\frac{C_i}{C_o} = \frac{1}{1+e^{\left(\frac{K_{Th}}{Q}\right)*(q_o m - C_i V_{ef})}} \ldots\ldots (8)$$

where C_o and C_i are respectively the concentrations of input and output of the column, K_{Th}, Thomas's velocity constant $\left(\frac{ml}{mg * min^{-1}}\right)$, q_o the maximum concentration of solute in the solid phase, $\left(\frac{mg}{g}\right)$, m is the mass of adsorbent in the column (g), V_{ef} is the effective volume (ml) and Q is the volumetric flow $\left(\frac{ml}{min}\right)$.

The linearization of equation (8) is:

$$\ln\left(\frac{C_0}{C_i} - 1\right) = \frac{K_{Th} * q_0 * m}{Q} - \frac{K_{Th} * C_i}{Q} * V_{ef} \ldots\ldots (9)$$

Values of q and K_{Th} were determined from the intercept and slope of the linear plot of $\ln\left(\frac{C_0}{C_i}-1\right)$ against time (t).

2.6. YOON AND NELSON MODEL

Yoon and Nelson [13] developed a model aimed at the adsorption of vapors or gases in activated carbon. This model assumes that the speed at which the adsorption probability decreases for each adsorbate molecule is proportional to the adsorption probability and the probability that it does not adsorb on the adsorbent. The mathematical model proposed by Yoon and Nelson is expressed as:

$$-\frac{\partial A}{\partial t} = K_{YN} * (t-\tau) \quad (10)$$

The linearized Yoon and Nelson model for a single component system is expressed as:

$$\ln\left(\frac{C_i}{C_0 - C_i}\right) = K_{YN} * (t-\tau) \quad (11)$$

where K_{YN} (1/min) constant speed Yoon and Nelson and τ (min) time required to retain 50% of the initial adsorbate (min). From a linear plot of $\ln\left(\frac{C_0}{C_i}-1\right)$ against sampling time (t), values of k_{YN} and τ were determined from the intercept and slope of the plot for a given height, flow, and the initial concentration.

2.7. DOSE-RESPONSE MODEL

This model has been commonly used in pharmacology to describe different types of processes, is currently used to describe column behavior in biosorption process [14, 15]. The general equation that represents the model is the following:

$$Y = b_0 - \frac{b_0}{1+\left(\frac{X}{b_2}\right)^{b_1}} \quad (12)$$

where X and Y represent the dose and the response in terms of percentage of the maximum possible response, respectively. The parameter b_0 is the expected response when saturation is reached, b_1 represents the slope of the function, and b_2 indicates the concentration at which half of the maximum response occurs.

Equation (13) describes this model for the biosorption process:

$$\frac{C_i}{C_0} = 1 - \frac{1}{1+\left(\frac{V_{ef} * C_i}{q_0 * m}\right)^{a}} \quad (13)$$

This model is of relative importance since it usually describes the complete breakthrough curve with high precision; however, it is difficult to relate the empirical parameter "a" with the experimental conditions, making it practically impossible to carry out a change in the scale of the system [14].

2.8. BIOSORBENT MATERIAL

The biosorbent used was the agricultural waste of sorghum (AWS), it was obtained from a producer in the municipality of "Encrucijada" belonging to the province of Villa Clara, Cuba; collecting days after the harvest and subjected to a process of washing with distilled water. Once washed, they were dried, crushed and sieved. The particle size used ranged between 0.342 mm and 2.40 mm. Figure 1 corresponds to a sample of biosorbent material.

Fig.1: Agricultural waste of sorghum (AWS), washed, dried and crushed.

The agricultural waste of sorghum (AWS) used were characterized employment a set of physical and chemical tests such as determination of the zero charge point, acid and basic sites, analysis of the elemental composition of the biosorbent material, infrared analysis and thermogravimetric analysis. The results of the characterization of the AWS are shown in Table 1. This results presented in this table are published in the journal of the Faculty of Chemistry-Pharmacy of the Central University "Marta Abreu" of Las Villas, Cuba, Centro Azúcar [16].

Table 1. Physical-chemical characterization carried out on agricultural waste of sorghum (AWS) by means of infrared, thermogravimetric analysis, elemental composition, zero load point and acid and basic sites [17].

Physical-chemical characterization of agricultural waste of sorghum (AWS).	
Zero load point (ZLP)	pH= 7.5
Acid sites	0.75 $\frac{meq}{g}$
Basic sites	0.525 $\frac{meq}{g}$
Elementary composition of N,C,H,O y S.	0.51 % nitrogen; 47.58 % carbon; 8.72 % hydrogen; 43.19 % oxygen; insignificant sulfur concentration
Infrared Analysis	Hydroxyl (OH), Carbonyl (C = O),

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(Main functional groups detected).	aliphatic structures, structures of simple bonds carbon-carbon (Csp3-H), esters and ethers (C-O-C). Figure 2.
Thermogravimetric analysis.	Three fundamental zones are detected, one corresponding to the temperature range from 0 ° C to 200 ° C where the desorption of the retained water and the combustion of the cellulose take place, a second zone comprised in the temperature range of 200 ° C and 550 ° C where anaerobic pyrolysis of the hemicellulose takes place and a third zone in the temperature range of 500 ° C to 800 ° C where there is a constant mass loss which is associated with the loss of residual H +, where occur the decomposition of the lignin. Figure 3.

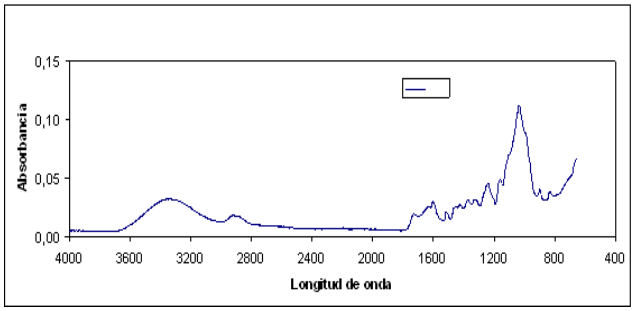

Fig.2: Analysis of samples of agricultural waste of sorghum using infrared spectrum. (AWS).

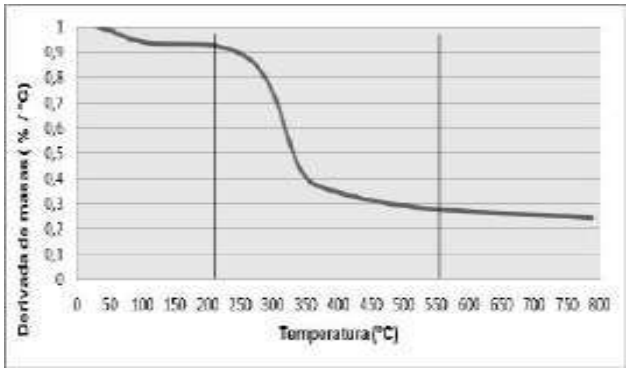

Fig.3: Thermal analysis performed in agricultural waste of sorghum (AWS) in the temperature range (0 to 800) ° C.

2.9. HYDRAULIC TEST AND SELECTION OF OPERATION PARAMETERS

Hydraulic tests are carried out before carrying out the adsorption tests. The column is filled with AWS and distilled water is pumped for the purpose of determining the most suitable flows in order to avoid particle dragging and fractionation of the bed when the column is in operation.

The flows selected for the test were (6 and 9 $\frac{ml}{min}$) allowing the bed to remain stable not fragment and no-draining when the operation stops. A standard solution of the methylene blue colorant was prepared at concentrations of 100 and 500 $\frac{mg}{l}$, the solution is adjusted to pH = 5 using HCL or 0.1 N NaOH.

For the selection of the height of the bed, the design criteria suggested in the literature [18] are taken into account, which state that the internal diameter of the column may be six times or more. The heights of the packing evaluated were 17 cm and 21 cm corresponding to the AWS masses of 3.85 g and 4.72 g respectively. The feed solution and the fixed bed column temperature were maintained at 30˚C. The operating variables of this test are shown in Table 2.

Table.2: Operational variables studied during continuous biosorption of methylene blue using AWS.

Operating conditions	**Q (ml/min)**	**H_b (cm)**	**C_o(mg/l)**
Scale 1	9	21 (4.72g)	500
Scale 2	6	17 (3.85g)	100

2.10. QUANTIFICATION OF THE SAMPLES

The absorbance readings of methylene blue were quantified in a Rayleígh VIS-7236 spectrophotometer at a wavelength (λ = 575 nm) previously determined in this same equipment, for which a sweep was performed in the wavelength interval (λ) from 320 to 700 nm.

III. RESULTS AND DISCUSSION

3.1. EFFECT OF THE OPERATIONAL VARIABLES ON THE CHARACTERISTICS OF THE BREAKTHROUGH CURVES

Table 3 shows the main parameters obtained through the *breakthrough* curves for each experimental, already averaged with their respective replicas.

Table 3. Main parameters obtained employing the breakthrough curves of the biosorption operation of methylene blue (MB) with AWS at pH 5, temperature 30 ° C and colorant concentration of 100 and 500 mg / l.

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Parameters of the breakthough curves

Operating Conditions			Parameters	
C_o (mg/l)	H_b (cm)	Q (ml/min)	Efficiency (%)	q_e (mg/g. Veffective (ml)
100	17	6	93.49	16.89 504
100	21	6	90.68	17.82 654
100	17	9	90.00	21.44 513
100	21	9	92.87	10.12 387
500	17	6	98.24	21.72 66
500	21	6	98.78	18.85 60
500	17	9	91.48	17.81 54
500	21	9	95.73	28.33 108

Analyzing table 3 it is noted that the highest effective volume is reached when the column is operating at a concentration of 100 mg/l, a bed height corresponding to 21 cm (4.72 g) and a feeding flow of 6 ml/min for 654 ml of effective volume, under these conditions has an efficiency of 90.68% and a maximum capacity of adsorption (q_e) of 17.82 mg of (MB)/g of AWS, so we can say that C_o = 100 mg (MB)/l, Q = 6 ml/min and a H_b = 21 cm (4.72g) are the optimal parameters to operate the fixed-bed column system with agricultural waste of sorghum (AWS) in the removal of methylene blue (MB).

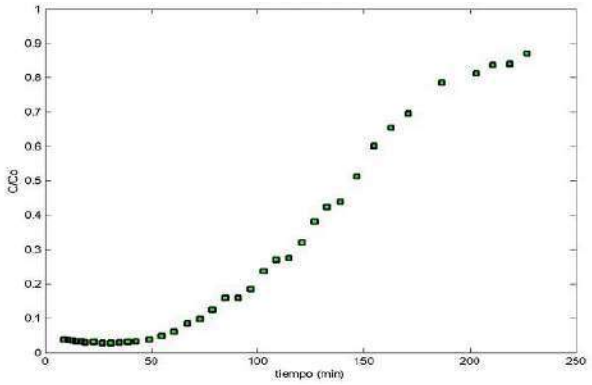

Fig.4. Breakthrough curve of the biosorption operation of methylene blue with agricultural waste of sorghum at a concentration of 100 mg/l of methylene blue, flow of 6 ml /min and height of the AWS bed of 21 cm (4, 72g).

2.2. BREAKTHROUGH CURVES: ADJUSTMENT OF MODELS AND DETERMINATION OF THE MAIN PARAMETERS OF EACH EQUATION

2.2.I. ADAMS AND BOHART MODEL FOR FIXED-BED COLUMN

From the equation 7 we obtain the parameters of the model and adjustment of Adams and Bohart, which are shown in table 4 for each of the combinations of concentration, flow of feeding and height of the bed studied. Figures 5 and 6 show the adjustment of the linearized model and its breakthrough curve for the optimal conditions of the experimental design. It is appreciated that the Adams and Bohart model does not present a good fit for any of the experimental design conditions. At high concentrations of methylene blue colorant (500 mg/l) the linear correlation coefficient has very low values. The capacity of volumetric sorption does not decrease in almost all cases when increasing the packing height except at the conditions of C_o = 500 (mg (MB)/l), Q = 6 ml/min and H_b = 21 cm. These results are similar to the other authors like [19].

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Table 4. Parameters of the models of Adams and Bohart, Thomas, Yoon and Nelson and Dosage-Response for the experimental data of the biosorption process of methylene blue using AWS.

Operating Conditions			Admos and Bohart			Thomas	Yoon and Nelson		Dosage-Response		
$Co(\frac{mg}{l})$	$H\,(cm)$	$Q(\frac{ml}{min})$	$K_{AB}(\frac{l}{mg*min})$	$N_o(\frac{mg}{l})$	$q_e(\frac{mg}{g})$	$K_{Th}(\frac{ml}{mg*min^{-1}})$	$q_e(\frac{mg}{g})$	$K_{YN}(\frac{1}{min})$	τ(min)	a	$q_e(\frac{mg}{g})$
100	17	6	0.000276	2490.17	8.71	0.36	18.75	0.036	120.37	1.51	26.71
100	21	6	0.000190	2203.64	7.71	0.28	18.97	0.027	149.27	1.75	20.23
100	17	9	0.000245	1699.59	5.94	0.35	23.39	0.035	100.06	1.81	21.12
100	21	9	0.000620	1391.80	4.87	0.83	10.85	0.082	56.90	2.18	12.30
500	17	6	0.000143	3374.81	11.80	0.24	25.16	0.118	32.29	3.17	21.13
500	21	6	0.000113	5261.29	18.40	0.19	21.49	0.095	33.80	2.89	17.07
500	17	9	0.000106	3484.84	12.18	0.24	19.69	0.120	16.85	2.48	16.74
500	21	9	0.000105	3443.28	12.04	0.25	30.61	0.124	32.11	3.71	25.41

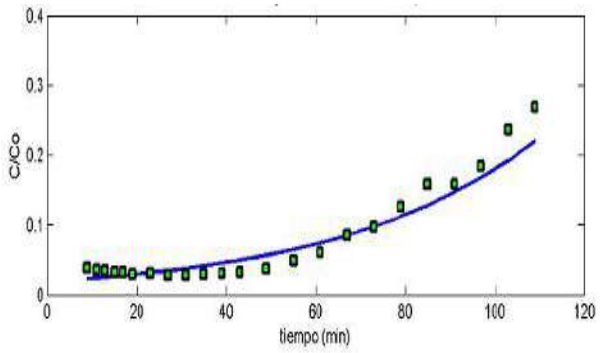

Fig.5. Breakthrough curve of the Adams and Bohart model for the biosorption process of methylene blue with AWS at $C_o = 100\frac{mg(MB)}{l}, Q = 6\frac{ml}{min}$ *and a* $H_b = 21\ cm\ (4.72\ g)$.

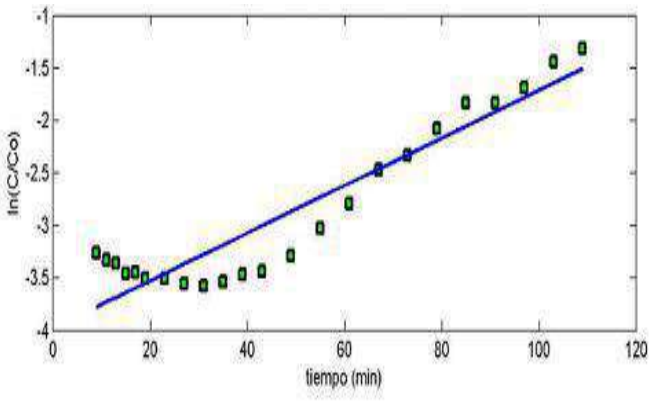

Fig.6: Linearized Adams and Bohart model for the biosorption process of methylene blue with AWS at $C_o = 100\frac{mg(MB)}{L}, Q = 6\frac{mL}{min}$ *y una* $H_b = 21\ cm\ (4.72\ g)$.

2.2.2. THOMAS MODEL FOR FIXED-BED COLUMN

From the equation 9 the parameters of the Thomas model and of adjustment are obtained that are shown in table 4. In the figure 7 and 8 the adjustment of the

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linearized model and its breakthrough curve for the optimal conditions of the experimental design is observed. The Thomas model in a general way represents very accurately the process of biosorption of methylene blue using agricultural waste of sorghum, this can be evidenced by analyzing the values corresponding to R2 for this model. Analyzing the maximum adsorption capacities qe (mg/g) of this model with those obtained experimentally, a great similarity between both datas set is observed. These results correspond to those of other researchers such as [20].

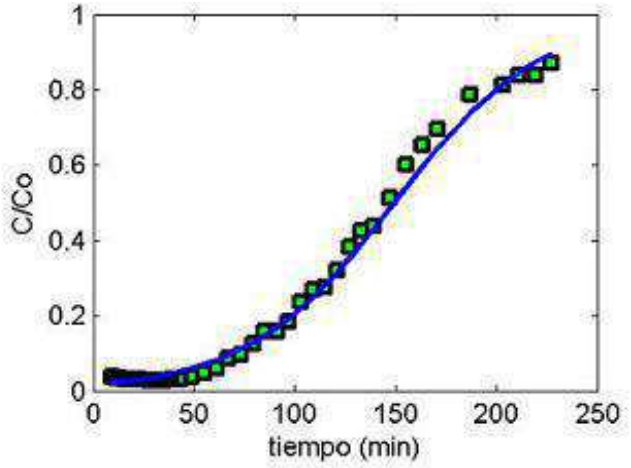

Fig.7. Breakthrough curve of the Thomas model for the biosorption process of methylene blue with AWS at $C_o = 100\ \frac{mg(MB)}{l}$, $Q = 6\ \frac{ml}{min}$ *y una* $H_b = 21\ cm\ (4.72\ g)$.

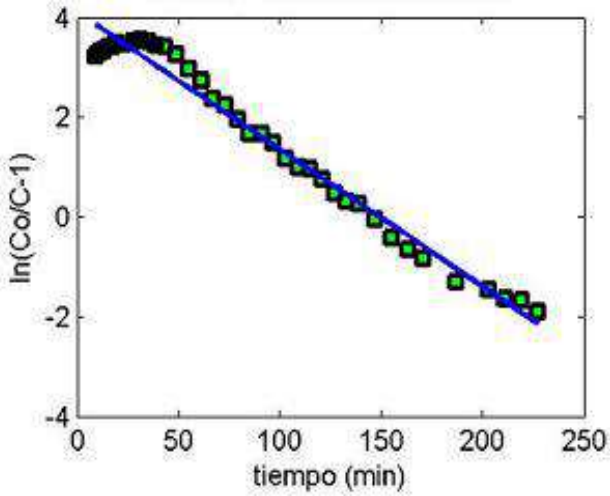

Fig.8. Linearized Thomas model for the biosorption process of methylene blue with AWS at $C_o = 100\ \frac{mg(MB)}{l}$, $Q = 6\ \frac{ml}{min}$ *y una* $H_b = 21\ cm\ (4.72\ g)$.

III.2.3. YOON AND NELSON MODEL FOR FIXED-BED COLUMN

The equation of the Yoon and Nelson model is mathematically analogous to the equation that represents the Thomas model (equation 9). From the equation 11 the parameters of the model and of adjustment are obtained that are shown in table 4. Figures 9 and 10 show the adjustment of the linearized Yoon and Nelson model and its breakthrough curve for the optimal conditions of the experimental design. This model, being mathematically equal to that of Thomas, has given rise to the same adjustment results, therefore, it reproduces acceptably the breakthrough curves. However, the values of the time required to retain 50 % of the initial colorant, t, are very similar to those obtained experimentally, which coincides with other researchers during studies of different biosorbent-colorant systems in fixed-bed column [21].

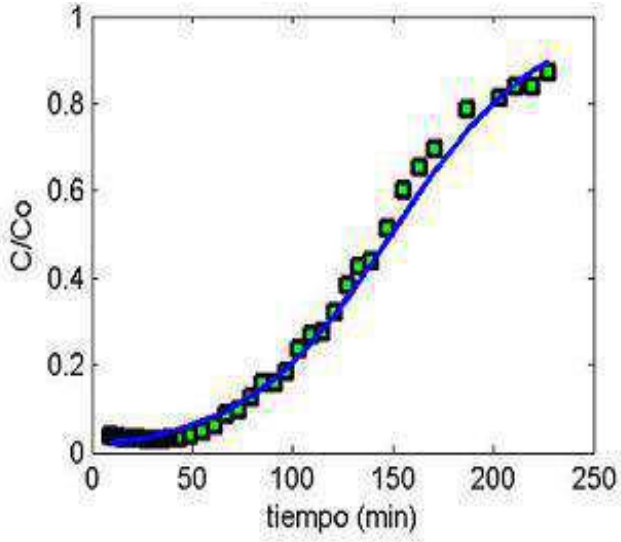

Fig.9. Breakthrough curve of the Yoon and Nelson model for the biosorption process of methylene blue with AWS at $C_o = 100\ \frac{mg(MB)}{l}$, $Q = 6\ \frac{ml}{min}$ *y una* $H_b = 21\ cm\ (4.72\ g)$.

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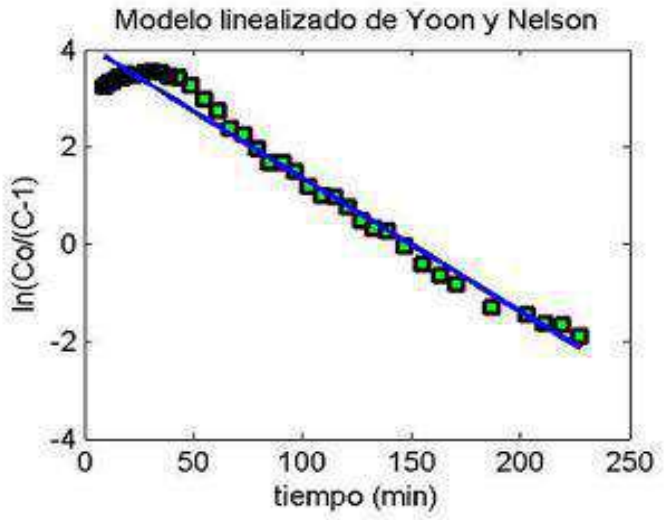

Fig.10. Linearized Yoon and Nelson model for the biosorption process of methylene blue with AWS at $C_o = 100\ \frac{mg(MB)}{l}$, $Q = 6\ \frac{ml}{min}$ *y una* $H_b = 21\ cm(4.72\ g)$.

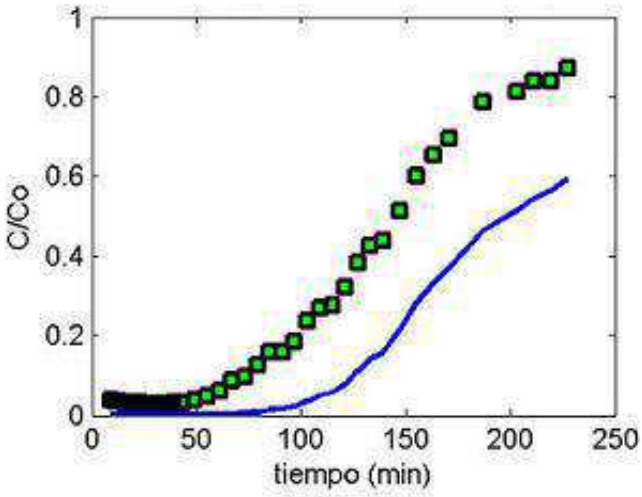

Fig.11. Breakthrough curve of the Dose-Response model to the biosorption process of methylene blue with AWS at $C_o = 100\ \frac{mg(MB)}{l}$, $Q = 6\ \frac{ml}{min}$ *y una* $H_b = 21\ cm\ (4.72\ g)$.

2.2.4. DOSE-RESPONSE MODEL FOR FIXED-BED COLUMN

From the equation 13 and by means of non-lineal regression, the parameters of the Dose-Response model are obtained, which are shown in table 4. Figures 11 and 12 show the adjustment of the linearized model of Dose-Response and its breakthrough curve for the optimal conditions of the experimental design. The results show that this model reproduces in an acceptable way some of the breakthrough curves for the biosorption process studied, however, in some cases, it is difficult to relate the adjustment parameters with the operating conditions, so it is of little use to model the behavior of the column. On the other hand, the values of maximum adsorption capacity (qe) correspond quite well with the experimental values. These results are similar to those obtained by other researchers [22, 23, 15].

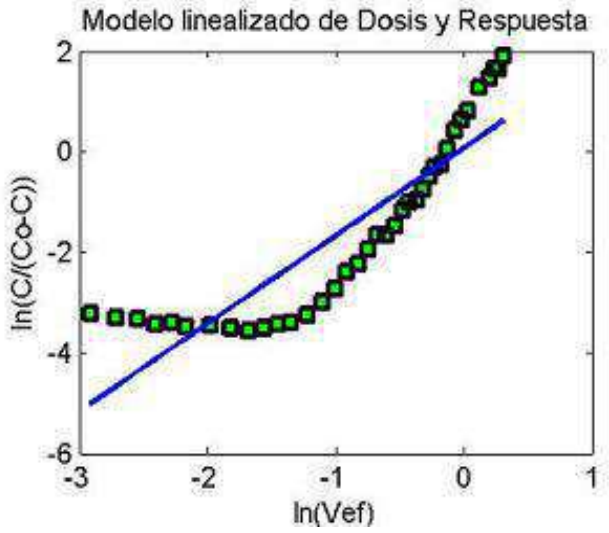

Fig.12. Linearized Dose-Response model for the biosorption process of methylene blue with AWS at $C_o = 100\ \frac{mg(MB)}{l}$, $Q = 6\ \frac{ml}{min}$ *y una* $H_b = 21\ cm\ (4.72\ g)$.

3.3. COMPARISON OF THE RESULTS

The results obtained in the process of biosorption of methylene blue (MB) using agricultural waste of sorghum (AWS) are compared with those of other researchers of the subject such as [24, 25, 26, 27] among others, they are shown in Table 5

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Table 5. Comparison of the biosorption capacity of agricultural waste of sorghum (AWS) with different biomass.

Biosorbent Material	T (ºC)	g_e (mg/g)	Reference
Seaweed (*Caulerpa racemosa*)	18	5.25	[24]
Orange Shell	30	13.90	[25]
Banana Shell	30	15.90	[25]
Tripoli	25	16.60	[26]
Agricultural waste of Sorghum (AWS)	30	18.97	This Studio.
Madhuca Seed	30	40.00	[27]
Waste of Tea	25	85.16	[28]
Stems Anana	30	119.05	[29]
Activated Carbon	-	435	[30]

IV. CONCLUSION

The experiments were carried out to laboratory scale using fixed-bed column with agricultural waste of sorghum (AWS) and results showed that the biosorption is adequately alternative to remove methylene blue from aqueous solutions. Obtained data indicated that to remove methylene blue, the best operation conditions were obtained for a bed height of Hb=21cm, initial concentration of 100 mg/l and a flow of 6 ml/min. The characteristics of the breakthrough curves of the biosorption process of methylene blue with AWS allow to evaluate that the column operates with a high efficiency, since removals of methylene blue of up to 90.68% are achieved. Under these conditions the Thomas model best represents the experimental data of the biosorption curves of methylene blue with RAS a biosorption capacity of 18.97 (mg(MB))/(g(AWS)), comparable with that of other lignocellulosic biosorbents.

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Technologies of the Industry 4.0: Perspectives of Application in the Brazilian Agribusiness

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Abstract *— This study aimed to verify the applicability of the terms of Industry 4.0 in Brazilian agribusiness, verifying its use as a mechanism to reduce production costs. In this sense, an exploratory research was developed with a qualitative and quantitative approach of the problem by collecting the opinion of experts on the applicability of these technologies. Taking as a starting point the nine technologies of Industry 4.0 presented by Rübmann et al. (2015), the answers were divided into two groups: the first one was examined for applicability, some of which in the opinion of experts are already practiced, others will be in the near future and some will not be practiced by agribusiness due to uncontrollable variables like climate and plagues. As for the reduction of production costs, two technologies represent advantages for agribusiness in the opinion of specialists. In addition to these contributions, this research suggests the creation of a national repository to house innovations and applications of these technologies, demonstrating the state-of-the-art evolution of Agriculture 4.0 in Brazil.*

Keywords *— **Industry 4.0, Brazilian Agribusiness, Agriculture 4.0, Technologies. Costs.***

I. INTRODUCTION

Brazil is, admittedly, a reference in world grain production. Thanks to new technologies such as Geographic Positioning System (GPS), Geographic Information System (GIS), sensors and advanced software for precision application (McCormick et al., 2009; Robertson et al., 2012), precision farming has contributed significantly to this scenario, characterized by increased efficiency and consequent productivity gains. In the midst of this technological advance, precision livestock farming has followed the same path, offering an even greater share of the country's recognition as a world food supplier (Bernardi & Inamasu, 2014).

Geo-referenced soil samplings, the application of variable rate inputs and the specialized maps of soil attributes and of recommendations are the main ways of using precision agriculture (Bernardi & Inamasu, 2014; Bernardi et al., 2015). Precision livestock farming is being characterized by the use of environmental control systems; physiological; behavioral; identification; monitoring; control of feeding and reproduction (Paiva et al., 2016).

These technologies are inserted in the universe denominated Agriculture 4.0, allusion to the concept of Industry 4.0 that had its origin in industrial automation (VDMA, Verlag, 2016). This industry is born in Germany, but other European countries, as well as Asia and the United States, almost instantly followed this trend that passes through the concept of "Intelligent Factory" (Kagerman et al., 2013, Wahlster et al., 2013).

According Kaufmann (2015), Industry 4.0 can be considered as the fourth Industrial Revolution, having as main characteristic the consolidation of information technologies, computational simulations, cloud computing, sensor enhancement, connectivity with PLC and, mainly with the use of the internet of things and artificial intelligence.

The definition of Industry 4.0 is constantly evolving and therefore not yet finalized. According to the European Commission's (2013) bulletin, the technologies applied by Industry 4.0 can provide efficiency gains, generating new opportunities, including for small businesses (Kaufmann, 2015).

Therefore, it is inevitable to make comparisons with what established authors postulated about sustainable competitive advantages (Porter, 1986), which addressed in their works attributes as leadership in cost, innovation, differentiation and focus; Barney (1991) with the resource-based view; Collis and Montgomery (1995) with attributes suitable for operations performance objectives; Hammel and Prahalad (1995) with the need for predictive capacity; Mintzberg et al. (2000) with the need to

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establish the supply chain; and Slack and Lewis (2009) inserting reliability, flexibility and quality as priorities in operations performance.

In line with what is currently occurring in the world, the use of computational methods; connectivity between systems and machines, improving man / machine operation; methods of analysis and decision-making based on big data and artificial intelligence, can lead the Brazilian agribusiness to another level in the world competition, consolidating or overthrowing its current position, depending on the intensity of the application of Agriculture 4.0 in comparison with other countries.

Therefore, it is necessary to analyze what has already been produced in terms of Industry 4.0 to know if these technologies can be reproduced in the Brazilian agribusiness. In this sense, the objective was to verify the applicability of the terms of Industry 4.0 in the context of Brazilian agribusiness and its use as a mechanism to reduce production costs.

II. LITERATURE REVIEW

2.1 Industry 4.0

At an annual fair held in Hannover, Germany, Kagermann, Lukas and Wahlster (2011) coined the term "Technologies of Industry 4.0", claiming that they were responsible for the stability of German industries and for the maintenance of jobs, even in financial crisis of 2008.

Sendler (2013) defined Industry 4.0 as the connection of products and services between each other and with their respective environment through the Internet and other network services, which allow the development of new products and services in which many functions are autonomous. Industry 4.0 can be defined as the incorporation of intelligent products into digital, physical and virtual processes, interacting with each other, across geographic and organizational boundaries (Schmidt et al., 2015).

Strictly speaking, the concept proposes significant changes in how traditional industry deals with products, processes, inter organizational relationships, globalization, and competition. For Hofmann and Rüsh (2017) with regard to the product, the main changes are contained in the relaxation of production, that is, in the capacity that the company has to meet specific customer requests. The relationship in the supply chain can be made even easier by the great ease of communication, creating opportunities, even for small companies, as the value chain fragmentation may occur, allowing small companies to compete with big (Hofmann & Rüsh, 2017).

To better understand the changes brought about by Industry 4.0, you need to understand the technologies that are currently in use and future possibilities.

2.1.1 Major Industry Technologies 4.0

The prominent digital industrial technology known as Industry 4.0 is subsidized by nine technological advances considered fundamental in this process. Fig. 1 illustrates these technologies.

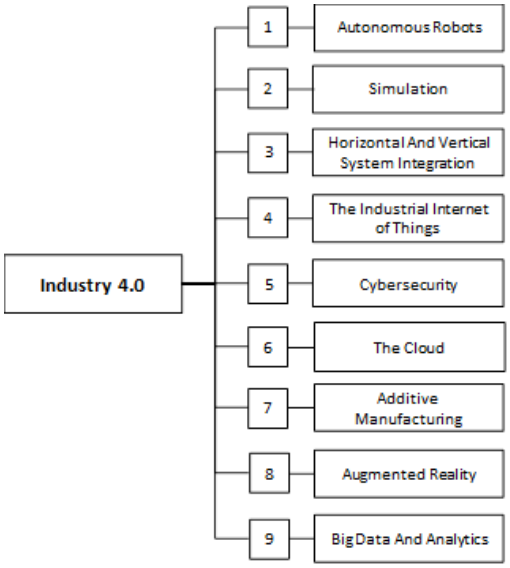

Fig.1: Founding Technologies of Industry 4.0

By Autonomous Robots, it is understood the use of this technology between machines and between machines and man, generating a more efficient communication with the objective of obtaining greater precision, flexibility, agility, speed, low cost, generating the key concept of intelligent factory - smart factory (Kagermann et al., 2011). The control of complex scenarios, product flexibility, high quality and profitability, are achievements of those who implanted the autonomous robotic technology (Brettel et al., 2014; Gorecky et al., 2014; Russwurm et al., 2014; Roblek et al., 2016).

According to a study prepared by the National Confederation of Industry - NCI (2016), it is inherent to the intelligent factory and therefore to autonomous robots, the use of digital automation with sensors for process control, product identification and operating conditions making production lines flexible, remote monitoring and production control with Manufacturing Execution System (MES) and Supervision and Data Acquisition Systems (SCADA) systems.

Simulation are activities aimed at 3D simulation of materials, products and processes, involving, for example, finite elements, computational fluid dynamics, among

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others (CNI, 2016). According to Brettel et al. (2014), the simulation has the ability to mirror the physical world in a virtual world, integrating machines, products and men, reducing setups, lead time, generating the objective of operations performance called speed and flexibility, being considered as generators of advantage sustainable development (Collis & Montgomery, 1995; Slack & Lewis, 2009).

Horizontal and Vertical System Integration are the various information technologies integrated vertically and horizontally, so that the whole plant becomes a large system (Rübmann et al., 2015). Brettel et al. (2014) argue that vertical integration is linked to the concept of hubs, whose jobs require machines to manage the flow of goods and information within the value chain by integrating players. Internally, that is, in vertical integration, the goal is to increase flexibility and quality, interconnected by relevant information, whose power of the system is self-organization.

The Industrial Internet of Things is an allusion to the term Internet of Things (IoT) that came before Industry 4.0. Giusto (2010) mentions that IoT refers to the use of sensors, objects, mobile phones, things that interact and that act through intelligent devices to reach a certain goal, incorporating digital services in the products. The gain is the decentralization of decision-making to the creation of a network of cyber systems capable of operating in real time (Hermann et al., 2016).

According Lee et al. (2014) an example of IoT application is the maintenance of equipment, where, through sensors and a network of cyber systems, it is possible to self-evaluate the wear according to the required performance. It is the so-called self-consciousness, which through algorithms processes the past, present and future of that equipment, calculating the exact moment of its maintenance. For Almada-Lobo (2016), the main thing is that all this technology is based on low-cost hardware and software, without requiring heavy systems and interfaces such as the Windows 10 IoT operating system, passive identification tags, as well as transmitters Wi-Fi ESP 8266 that are being sold on average for $1 per unit, ensuring that small businesses can also enjoy these technologies.

Regarding Cybersecurity, it is inevitable to state that this is one of the main links of Industry 4.0, because if there is reliability in cyber systems, there will certainly be reliability of machines, operations and products, allowing the generation of operational performance objectives competitive advantage (Slack & Lewis, 2009). Rübmann et al. (2015) point out that there will be no Industry 4.0 without Cybersecurity. Therefore, establishing secure and reliable communication is a critical success factor that pervades internal and inter-organizational relationships, thus requiring security protocols.

The Cloud, started by making the data available in a remote repository beyond the information processing site and today becomes one of the main strengths of Industry 4.0, enabling the sharing of information and decision-making in milliseconds (Schmidt et al., 2015). This combination favors all those involved upstream and downstream in real time, provided they have skillful tools, such as programming language that allows interoperability between systems, for example.

Additive Manufacturing is Additive Manufacturing, Rapid Prototyping or 3D Printing, which anticipates the outcome of a product or service embodied in a prototype. Schwab (2016) mentions that the 4D generation is capable of delivering even greater advancement for Industry 4.0, since prototypes built from this technology will have the power to shape adversities in their use, such as extreme temperatures. This will save materials as well as ensure the reliability of operations and products.

According Almada-Lobo (2016), the use of Additive Manufacturing opens the doors to the Augmented Reality, which holds at its core a range of possibilities that will foster industrial activities, mainly for their ability to track and analyze. The Augmented Reality will allow a more effective maintenance, allowing systems to be autonomous, avoiding bottlenecks in the face of anticipation in decision-making.

Finally, Big Data and Analytics. According to Lee et al. (2014), Big Data Analytics has its architecture based on a large data set with speed, volume and variety supported processing and storage, with ample possibility of data and information analysis in a timely manner, being fundamental the management and distribution of machines to become self-aware and self-learning.

Rübmann et al. (2015) argue that Big Data and Analytics recruits algorithms and cloud computing to be even more efficient and contribute to optimization and production quality with reduced production and maintenance costs as well as flexibility, quality and speed. In this sense, it is vital that the other decision support systems be integrated into the whole.

Other practices involving these technologies are also being used in agribusiness as presented in Table 1.

Table 1 - Main technologies used in agribusiness.

Technologies	Main Features	Theoretical

https://dx.doi.org/10.22161/ijaers.6740 *ISSN: 2349-6495(P) | 2456-1908(O)*

		Support
Autonomous Robots	Control of complex scenarios, production, logistics and office management, product flexibility and high quality.	Brettel et al. (2014); Gorecky et al. (2014); Russwurm et al. (2014); Roblek et al. (2016); Bahrin et al. (2016); Boysen et al. (2018)
Simulation	Generators of sustainable competitive advantage. The simulation allows the previous analysis of all the steps and facilitates the visualization of errors, cost-benefit and time.	Collis e Montgomery (1995), Slack e Lewis (2009); Brettel et al. (2014); Abreu et al. (2017); Alpala et al. (2018)
Horizontal and Vertical System Integration	Machines manage the flow of goods and information within the value chain, integrating players, increasing flexibility and quality, interconnected by relevant information.	Brettel et al. (2014); Saucedo-Martínez et al. (2018); Pérez-Lara et al. (2018); Telukdarie et al. (2018)
Industrial Internet of Things	Decentralization in decision-making vis-à-vis the creation of a network of cyber systems capable of operating in real time.	Giusto (2010); Lee et al. (2014); Thames and Schaefer (2016); Wan et al. (2016).
Cybersecurity	Reliability of machines, operations and products. Generation of performance objectives of superior operations. Competitive advantage.	Rübmann et al. (2015); Lezzi et al. (2018); Tsuchiya et al. (2018)
The Cloud	Operation of cloud-based services. Data storage on a distant device. Information accessed remotely.	Schmidt et al. (2015); Gubán and Kovács (2017); Molano et al. (2018)
Additive Manufacturing	Economicity. Reliability of operations and products. Location of additive manufacturing in centers major world markets.	Anderl (2014); Schwab (2016); Strange and Zucchella (2017); Rao and Prasad (2018).
Augmented Reality	Greater effectiveness in maintenance. Increased productivity. Support for maintenance and training processes.	Almada-Lobo (2016); Albertin et al. (2017); Blanco-Novoa et al. (2018)
Big Data and Analytics	Analysis of data / information in real time. Wide range of benefits. Optimization of processes, reduction of costs, improvement of operational efficiency.	Lee el at. (2014); Rübmann et al. (2015); Zhou and Zhou (2015); Frank et al. (2019).

Based on the technological assumptions for Industry 4.0 advocated by Kagermann et al. (2011), the scenario over a number of years has evolved in industries, as well as other sectors have seized and made the necessary adaptations. This is the case of Precision Agriculture and Livestock which are migrating to the concept of Agriculture 4.0, discussed in the next section.

2.2 Agriculture 4.0

Many are the advantages that the technologies of Industry 4.0 can generate for the agribusiness, thus expanding its database, management and knowledge (Baurer et al., 2015, Posada et al., 2015, Stock et al., 2016). For these authors, the same definition of Industry 4.0 provided by Kaufmann (2015) can be used for Agriculture 4.0, observing the respective scenarios of applicability, mainly the growth of the world population and the increase in the demand for food, the climatic changes and restrictions in the use of water and soil.

As regards livestock and, more specifically, the greenhouse gases emitted by ruminants, Banhazi et al. (2012) mention that it is possible to move forward with mitigating technologies, among other approaches inherent to the sector. However, a report published by the Global Institute for Food Security (GIFS, 2015) found that less than 20% of agricultural land worldwide is managed using digital agricultural technologies.

In contrast to the GIFS (2015), a successful example is the applicability described by Schlick (2014) in a dairy in Germany that uses the technology of autonomous robots for the production of milk and cheese integrated to horizontal and vertical systems, automating the production according to the demand (pulled production), reducing losses of materials and of labor. In this company, the system controls from cattle feed to milk processing, that is, whether it will be sold in natural or processed, all in an automated and integrated way with several systems, reducing environmental impacts.

Weltzien (2016) reveals that although Agriculture is already considered 4.0, there is still much to be done,

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because all technologies are not fully utilized. In addition, it seeks only a few performance goals such as cost and speed reduction, leaving aside other goals such as quality, reliability and flexibility.

Weltzien's (2016) criticism relates to the lack of connection between the technologies that sustain Industry 4.0 and the technologies in use by Agriculture 4.0. In the first, the technology is used to develop an innovative and intelligent product, while in the second, it is used to achieve the performance objectives of operations mentioned in the previous paragraph, so that the cycle does not complete. From the perspective of the author, this attribute will be reached when the other technologies defended by Rübmann et al. (2015) are fully utilized in Agriculture 4.0.

It is not enough to gather data via the Internet with the so-called N-Sensors, automate agricultural machines, use drones to analyze plant growth and check pests, among other technologies that are involving autonomous robots, IoT and augmented reality. It becomes more important to integrate all of this with Big Data and Artificial Intelligence, as well as creating a taxonomy that allows interoperability between systems. This effectively provides both upstream and downstream integration, enabling not only the creation of a cloud-based cybersecurity database, but also intelligent decision-making in relation to markets and their demands, as well as commodity and, mainly, something that goes beyond transgenic, that is, the creation of intelligent agricultural products (Weltzien, 2016).

Rose and Chilvers (2018) concluded in their research that the fourth agriculture revolution should be more responsive to the population's longings about quality of life involving food. It is essential that agriculture also seek responsible ecoefficiency and innovation via technologies advocated by Rübmann et al. (2015). Some nations seem to be more concerned with leadership than with outcomes, as is the case in the UK that invested £90 million to bring about a technological revolution. The criticism is about the creation of a possible monopoly and the disappearance of sustainable agriculture. One word strongly defended by authors in this context is inclusion (Rübmann et al., 2015).

Braun et al. (2018) agree with the idea that Industry 4.0 technologies applied in their own environment or adapted in other areas such as Agriculture 4.0 will only have full effects if they are constructed in a modular form of the information structure in the processes to combine the blocks with flexibility, where the system design allows interventions without affecting the productivity of other subsystems. It is not enough to use technologies such as GPS, Bluetooth or RFID, integrating men and machines, but rather integrate the entire supply chain, in other words, before, inside and after the gate.

Dumitrache et al. (2017) had already reported on the need for a generic framework that would allow the design of corporate architectures in order to unite business and production models, as well as the ability to extend to complex business systems, and ended up proposing a generic architecture in consonance with what has been raised up to now in relation to ecoefficiency, sustainable production, among other highlights. The result of this architecture is represented in Fig. 2, where the building blocks organized in layers and detailed with the aid of architectural views encompass concepts relevant to the organization of Agribusiness.

Fig. 2: Generic Architecture for a Farm
Source: Adapted from Dumitrache et al. (2017).

The blocks at the bottom of the Fig. 2, in the lighter color, represent what is common in a farm, that is, Agribusiness. Second level (Know-How and Data) represents what is necessary and can be achieved with the technologies of Industry 4.0, which is knowledge and experience supported by large databases. Third level consists of information associated with products and by-products that will have their operations planned from the analysis at the second level. Finally, the planning, upstream and downstream integration demonstrated by the hexagons in the darker color, representing quality management, supply chain, business intelligence, decision-making systems, management systems and knowledge.

It is evident that the technologies by themselves do not guarantee a more efficient and effective production according to premises that should be the guide for this new moment. Thus, it is important to understand what experts think about it, and what are the prospects of reducing production costs for Brazilian agribusiness.

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2.3 Results of research on Production Costs in Brazilian Agribusiness

In research on business sustainability in the context of Brazilian agribusiness, Callado et al. (2017) verified that in the period from 1997 to 2015, 36 articles were published in journals listed in CAPES's Qualis, and approximately 50% of these publications occurred after the year of 2013. For the authors, although the publications are increasing, this growth is low, due to the importance and importance of this sector for the country.

According to Artuzo et al. (2018), except large companies, in the production of soybean and maize the decisions are made separately by producer, even cultivars are highly dependent on inputs. As the price is determined by the market (commodities), it is fundamental to control production costs to earn profits. The findings of this research showed a strong correlation of production costs with the price of corn and soybean commodities. According to the authors, comparing the national production per hectare with the production of the United States, it is clear that much management and innovation is lacking so that the Brazilian agribusiness reaches its full efficiency.

Xavier Junior and Lima (2018) used the analysis of Interorganizational Cost Management (ICM) - which aims to reduce total cost through coordinated actions throughout the chain, and therefore, its upstream and downstream strengthening, seeking to generate competitive advantages - in a case study with a large cereal in the northwest of Minas Gerais. It was verified that there are more than a hundred suppliers and clients, however, there is a lack of joint actions in the strategic and operational process, making it impossible to effectively characterize the ICM. A similar study had already been made by Souza and Rocha (2008), arriving at the same considerations about the lack of applicability of the ICM.

The vertical and horizontal integration, one of the nine technologies used by Industry 4.0 and defended by Rübmann et al. (2015) can reduce production costs in agribusiness, according to examples of applicability provided by Brettel et al. (2014), Saucedo-Martínez et al. (2018). The case study developed by Xavier Junior and Lima (2018), may be a sample of the need to implement this technology. It is necessary to do more research in the sector as defended by Artuzo et al. (2018).

Soares and Jacometti (2016) carried out a study in the Brazilian agribusiness, analyzing which strategies added value from the year 2000, based on secondary sources, such as the Center for Advanced Studies in Applied Economics (CEPEA), Ministry of Development, Industry and Foreign Trade (MDIC) and National Supply Company (CONAB), among others. One of the products of this study was a SWOT matrix that determined, among other points, technological lag, low specialization and variability of production as weaknesses of the sector and as one of the opportunities, mechanization of the field. These findings corroborate the results of research by Brettel et al. (2014) and Abreu et al. (2017) who affirm that the simulation can guarantee a pattern to the agribusiness production, as well as to that defended Rübmann et al. (2015) with the nine technologies of Industry 4.0.

In turn, Milagre et al. (2018) found in the micro-region of Frutal - MG the use of IoT by agribusiness, characterizing reduction of the cost of production due to the use of various software and hardware, considerably reducing expenses with fuel for agricultural machines, water and fertilizers, because according to main application, all the mapping of the blocks in production are carried out by drones, where the inputs are used only in locations identified as critical points, generating resources economics in counterpoint to the model that was used before, which was the identification of these needs by tax of field.

Santos et al. (2018) investigated the influence of innovation on the performance of agribusiness ventures in the region of Jaboticabal - SP, seeking to analyze their relationship and impact on market performance and costs. The research revealed that the innovation efforts made by rural producers that refer to the management of operations and supplies and agricultural technology had little influence on the behavior of costs. The authors verified that there were investments in innovation until the year 2013. However, it was not possible to detect in which agricultural technology was invested, that is, if it was only mechanization or if there were characteristics of AP or Agriculture 4.0. This finding goes against what Artuzo et al. (2018) identified in their research, that is, the costs accompany the variation of commodities, in this case, in the agribusiness ventures surveyed in the Jaboticabal region, most of them being dedicated to sugarcane, peanuts, soybeans and corn.

The next section deals with the methodology used for data collection, as well as the manner in which the analyzes were performed.

III. MATERIALS AND METHODS

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This research is characterized as exploratory, since according to Hair Jr. et al. (2016) is based on the condition that the researchers have little information to test hypotheses, because it is a recent topic and with technologies that are constantly changing.

The approach to the problem is a qualitative research, which according to Rea and Parker (2002) responds to particular questions, having an open and flexible plan, focusing reality in a complex and contextualized way. It also assumes quantitative research character, since the respondents' positions are represented quantitatively.

As for the technical procedure, this is a survey with the application of electronic questionnaires, which were sent using the Goodle Forms platform to 20 (twenty) specialists in agribusiness, linked to institutions such as the Brazilian Agricultural Research Company (EMBRAPA), as well as the events (Agrishow Digital). The choice was made by market professionals, mostly consultants of agribusiness technology companies, agronomists of small and large farms, as well as academic professionals and researchers. We obtained a 30% return of the total number of questionnaires sent.

The elaboration of the questionnaire was based on the literature and on empirical studies already done, so that the sentences were grouped into two categories: (i) the positioning of the specialists regarding the use of technologies of Industry 4.0 by the Brazilian agribusiness, represented in Fig. 1, and (ii) reduction of production costs from the use of technologies of Industry 4.0 by the Brazilian agribusiness, represented in Fig. 2.

For the interpretation of the answers, the content analysis was used (Bardin, 1977), which consists of the pre-analysis, the exploration of the material and the treatment of the results, leading to inferences and interpretations. For this purpose, the nine technologies defended by Rübmann et al. (2015), summarized in Table 1, with the bias of reducing production costs in Brazilian agribusiness.

IV. RESULTS AND DISCUSSION

The experts were asked about the possible application in the Brazilian agribusiness of the Autonomous Robotics (AR) technology through digital automation with sensors for process control, product identification and operational conditions, making planting and harvesting more flexible to climate change, allowing the monitoring and remote control of the harvest with MES and SCADA type systems. These technologies are considered precursors of changes in processes and products (CNI 2016).

The frequency obtained with the respondents is presented in Fig. 3, whose legend presents the response options in the quantitative survey ("y" axis). The acronyms of the "x" axis represent the nine technologies of Industry 4.0.

For three experts, IoT, CC and BDA are already practiced. Two experts report the technologies S, A.M. and Au.R. as already practiced. Three other experts consider the possibility of using HVSI technology in the near future, and two of AR, AuR and BDA.

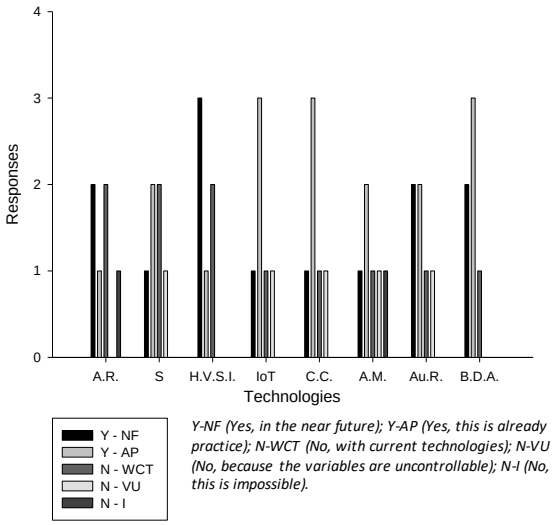

Fig.3 - Positioning of specialists regarding the use of technologies

One expert added that "*many agricultural machines already work without human intervention, in addition to the use of drones monitoring areas of cultivation*." Another mentioned that "*the use of current technology does not guarantee the fullness of what is questioned, since climatic variables are uncontrollable, so the technologies developed to date by Industry 4.0 involving autonomous robots are not enough to overcome the risks and adversities of agribusiness* ".

The response of half the respondents is in line with the study presented by GIFS (2015), where it is found that less than 20% of agricultural land worldwide is managed using digital agricultural technologies.

According to Collis and Montgomery (1995), Slack and Lewis (2009) better operation's performance can lead to a competitive advantage. Brettel et al. (2014) and CNI (2016) argue that among other objectives, Simulation (S) has the ability to mirror the physical world in a virtual world, integrating machines, products and men, reducing setups and lead time.

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The experts were also questioned about the use of Simulation in agribusiness, more specifically in livestock. It was found in his answers strong division of opinions. No respondents complemented their choice of answer, leaving questions about the use of this technology. However, Banhazi et al. (2012) state that it is fundamental to control the greenhouse gases (CGG) produced by agriculture and livestock. Therefore, this could be one of the applications of the Simulation, changing maneuvers and confinement, simulating its results and the respective emissions.

Regarding the Horizontal and Vertical Integration of Systems (HVSI), the experts were asked about the application of this technology connecting the agribusiness upstream and downstream, joining information and decisions before and after the gate, promoting, for example, automatic purchase control of a fertilizer, as well as the automatic delivery of horticultural products in function of the reduction of the stock of a marketer, practicing the horizontal cooperation between firms and the real-time processing, which allows the self-organization of the decisions vertically. Half of the respondents say that this will be practiced soon, 1 (one) respondent said that this is already practiced, and 2 (two) respondents said that this will not be possible with current technologies.

The criticisms made by Weltzien (2016) regarding the lack of connection between the technologies supporting Industry 4.0 and technologies in use by Agriculture 4.0 are corroborated by these results. While industries around the world already use advanced production models such as supply chain management (SCM), total cost of ownership, among others, Brazilian agribusiness still works in isolation, mainly due to the lack of connection between large producers and small players, commonly advocated and exploited by the industrial environment as outsourcing.

As for the questioning involving Internet of Things (IoT), Cyber Security and Cloud Computing (C.C.), the vast majority assume that it is already in practice or will be in the near future, which leads to believe that, for these specialists, these technologies are already present in some way in the day-to-day of Brazilian agribusiness. Only one respondent stated that these technologies will not be used, "*because the variables are uncontrollable*".

On the use of Industry 4.0 technology named by Rübmann et al. (2015) as Additive Manufacturing (AM), in the development of new products or processes, as argued by Schwab (2016), there was a great divergence in the responses. Two experts supplemented their responses by stating that this technology will allow in the near future to understand and address pest control and the effect of pesticide use on products. These responses are in line with what Rose and Chilvers (2018) argued for food safety and the need to reduce the use of chemical barriers for this type of control.

Regarding the use of Augmented Reality (AuR), Almada-Lobo (2016) clarifies that this technology allows integration and practical application of other technologies. Thus, its applicability in agribusiness and, respectively, in Agriculture 4.0, would have as main function the prospecting of cultivation areas, maintenance of equipment and dams. Of respondents, one third (1/3) believe that this will be practiced in the near future, while two others believe it is already being practiced. There was no descriptive complement to this questioning.

Finally, questioned about Big Data (BDA), two respondents believe that agribusiness will be using these technologies in the near future, while three say they are already practiced, and only one respondent believes that current technologies are not enough to do so. Two respondents justified their responses by stating that meteorological control and the availability and disclosure of their data could be considered an example of this.

These responses are in line with what Lee et al. (2014) for which Big Data has its architecture based on a large dataset, with processing and storage supported by speed, volume and variety, with ample possibility of analysis of data and information in a timely manner, being fundamental the management and the distribution of data so that the machines become self-conscious and self-learning. The results are in line with those reported by Dumitrache et al. (2017) and Braun et al. (2018) that corroborate by providing a generic architecture for this large database and analysis that will be used by Agriculture 4.0 and which will only have full effect if they are constructed in a modular form of the information structure in the processes to combine the function blocks with flexibility.

A separate analysis of responses was made to the possibility of reducing production costs in Brazilian agribusiness as a result of the adoption of technologies developed by Industry 4.0.

The experts were questioned about the possible application in the Brazilian agribusiness of the technologies Autonomous Robotics (AR), Simulation (S), Horizontal and Vertical Integration of Systems (H.V.S.I.),

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Internet of Things (IoT), Cyber Security and Cloud Computing (CC), Additive Manufacturing (AM), Augmented Reality (AuR) and Big Data (BDA), defended by Rübmann et al. (2015) as pillars of Industry 4.0.

The respondents had the possibility to complement the answer in the electronic form, where, in general, the complements were made affirming that there is a reduction of costs with labor, logistics, but, mainly, with the possibility of exact application of irrigation, fertilizers and pesticides, which in the opinion of experts would reduce costs.

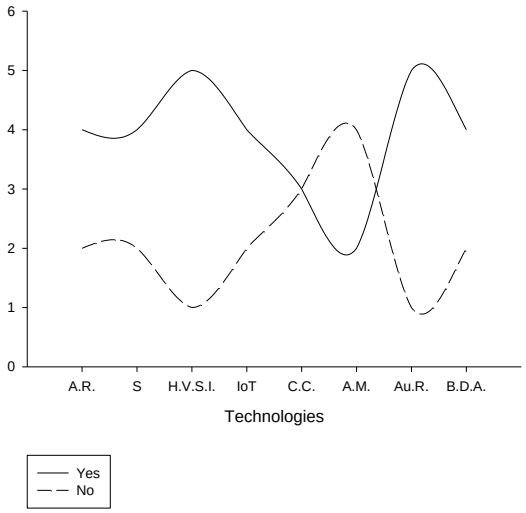

Fig.4 - Expert positioning regarding cost reduction.

The answers of the experts are corroborated by the literature review, especially the researches by Artuzo et al. (2018), Milagre et al. (2018) and Santos et al. (2018), whose results showed that the investment in technology and innovation, brings positive results regarding the reduction of production costs in Brazilian agribusiness.

Horizontal and Vertical System Integration (HVSI) and Augmented Reality (AuR) followed by Autonomous Robotics (A.R.), Simulation (S), Internet of Things (IoT) and Big Data Analytics (BDA) are considered by the specialists as cost reductions upstream and downstream, starting to share in the resource economy, such as the installation of solar panels for the generation of photovoltaic energy and the creation of Permanent Preservation Areas (APP) for the supply of shared use dams.

The adoption of Additive Manufacturing (AM) technology was not considered in the reduction of production costs by Brazilian agribusiness, and a specialist considers that prototyping to be full will cost more than the benefit that is expected to be achieved by the innumerable variables that interfere with the segment.

The results obtained in the research allow us to explain some considerations that are presented in the following section.

V. CONCLUSION

This study aimed to verify the applicability of the terms of Industry 4.0 in the Brazilian agribusiness as a mechanism to reduce production costs, according to six experts who answered an electronic questionnaire on this subject. The divergences evidenced among the specialists need to be better studied, as is the case of the use of Autonomous Robots (AR) by agribusiness.

As for Simulation (S) technology, two experts have stated that this technology is already employed, while two others have said that it is impractical with current technologies. This implies the need to deepen the analysis, whether due to the very concept of Simulation, or in the application and dissemination of this technology by the market.

Technologies such as Internet of Things (IoT), Cyber Security and Cloud Computing (CC) have received favorable responses to the development of Horizontal and Vertical Systems Integration (HVSI), since, according to experts, while the first three are already being applied, there is an environment favorable to the application of Horizontal and Vertical Integration of Systems, creating the connection defended by Weltzien (2016).

Possibly, these four technologies can be integrated to the Additive Manufacturing (AM), considering that it would be quite reasonable to use prototyping in conjunction with algorithms from HVSI technology, with a high level of reliability, through a large processing base (CC) powered by transmitters Wi-Fi ESP 8266 or more evolved (IoT). In relation to the Augmented Reality (AuR) and Big Data (BDA) it was evidenced that they are technologies in application or in the process of being implemented.

It can be considered that the Brazilian agribusiness is, even at a slow pace, on the way to Agriculture 4.0.

It is suggested that an official repository be set up, organized by an entity or a body linked to the Ministry of Agriculture, Livestock and Food Supply (MAPA), where all technologies developed (subject to legal property rights) converge with free access to interested parties. This could contribute to the formation of a consistent database supporting the diffusion of the status quo of Agriculture 4.0 in Brazil.

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Within this scenario, it is suggested to carry out new studies, carried out in an individual way involving each of the technologies that compose Industry 4.0 and its application in agribusiness. The systematic analysis of the work shows that the monitoring of these technologies is strategic and should be studied in Universities, Technological Development Centers, private companies linked to the sector through its Research, Development and Innovation (P, D & I) departments, among others. The study of the adaptability of the technologies involved in this horizon is fundamental for the development of Brazilian agribusiness.

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Optimization of Food-Waste Based Culture Medium for Cellulase Production by Thermophilic *Bacillus* sp SMIA-2 and effect of Divalent Metal Ions on Activity and Stability of the Enzyme at Higher Temperatures

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Abstract**—** *In general, the costs for cellulases production are associated with the value of the carbon source used in the process. Waste from the food processing industry contains several reusable substances that can replace the expensive components used in culture media for the production of cellulases. In this work, it was studied the combined interactive effect of different concentrations of sugarcane bagasse treated with alkali, passion fruit rind flour and corn steep liquor for maximal avicel-hydrolyzing enzymes – avicelases by thermophilic Bacillus sp SMIA-2, using statistical methodology. The influence of metal ions on the activity and stability of the enzyme was also investigated in order to increase the industrial applicability of enzymes. A concentration of 0.3% (w /v) of these three components in the production medium can be used successfully to obtain high levels of avicellase activity. The avicelase displayed enhanced activity in the presence of 10 Mm CoCl2 after incubation at 90ºC for 1 h, indicating that this enzyme depended on the metal ions to promote its activity and stability at higher temperatures.*

Keywords**— Avicelase, Bacillus, Food wastes, Metal ions, Thermostability.**

I. INTRODUCTION

Lignocellulose constitutes 60% of the plant cell wall [1]. Cellulose is a major polysaccharide found in lignocellulose and is made up of repeating glucose units. Besides cellulose, plant-based food wastes are rich in pectin, inulin, xylan, mannan, glucan, starch, etc., depending upon the nature of the waste product [2]. The sugarcane bagasse, a fibrous residue of cane stalks left over after the crushing and extraction of the sugar from sugarcane is rich in cellulose and hemicellulose [3]. It can be regarded either as a waste, affecting the environmentor, as a resource when suitable valorization technologies are implemented. Bagasse consists of cellulose 43.8%, hemicellulose 28.6%, lignin 23.5%, ash 1.3% and other components 2.8% and is abundantly and cheaply available as a byproduct from the sugar industry in Brazil [3]. Another food waste produced abundantly in Brazil is yellow passion fruit peel, which is rich in cellulose and hemicellulose contents, besides minerals, and especially pectin [4]. Like many other agro-industrial by-products, passion fruit waste has low commercial value and its deposition on a large scale may result in a negative environmental impact. Currently, its main use in Brazil is as a supplement to animal feed, which presents several transport and storage problems due its high moisture content [5]. Therefore, being rich in polysaccharides, sugarcane bagasse and yellow passion fruit peel have been studied as a potential media component for the production of various industrially important enzymes, in particular, cellulose-degrading enzymes [6,7].Cellulases are the third most abundant industrial enzyme [8]. Thermophilic cellulases are ideal biocatalysts for modern biotechnology because of their thermostability and better yields under extreme operational conditions [9,10]. The wide range of applications of thermophilic cellulases include the food, textile, chemical, pulp and paper industries, laundry detergents, and second generation ethanol production

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[11-16]. The thermophilic *Bacillus* sp. SMIA-2 expressed a promising level of avicel-hydrolyzing enzymes — avicelases) in cultures shaken at 50°C containing sugarcane bagasse, as cellulosic substrate, in combination with passion fruit rind flour, as co-substrate, and corn steep liquor as nitrogen source [7]. In this work, it was studied the combined interactive effect of the concentration of these three components for maximal avicelases by thermophilic *Bacillus* sp SMIA-2, using statistical methodology. The influence of metal ions on activity and thermostability of the avicelases was also studied in order to increase the industrial applicability of enzymes.

II. MATERIALS AND METHODS

2.1. Organism

The present study used a thermophilic *Bacillus* sp strain SMIA-2, previously isolated from a soil sample collected in the city of Campos dos Goytacazes, Rio de Janeiro, Brazil. Phylogenetic analysis revealed that the bacteria were closely related to *Bacillus caldoxylolyticus* and *Bacillus* sp strain AK1, and these three organisms exhibited levels of ribossomal DNA sequence homology of 94% [17].

2.2. Enzyme Production

The culture medium used in this work for cellulase production contained (g/L): KCl - 0.3, $MgSO_4$ - 0.5, K_2HPO_4 - 0.87, $CaCl_2$ - 0.29, ZnO - $2.03x10^{-3}$, $FeCl_3.6H_2O$ - $2.7x10^{-2}$, $MnCl_2.4H_2O$ - $1.0x10^{-2}$, $CuCl_2.2H_2O$ - $8.5x10^{-4}$, $CoCl_2.6H_2O$ - $2.4x10^{-3}$, $NiCl_3.6H_2O$ - $2.5x10^{-4}$, H_3BO_3 - $3.0x10^{-4}$. Sugarcane bagasse (SCB) treated with alkali (81.05% cellulose, 18.75% hemicellulose, 5.45% lignine) was used as a source of cellulose [3] and commercial corn steep liquor (Sigma Aldrich), as a nitrogen source. Passion fruit rind flour (obtained from a local market) was used as co-substrate. The SCB, corn steep liquor (CSL) and passion fruit rind flour (PFRF) concentrations were adjusted for each value according to central composite design (CCD), as presented in Table A.1. The pH was adjusted to 7.2 with 1.0 M NaOH and the medium was sterilized by steam-autoclaving at 121 °C, 1 atm for 15 minutes. The medium (50 mL in 250 mL Erlenmeyer flasks) was inoculated with 1 mL of an standard overnight culture (initial number of cells 10^4) and incubated at 50 °C in an orbital shaker (Thermo Forma, Ohio, USA) operated at 150 rpm. After 168 h triplicate flasks were withdrawn and the contents were then centrifuged (HERMLEZ 382K, Wehingen, Germany) at 15,500 g for 15 min, at 4 °C, and the cell free supernatant was used as crude enzyme preparation.

2.3. Enzyme Assay

The cellulolytic enzyme activities were determined using the dinitrosalicyclic acid method [18], which measures reducing sugars. The reaction mixture containing 0.5 mL of 1% (w/v) avicel, PH-101 prepared in 10 mM sodium phosphate buffer, pH 7.5, and 0.5 mL of appropriate concentration of enzyme solution, was incubated at 70 °C. After 10 min of reaction, 1 mL of dinitrosalicyclic acid reagent was added and boiled in water bath for 5 min. The resulting samples were then cooled to room temperature, and the absorbance was measured at 540 nm. When the activity was tested using avicel as substrate, the assay tubes were agitated during the course of the assay to keep the substrate suspended. One unit (U) of activity toward the substrates mentioned above was defined as 1 µmole of glucose equivalent released per minute under the above assay conditions, by using a glucose standard curve. Appropriate controls were conducted in parallel with all assays. Enzyme blank containing 0.5 mL of 10 mM sodium phosphate buffer and 0.5 mL of 1% (w/v) substrate solution were run. To exclude the background of reducing sugars found in the enzyme supernatant from the results, a substrate blank containing 0.5 mL of 10 mM sodium phosphate buffer and 0.5 mL enzyme solution was also run. The absorbance of the enzyme blank sets and the substrate blank were subtracted from the absorbance of the activity assay. All of the samples were run in triplicate, while the blanks were run in duplicate.

2.4. Experimental Design and Statistical Analysis

The surface-response methodology (SRM) was used to obtain a model for cellulase activity. To evaluate the effects of SCB, PFRF and CSL concentration on the production of cellulase, a central composite design (CCD) 2^3 was constructed. The factorial planning had five central points and yielded a total of 19 treatments. The factors and levels studied are described in Table A.1.The results were analyzed using the Statistica software system, version 5.0. In this context, the F test was used as a validation criterion of statistical significance of the models obtained at a confidence level of 95%.The optimization of condition was performed using CCD and surface-response was produced with fixed central points of 0.575% SCB, 0.575% PFRF and 0.575 CSL. The experimental model can be expressed as follows (Eq. A.1):

$$Y = bo + \sum_{i=1}^{4} bi\, xi + \sum_{i=1}^{4} bii\, xi^2 + \sum_{i \neq j=1} \sum bij\, xi\, xj$$

Eq. (A.1)

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Where *bo*, *bi*, *bii* and *bij* are the intercept terms, linear, quadratic coefficient and interactive coefficient, respectively, and *xi* and *xj* are coded independent variables.

2.5. Effect of metal ions on avicelase activity

The effect of different metal ions on avicelase activity was determined by the addition of the corresponding ion at a final concentration of 1mM and 10 mM to the reaction mixture, and assayed under standard conditions. The enzyme assay was carried out in the presence of $CoCl_2$, $CaCl_2$, $ZnSO_4$, $CuSO_4$, $MgSO_4$, $BaCl_2$ and $MnSO_4$.

Thermostability of avicelase was determined by incubation of crude enzyme at temperature of 60ºC, 70 ºC and 90ºC in a constant-temperature water bath. The residual activity (%) was measured at various intervals of time under standard assay conditions. The enzyme preparation was also incubated in the presence of $CoCl_2$ (10 mM) and $CaCl_2$ (10mM) at 70ºC and 90ºC. The residual activity (%) was measured at various intervals of time under standard assay conditions.

III. RESULTS AND DISCUSSION

3.1. Optimization of food-waste concentrations in the culture medium

The thermophilic *Bacillus* sp SMIA-2 produced avicelase (avicel-hydrolyzing enzymes) in 120 h submerged cultures containing SCB treated with alkali as source of cellulose and PFRF as co substrate (Table A.1). CSL was used in place of meat and yeast extracts, which are nitrogen sources of high cost. The use of waste from the food industry as raw materials for culture media, promote economic advantages, because they reduce environmental pollution and stimulate new research for science sustainability [19]. Passion fruit processing generates a substantial amount of residues, including peel. Its use as an additional source of carbon can enhance the growth and production of cellulases by *Bacillus* sp SMIA-2, eliminating the need for additional nutrients as it is rich in fiber, minerals and mainly pectin [7]. Whereas it is essential to study and quantify the effects of these three components on cellulase production and strike a balance between them to enhance the enzyme activity, a central composite design (CCD) 2^3 was constructed (Table A.1). A variation in avicelase activity was observed from 0.820 (Treatments 16) to 1.96 – 1.97 $U.mL^{-1}$ (Treatment 1, 2 and 7).

Table A.1 - Matrix of CCD 2^3 (real and coded values) used and its response (avicelase activity).

Essays	PFRF (%, w/V)	SCB (%, w/V)	CSL (%, w/V)	Avicelase (U/mL)
1	0.322 (-1)	0.322 (-1)	0.322 (-1)	1.961
2	0.828 (+1)	0.322 (-1)	0.322 (-1)	1.964
3	0.322 (-1)	0.828 (+1)	0.322 (-1)	1.044
4	0.828 (+1)	0.828 (+1)	0.322 (-1)	1.083
5	0.322 (-1)	0.322 (-1)	0.828 (+1)	1.214
6	0.828 (+1)	0.322 (-1)	0.828 (+1)	0.857
7	0.322 (-1)	0.828 (+1)	0.828 (+1)	1.974
8	0.828 (+1)	0.828 (+1)	0.828 (+1)	1.379
9	0.150 (-1.68)	0.575 (0)	0.575 (0)	1.575
10	1.00 (+1.68)	0.575 (0)	0.575 (0)	1.752
11	0.575 (0)	0.150 (-1.68)	0.575 (0)	1.360
12	0.575 (0)	1.000 (+1.68)	0.575 (0)	1.741
13	0.575 (0)	0.575 (0)	0.150 (-1.68)	0.871
14	0.575 (0)	0.575 (0)	1.000 (+1.68)	1.662
15	0.575 (0)	0.575 (0)	0.575 (0)	0.849
16	0.575 (0)	0.575 (0)	0.575 (0)	0.820
17	0.575 (0)	0.575 (0)	0.575 (0)	0.916
18	0.575 (0)	0.575 (0)	0.575 (0)	0.920
19	0.575 (0)	0.575 (0)	0.575 (0)	0.852

The statistical significance of the model equation was assessed by an F-test (ANOVA) and the data are shown in (Table A.2). An equation for avicelase activity (Eq. A.2) was developed based on a regression analysis of the following experimental data:

$$Y = 0.874863 - 0.044671\ x_1 + 0.259512\ x_1^2 + 0.09221\ x_2 + 0.219573\ x_2^2 + 0.051560\ x_3 + 0.119182\ x_3^2 - 0.025154\ x_1 x_2 - 0.124228\ x_1 x_3 + 0.384825\ x_2 x_3 \quad \text{Eq. (A. 2)}$$

Where x_1 is the PFRF, x_2 is the SCB and x_3 is the CSL concentration.

The outcome of ANOVA analysis revealed that the adjusted model was significant, according to the analysis of the F test. The regression model for avicelase production was highly significant ($p < 0.05$), with a satisfactory value of determination coefficient (R^2 = 83.11). The response surface was produced according to (Rodrigues and Lemma, 2009) [20].

Table A.2 - ANOVA for the variables of response surface quadratic model for avicelase production

Variable	Mean square	(Degrees of freedom)	Sum of squares	F Value	F Statistic 0.05
Regression	2.149	9	0.239	3.771	3.18
Residues	0.570	9	0.063		
Lack of adjustement	0.562	5	0.112	56.759	6.26
Pure error	0.008	4	0.002		
Total error	3.290	18			
				R^2 =	83.11%

Response surface and contour plot figures obtained by the analysis of the experimental data of CCD showed a relationship between two variables at time. The non-

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explicit variables were fixed at the central point (level 0) for the surface construction. The interaction effect between CSL and PFRF concentration on avicelase activity, when the SCB concentration was kept constant (0.575%, w/v) is displayed in Fig. A.1 (A). The activity of the enzyme increased both, when the CSL concentration was increased simultaneously with the decrease in the PFRF concentration and when the PFRF concentration was increased simultaneously with the decrease in the CSL concentration. The interaction effect between SCB and CSL concentrations on avicelase production, at constant PFRF concentration (0.575%, w/v), is presented in Fig. A.1 (B). Higher levels of avicelase activity were found as when higher as lower concentrations of SCB and CSL were utilized simultaneously. Finally, the interaction effect between SCB and PFRF concentrations on avicelase production was presented in Fig. A.1 (C). The 3D graph shows that when keeping the CSL concentration constant at 0.575% (v/v), irrespective of the increase or decrease of SCB and PFRF concentrations at the levels studied, the avicelase activity increased. According to these results, seems that lower concentrations of these three components in the production medium can be used to obtain high levels of avicellase activity.

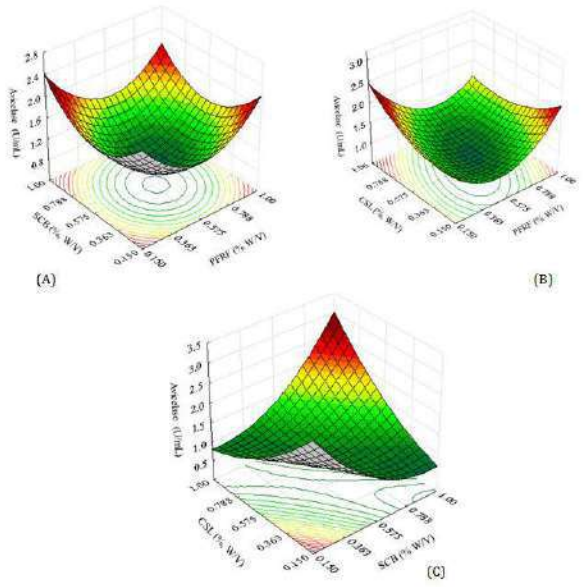

Fig. A.1 - Three-dimensional response surface plot for: (A) - Effect of SCB and PFRF concentration on avicelase production by Bacillus sp SMIA-2 at a constant CSL (0.575%, w/v); (B) - Effect of CSL and PFRF concentration on avicelase production by Bacillus sp SMIA-2 at a constant SCB (0.575%, w/v); (C) - Effect of SCB and CSL concentration on avicelase production by Bacillus sp SMIA-2 at a constant PFRF (0.575%, w/v).

The avicelase activity is low when the graphic has dark red color indicates high activity, while green and yellow color indicates low avicelase activity.

In fact, the maximum avicelase activity was obtained when *Bacillus* sp. SMI-2 was growth for 120 h in the culture medium containing 0.3% (w/v) of each of the three components (Fig. A.2). At higher concentrations, the avicelase activity was comparatively lower or was not affected. Besides, the concentration of 0.3% (w/v) of these three components gave better reproducibility in production experiments.

[7] Costa et al. (2017) reported that higher avicelase activities (2.73 U.mg protein^{-1}) were obtained when *Bacillus* sp SMIA-2 was grown in liquid medium containing 0.625% (w/v) treated SCB and 0.625% (w/v) CSL. The supplementing of this culture medium with 0.75% (w/v) passion fruit rind flour (PFRF) supported maximal enzyme activity. However, the combined interactive effect of the concentration of these three components was not investigated by the authors.

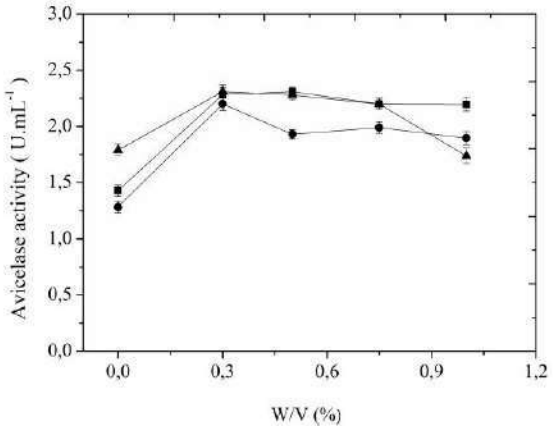

Fig. A.2 - Activity of avicelase in submerged cultures of Bacillus sp SMIA-2 (120 h) containing: (▲) 0.3% (w/v) SCB and 0.3% (w/v) PRFR and different concentrations of CSL; (●) 0.3% (w/v) PRFR and 0.3% (w/v) CSL and different concentrations of SCB (■); 0.3% (w/v) SCB and 0.3% (w/v) CSL and different concentrations of PRFR.

Comparison between the activities obtained and the published literature was hindered by the different definitions of enzymatic activity and different levels of enzyme purity used. Thus, a concentration of about 0.3% (w/v) of these three components in the production medium can be used successfully to obtain high levels of avicellase activity.

3.2. Effect of metal ions on activity and stability of avicelase

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The activity of the avicelase was increased in the presence of 1 and 10 mM $CoCl_2$ and inhibited by Ba^{2+} and Mn^{2+} (Table A.3). Cellulases from different microbial sources show diverse behavior towards metal ion requirement for their activity. Some enzymes require metal ions, some are inhibited by metal ions, while some are independent of their presence. [21] Duman et al. (2016) reported that the presence of Co^{2+} metal ions in the reaction mixture enhanced the cellulase activity of *Bacillus methylotrophicus* Y37 to 319% of the original level, while Mg^{2+} increased the activity at moderate levels (148% and 141%, respectively). [22] Gaur and Tiwari (2015) reported that cellulase activity of *Bacillus vallismortis* RG-07 was strongly stimulated by $CaCl_2$ and NaCl. The cellulolytic and hemicellulolytic enzymes activities from *Enterobacter* sp. SUK-Bio increased after the addition of $MnCl_2$ and $CoCl_2$ in the reaction mixture [23].

Table A.3 - Effect of various divalent metal ions on avicelase activity

	Residual avicelase activity (%)	
Divalent metal ions	1mM	10mM
Control	100 ± 0.019	100 ± 0.012
$CoCl_2$	109.8 ± 0.016	112.75 ± 0.011
$CaCl_2$	96.57 ± 0.017	98.72 ± 0.015
$ZnSO_4$	95.09 ± 0.011	108.13 ± 0.012
$CuSO_4$	92.65 ± 0.019	98.00 ± 0.019
$Mg\ SO_4$	91.67 ± 0.017	99.94 ± 0.019
$BaCl_2$	84.8 ± 0.013	65.20 ± 0.012
$MnSO_4$	72.06 ± 0.011	82.35 ± 0.014

The thermostability of avicelase from *Bacillus* sp at 60ºC, 70ºC and 90ºC is showed in Fig. A.3. The results are expressed as percentage of residual activity, taking into account the activity determined with the non-treated enzyme samples. The thermostability profile indicated that the enzyme remained 100% stable at 60ºC for 1 h, but lost about 47% and 68% of the original activity after 1 h heat treatment at 70ºC and 90ºC, respectively (Fig. A.3). It's known that at very high temperatures, inactivation of enzymes may occurs mainly due to thermal denaturation (loss of tertiary structure) and degradation (loss of primary structure) [24], and that metal ions are known to be important to the catalytic activity and stability of many enzymes [24,25]. In fact, after incubation of avicelase at 70º and 90ºC for 1 h, in the presence of $CaCl_2$ the avicelase lost about 28.9% and 54.3% of its original activity, but in the presence of $CoCl_2$ the enzyme displayed enhanced activity after incubation for 1 h at both temperatures, indicating that this enzyme depended on the metal ions to promote its activity and stability at higher temperatures. Thus, apparently the $CoCl_2$ protected the enzyme against thermal denaturation and play an important role in modulating both the stability and the activity of avicelase produced by *Bacillus* sp SMIA-2. According to [26] Vasconcellos et al. (2016), high activity and stability are essential for (hemi) cellulolytic enzymes used in biomass conversion and one potential strategy is the addition of inexpensive metal ions to improve its activity, thermostability, and saccharification efficiency.

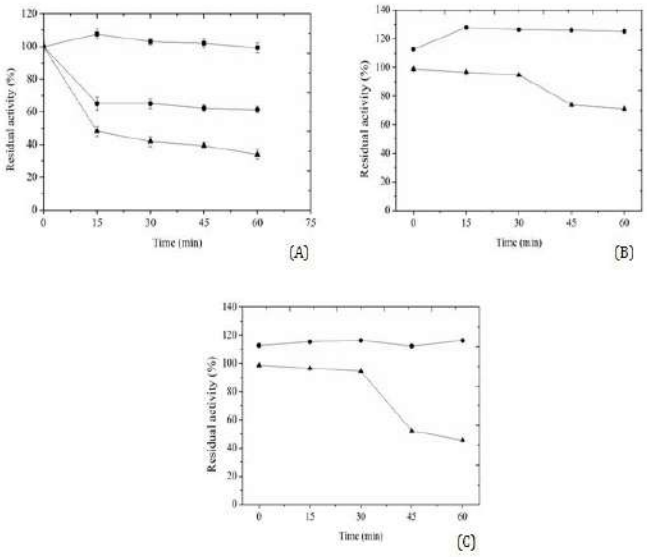

Fig. A.3 - (A) - Thermostability of avicelase at 60ºC (■), 70ºC (●) and 90ºC (▲); (B) - In the presence of 10 mM $CoCl_2$ (●) and $CaCl_2$ (▲) at 70ºC (C) – In the presence of 10 mM $CoCl_2$ (●) and $CaCl_2$ (▲) at 90ºC (C). (100% of enzyme activity = 1.98 UmL^1).

IV. CONCLUSION

Our results showed that the combination of 0.3% sugarcane bagasse, passion fruit rind flour and corn steep liquor in a basic mineral media provides the achievement of high levels of cellulase activity by *Bacillus* sp SMIA-2. This opens perspectives for use of these agricultural byproducts as novel industrial culture mediums for the production of cellulase, combinating environmental concern with sustainable processes to reduction of production cost. The avicelase displayed enhanced activity in the presence of 10 mM $CoCl_2$ after incubation at 70º and 90ºC for 1 h, indicating that this metal ion apparently protected the enzyme against thermal denaturation and play an important role in modulating both the stability and the activity of the enzyme. This result is very important because increase the industrial applicability of avicelase from *Bacillus* sp SMIA-2 in processes that operate at high temperature.

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Initial Establishment and Physiological Performance of Rice as Affected by Ryegrass Mulching Levels

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Abstract *— We aimed to evaluate the initial growth and physiological characteristics of rice planted following ryegrass in lowland areas. The experiment was conducted in Capao do Leao, Brazil, in Typic Albaqualf. Ryegrass was planted preceding the experiment installation. Prior to rice planting, the area was burndown with herbicide, when treatments were established: ryegrass plants were cut at 0, 15, 30 or 45 cm above ground, resulting in different mulching levels. Rice was then planted, being managed according to local recommendations for the crop. We evaluated the variation in soil moisture levels, rice establishment in density and seedling height, and physiological parameters: relative fluorescence, chlorophyll, flavonoid and nitrogen balance indexes. High mulching levels by ryegrass allowed rice five additional days on a dry season, before harmful soil water tension, compared to bare soil; seedlings able to emerge under the ryegrass mulching, grew without considerable barriers; plant physiology in fields with residual ryegrass mulching was little affected, and ryegrass cut up to 45cm height prior to planting rice seem not to affect it. This corresponds to a maximum of about 4500 kg ha-1 of ryegrass straw on soil surface prior to planting rice to avoid damages to crop establishment.*

Keywords *— Oryza sativa, Lolium multiflorum, lowlands, growth.*

I. INTRODUCTION

The state of Rio Grande do Sul is the main rice producer in Brazil, accounting for about 70% of the country's total production in an approximate area of one million hectares produced annually (Sosbai, 2016), of a total area of three million hectares available for the crop (Gomes et al., 2006).

Currently the predominant planting system, used in approximately 60% of the areas, involves low soil disturbance (involving minimum tillage, fall tillage and no-tillage) aiming for immediate planting as soon as the weather allows it. The conventional tillage system, involving soil harrowing and disking prior to planting, is present in 30% of the areas, and the water-seeded rice is used in about 10% of the area (Irga, 2016). This management based on conservation principles has various benefits, from the improvement of soil properties to the possibility of income diversification, allowing the crop-livestock integration (Marchesi et al., 2011) or crop rotation (Gomes et al., 2006).

However, innate characteristics of lowland soils such as high macro / micropore ratio, high density and low drainage capacity, which is the consequence of a subsurface layer with low permeability, among other factors, limit root growth of plants that are not adapted to the hypoxia (Pauletto et al., 2004). These traits influence rice planting in succession to mulching plants, since soil humidity alters the rate of mass decomposition and releasing organic acids to soil, that may lead to delayed rice seedling establishment and poor development of rice plants (Marchesi et al., 2011).

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Studies show that ryegrass (*Lolium multiflorum* Lam.) is relatively adapted to lowland soils, promoting benefits such as nitrogen cycling, fast mulching establishment, as well as helping to suppress weeds (Reddy, 2001).

However, the inadequate management of the rice-ryegrass succession system may result in unsatisfactory results, since the release of organic acids occurs when the soil has low oxygen concentrations (Adeleke et al., 2017). These acids can cause phytotoxicity in seeds when in high concentrations, generating physiological disturbances such as cell wall degradation, inhibition of respiratory functions, and consequently, decrease of the cellular division of the root system (Tunes et al., 2013) and damages in the photosynthetic apparatus.

Therefore, the study aimed to evaluate the initial growth and physiological characteristics of rice plants planted following ryegrass in lowland areas.

II. MATERIAL AND METHODS

The experiment was carried out in the experimental field of the Center for Herbology Studies (CEHERB), plant health department, Federal University of Pelotas, Capão do Leão - RS, Brazil (31° 48' 22" S; 52° 28' 56" W). The soil was classified as Solodic Eutrophic Hydromorphic Planosol (Embrapa - CNPS, 2006), corresponding to the Typic Albaqualf in the North American soil classification system.

The area chosen for the experiment was previously under fallow and went through harrowing and disking prior to planting. Ryegrass (*Lolium multiflorum*) - cv. BRS-Ponteio was planted as cover crop on 05/30/2017 at the density of 30 kg ha^{-1}; fertilization consisted of 90 kg ha^{-1} of nitrogen, being $^2/_3$ applied at early tillering and $^1/_3$ applied at stem elongation.

The experimental design was a randomized block with four replications. Four soil mulching levels were tested, being established by the cutting height of the ryegrass plants: 15 cm, 30 cm and 45 cm from soil level, plus a control treatment with no ryegrass (0 cm). The mass cut from plants was entirely removed from the experimental plots.

After treatment establishment, ryegrass residual mass was randomly sampled into the experimental area, and drying was accomplished in oven at 60 °C (± 5 °C) to establish the relationship between cutting height and straw mass. The resulting straw corresponded approximately to 0 (control), 1.5, 3.0 and 4.5 t ha^{-1} of dry mass remaining on soil surface, proportionally to the cutting heights.

Subsequently, on 09/18/2017, two days after cutting, ryegrass was burndown with glyphosate at 1620 $g_{a.e.}ha^{-1}$ to establish the mulching. On 09/25/2017, soil moisture sensors (Watermark electro-tensiometers, Irrometer Co.) were installed, one per plot at depth of 5 cm in order to monitor moisture in the 0-10 cm soil layer. All sensors were connected to dataloggers which recorded the soil water tension every hour.

Rice was planted on 10/09/2017, with the cv. IRGA 424 RI in the density of 90 Kg ha^{-1}. Nitrogen fertilization amounted 150 kg ha^{-1} of N, being 55% applied in the V4 stage and 45% in the R2 - booting stage (Counce et al., 2000). The other cultural managements were carried out according to the technical recommendations of the rice research for Southern Brazil (Sosbai, 2016).

Before rice emergence, high rainfall events were reported (126 mm between 10/10/2017 and 10/15/2017 and 62 mm on 10/18/2017), with 50% emergence occurring in 10/19/2017. On 10/27/2017, when seedling emergence and plant height were evaluated daily. Plant emergence was quantified by marking two permanent sub-samples 1 m long in different planting rows of each plot. Rice plant height was measured in five plants per plot.

On 11/22/2017, chlorophyll and flavonoid indexes and nitrogen balance index were assessed, with the aid of a chlorophyllometer (Dualex FORCE-A, Orsay, France), being registered four readings per plot, from distinct plants, amounting 16 readings per treatment. The quantum efficiency of photosystem II was obtained by using a fluorometer (Opti-Sciences, OS-30p), and readings were performed in two plants per plot, totaling 8 readings per treatment. Prior to fluorescence readings, leaves were submitted to 20 minutes dark and then the readings were taken according to Murchie & Lawson (2013). Rice plants were in the overall developmental stage V6 by the time of the assessments.

Statistical analyzes were performed into the "R" environment (R Core Team, 2017). Plant density and height were scatter plotted against time (days after planting - DAP), by treatment, while all physiological variables were scatter plotted against the ryegrass cutting height. In all cases were adjusted to each data set a 2nd degree Loess curve (Cleveland & Devlin, 1988), with the respective 95% confidence intervals, according to Patino & Ferreira (2015).

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III. RESULTS AND DISCUSSION

The oscillations of soil water status, depending on the environmental conditions, were dependent on the cutting height of ryegrass, since the higher water tension was observed in the soil where there was no cover with ryegrass (0 cm cutting height), in periods with sparse rains (Figure 1). The highest values of soil water tension were obtained approximately 25 - 30 days after rice emergence (DAE), where the bare soil (0 cm cutting height) presented 160 kPa of water tension; the soil with 15 cm cutting height presented 150 kPa, and at the one with the highest cutting height (45 cm) presented 120 kPa of water tension (Figure 1).

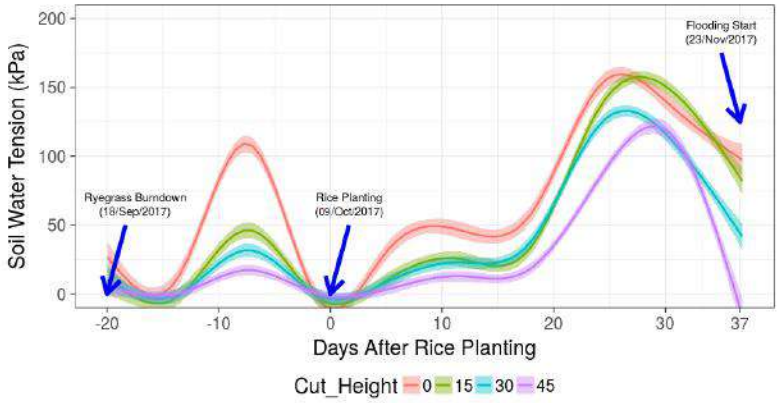

Fig. 1: Variation on the soil water tension (kPa) from the ryegrass burndown, in the distinct cutting heights. Capão do Leão, RS, Brazil, 2017.

The soil mulching has the effect of attenuating water evaporation; thus, the water tension in soil increases more slowly the greater the soil mulching (Monteiro et al., 2013). Our data show that high soil mulching (45 cm cutting height) allowed rice five additional days on a dry season, before high soil water tension was reached, compared to the bare soil treatment. This is particularly important for rice fields grown under schemes and / or alternative irrigation methods such as intermittent or sprinkler irrigation (Parfitt et al., 2017b). In addition, the maximum soil water stress levels obtained in the same period (25 - 30 DAP) also differed (Figure 1); while the treatment with bare soil reached water tensions of 163 kPa, the mulched soil reached a maximum of 126 kPa. Under milder conditions of lack of water (10 DAP), the treatment with 45 cm ryegrass cutting height presented water tensions of approximately 18 kPa while the bare soil already reached tensions around 50 kPa (Figure 1).

Ryegrass used as winter mulching helped to maintain adequate levels of soil moisture for longer after rains (Figure 1), but on the other side, it harmed rice emergence (Figure 2). From 9 days after planting (DAP) onwards, there was a reduction in rice density in treatments with any mulching level in comparison to the control treatment (bare soil).

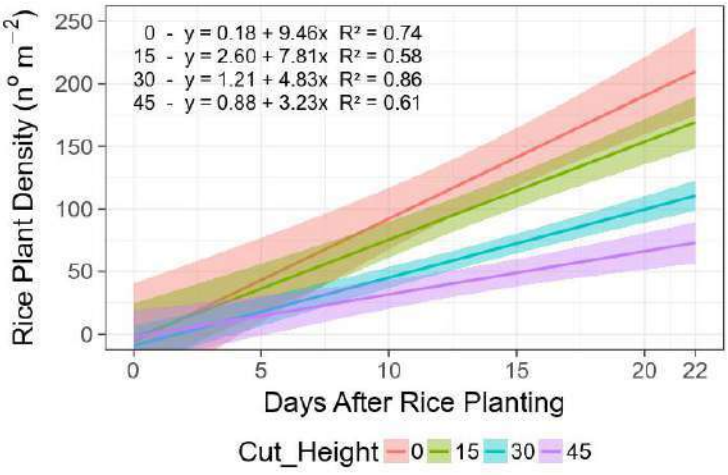

Fig. 2: Rice plant density ($n^o m^{-2}$) as function of days after planting (DAP) and ryegrass cutting heights. Capão do Leão, RS, Brazil, 2017.

https://dx.doi.org/10.22161/ijaers.6742 ISSN: 2349-6495(P) | 2456-1908(O)

The worst results were reported in treatments with ryegrass cutting height of 30 and 45 cm, where the density of plants 22 DAP was remarkably lower than those observed for control (Figure 2). The high mulching level makes it difficult to the soil to lose the excess water quickly following heavy rains, intensifying the decomposition of residues under hypoxia. The toxicity by organic acids occurs, mainly, in the beginning of the rice development, causing lower germination rate, slow initial growth rate, lower root development, and the consequent lower nutrient absorption by roots and reduced grain yield (Bortolon et al., 2009).

The stabilization in the increase of rice density was achieved around 20 DAP (Figure 2), where 150 - 220, 127 - 174, 86 - 110 and 50 - 79 plants m^{-2} were observed for the cutting heights of 0, 15, 30 and 45 cm, respectively. This difference was not recovered before the beginning of permanent flood irrigation (Figure 2). However, rice is a species with high phenotypic plasticity, and under favorable development conditions, the tillering is expected to compensate at least in part for this lower seedling establishment (Martinez-Eixarch et al., 2015). It should be noted, however, that in the highest ryegrass cutting height, rice seedling density was approximately 30% of that observed in the control with bare soil; differences of this magnitude may not be fully compensated by tillering (Zhong et al., 2002). In climatic conditions of Southern Brazil (cold and wet winter), where the mulching provided by the plant used as winter cover crop is very high, pre-planting operations such as the knife-roller (Silva et al., 2012) or shallow mowing (Brito et al., 2016), may be necessary for both reducing mulching and controlling weeds.

Seedlings that were able to emerge and establish under the wilted ryegrass cover, on the other hand, have grown without considerable barriers (Figure 3). The greatest difference in height of rice plants was observed around 15 DAP (five days after the average emergence) when the plants measured between 4 and 6 cm, with a difference of only 1 - 2 cm between the largest plants from the bare soil treatment, and those growing in the treatment with 45 cm cutting height. There was no significant effect of soil mulching levels on rice plant height at the time of irrigation start (Figure 3).

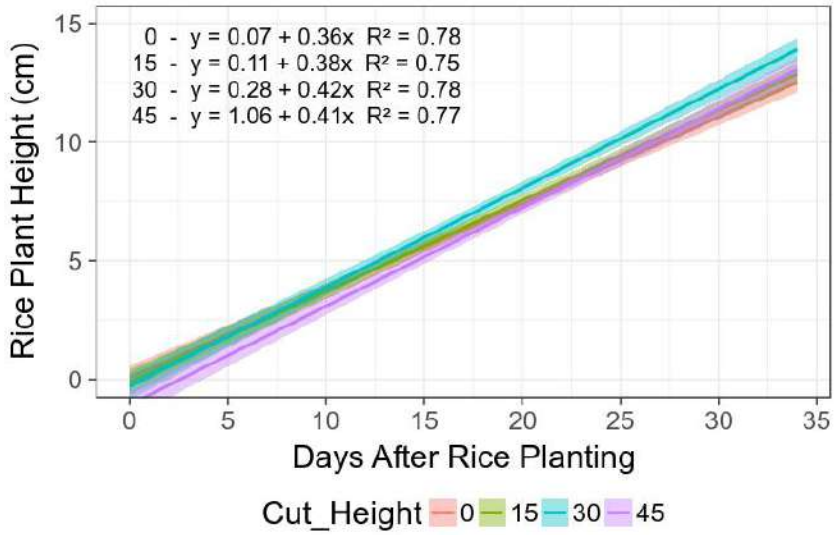

Fig. 3: Rice plant height (cm) as function of days after planting (DAP) and ryegrass cutting height. Capão do Leão, RS , Brazil, 2017.

The chlorophyll index (SPAD) did not vary enough among treatments to reach statistical significance, with mean value of 19.4 (Figure 4), although ryegrass cutting at 15 cm height presented a tendency for augmented chlorophyll index. This is an indication that the photosynthetic ability of rice plants grown on distinct heights of ryegrass straw was not affected. According to Martinazzo et al. (2007), chlorophylls (a and b) are the most important light-absorbing pigments at tylacoid membranes, being preponderant in plant growth and adaptability to distinct environments and, thus, defining crop productivity.

The flavonoid index, on the other side, was affected by ryegrass cutting height (Figure 5). A linear increase from 1.24 to 1.50 in flavonoid index was observed when the ryegrass cutting height increased from 0 cm to 45 cm, with a narrow confidence interval which positively support treatment effect on this variable. Flavonoids are secondary metabolites in the polyphenol class, formed when plants grow under nitrogen deficiency (Demotes-

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Mainard et al., 2008), acting in the protection of the photosynthetic system against photo inhibition by excessive radiance levels (Zhou et al., 2016). Thus, most possibly, the low initial availability of nitrogen and the exsudation of organic acids by the ryegrass straw may help explaining the increase in the flavonoid index in rice plants as the straw level on soil was increased.

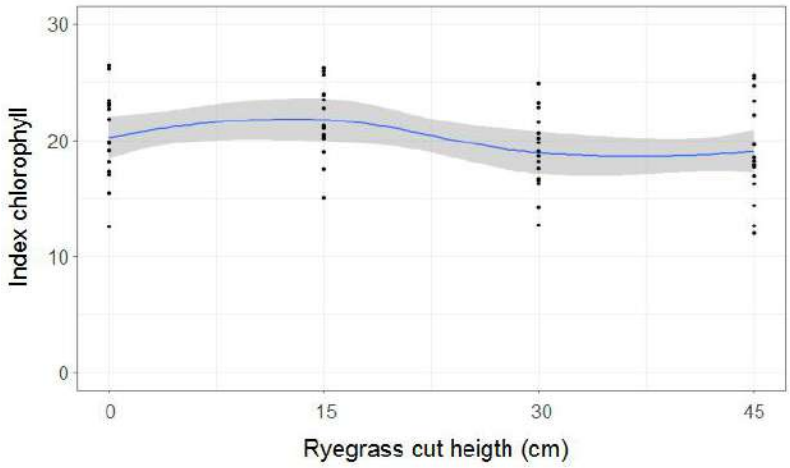

Fig. 4. Chlorophyll index as function of ryegrass cutting height. Capão do Leão, RS, Brazil, 2017.

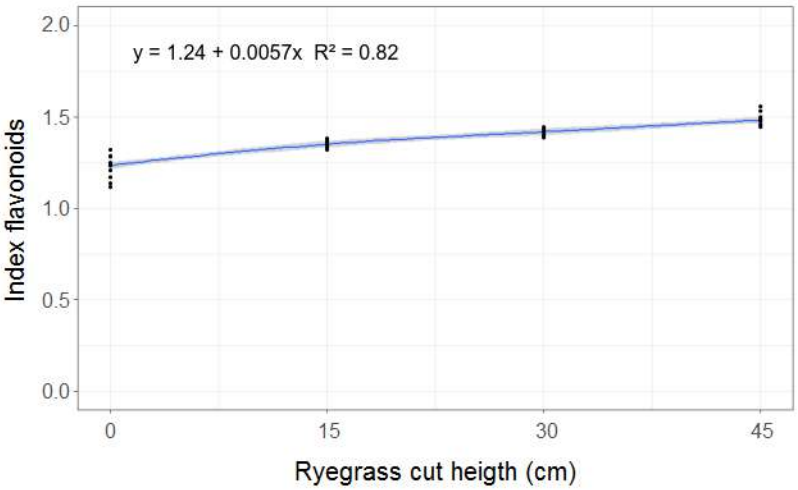

Fig. 5. Flavonoid index of rice plants as function of ryegrass cutting height, prior to planting rice. Capão do Leão, RS, Brazil, 2017.

The nitrogen balance index was also not affected by the ryegrass cutting height (Figure 6).The overall mean for nitrogen balance index was about 14.8, ranging from 12.3 and 17.5 among treatments. Although Xiong et al. (2015) report that chlorophyll readings used to guide N application in agricultural crops are widely affected by environmental factors, our data showed high and consistent correlation (data not shown) between chlorophyll index (Figure 4) and nitrogen balance index (Figure 6). Gholizadeh et al. (2017) concluded that this correlation reduces with the growth stage, reporting better relationship between rice leaf N content ($R^2 = 0.93$), as well as yield ($R^2 = 0.81$), with SPAD readings at the panicle formation stage.

The $^{Fv}/_{Fm}$ ratio (Figure 7), an indicator of the maximum efficiency of the photosystem II (PSII), also did not vary statistically among treatments, with mean of 0.62 and absolute variation between 0.50 and 0.75. Falqueto et al. (2010) reported $^{Fv}/_{Fm}$ values for rice cv. BRS-Pelota and BRS-Firmeza as ranging between 0.80 and 0.85, which are above the reported in the present study. Weng (2006) found that in sunny days of subtropical locations, the $^{Fv}/_{Fm}$ ratio may often be underestimated. The author reports that under these conditions, in summer large Fo (minimum fluorescence) values are consequence of high leaf temperature caused by the clipping fixed on the leaf, especially for long dark periods (e.g. 20 min). This would reduce $^{Fv}/_{Fm}$ ratio. In the

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present study, we defined 20 min as the darkening period prior to fluorescence assessments.

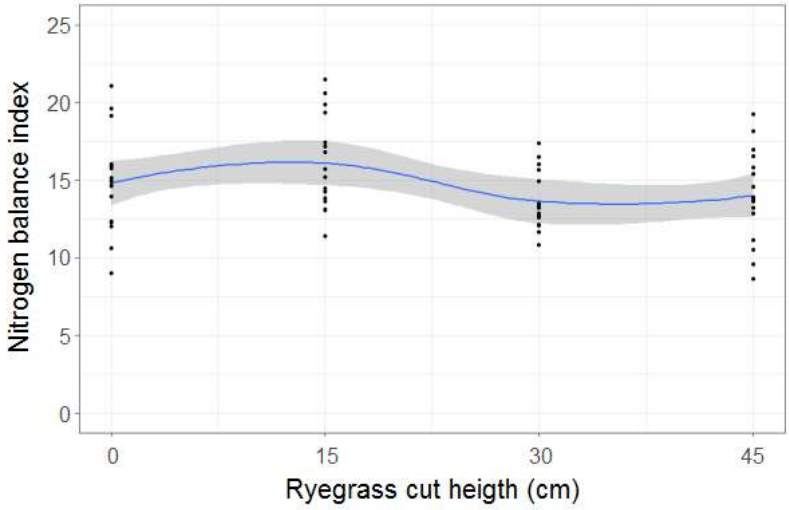

Fig. 6. Nitrogen balance index of rice plants as function of ryegrass cutting height, prior to planting rice. Capão do Leão, RS, Brazil, 2017.

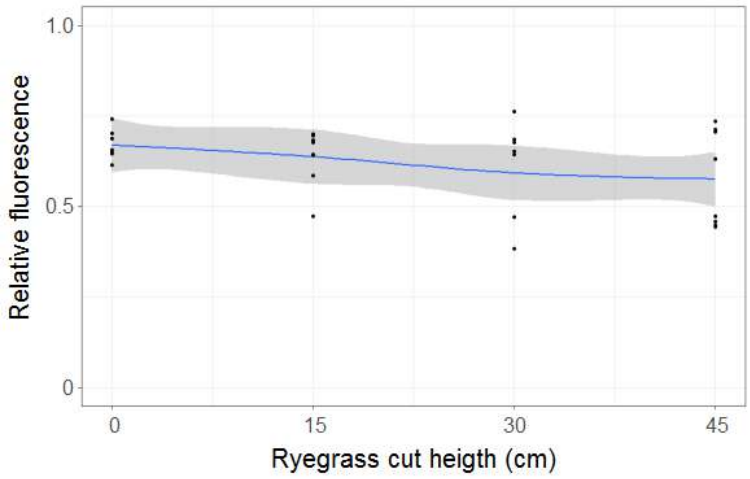

Fig. 7. Quantic efficiency / relative fluorescence of photosystem II (PSII) of rice plants as function of ryegrass cutting he ight prior to planting rice. Capão do Leão, RS, Brazil, 2017.

We hypothesize that the lower $^{Fv}/_{Fm}$ ratios observed for rice in the present study, for all treatments, may be regarded to the temperature effect reported by Weng (2006), as there was no treatment effect on this variable. To support this, Puteh et al. (2013) reported that the minimum fluorescence (Fo) of the cultivated and weedy rice genotypes increased under water stress; the maximum quantum yield ($^{Fv}/_{Fm}$) and maximum primary yield ($^{Fv}/_{Fo}$), of PSII, on the other side, declined. The author also reported high spikelet sterility levels (> 80%) for all genotypes.

IV. CONCLUSIONS

High soil mulching levels by ryegrass allowed rice five additional days on a dry season, before harmful soil water tension was reached, compared to the bare soil; rice seedlings able to emerge under the ryegrass mulching, have grown without considerable barriers; the physiology of rice plants growing in fields with residual ryegrass mulching were little affected, and ryegrass mulching cut up to 45 cm from soil prior to planting rice tends not to affect it. This would, in rough numbers, correspond to an acceptable volume of up to 4500 kg ha^{-1} of ryegrass straw on soil surface prior to planting rice to avoid damages to crop establishment.

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Practices in Mental Health in Primary Care: An Integrative Review

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Abstract *— The Objective of the present study was to analyze the scientific production of the 10 years (2005-2015), highlighting the practices in Mental Health in PHC implemented through public policies. Method: integrative literature review, with research in LILACS and SCIELO databases. The descriptors Mental Health, Primary Care; Basic Attention and Public Policies. Full Text were included; Main subject; Country / Region as subject, only studies carried out in Brazil; Language: English Spanish and Portuguese; Year of Publication (2006 to 2015) and Subject of the Journal. Through this study, it was possible to identify 22 studies focused on the subject of Mental Health in Primary Care, which were categorized into 4 main themes: Matrix support, Biomedical Model, Importance of community health agent (CHA) and Implementation of Public Policies in Mental Health. The main practices in Mental Health highlighted are the matrix support, which in most studies is considered as an important tool for the effectiveness of mental health services in primary care, network articulation, co-responsibility of the teams involved in care, municipal management.*

Keywords *— **Mental Health, Mental Health Practices, Primary Care.***

I. INTRODUCTION

Mental health can be defined as the internal balance and with the external environment where the individual is inserted, but the World Health Organization (WHO) says that there is no "official" definition and can change according to the context of insertion of the individual, culture, theories and philosophical currents. However, WHO defines Mental Health as an indispensable part of health, a state of well-being in which each individual realizes his own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to their community, so to have mental health requires a synchrony between the cognitive and the emotional of the individual. (1) In this context, seeking a proper Mental Health care, the thought of the care provided was totally modified over the years, from a hospital-centered and biomedical model, where hospitalizations and medication-therapy were the only forms of treatment, for a holistic model centered on the individual and not in the disease, with care services totally focused on the humanized model of Health (2)

In Brazil, the change began in the 1970s with the participation of professionals and relatives of mental patients, in a movement that consolidates the Psychiatric Reform itself, with significant changes in Mental Health treatment and services. In 2001, with the approval of Federal Law 10.216, which provides for the protection and rights of persons with mental disorders, long-term psychiatric beds were abolished, thus initiating the admission of this patient in general hospitals and with a short stay. With this significant change in the treatment provided, there was a need to develop a care strategy where the patients with mental disorders could be supported and reinserted in the family and in the community, resulting in the Psychosocial Care Centers (CAPS), Therapeutic Residential Services (RTs) and Psychiatric Units in General Hospitals (UPHG), in addition to the patient's insertion in Primary Health Care, all of which aim at a humanized care that contemplates

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the reinsertion of the individual into society and his / her psychosocial rehabilitation. At the state level, Mental Health encounters difficulties with regard to the CAPS to implement the practices recommended according to the National Mental Health Policy (PNSM), not playing its role in mental patient care, but remained in the old model of care so opposed by the Reform Psychiatric (4) (5)

The PNSM was created through Law 10.216 in 2001, as a result of the transformations provided by the Psychiatric Reform, seeking to discuss the rights of people with mental disorders and directing them to a new model of mental health care. The main changes were the exclusion of the hospital-centered and biomedical model as the only form of treatment, insertion in health care services and reinsertion in society. Although the creation of the CAPS took place prior to the PNSM, it was in 2002 by Administrative Rule 336 / GM on February 19 that they were categorized into CAPS I, CAPS II and CAPS III, CAPSi II, CAPSad II according to their degree of care complexity, supporting all types of mental disorders, allowing the practices of the CAPS to be clearly visualized. (5) (6) Primary Care is recognized as the gateway to any health service offered to society, in this context the individual with a claim in the area of Mental Health has his right of insertion in this model. It is up to the Primary Care team to recognize this individual and his support according to their needs, using practices such as matriciation, where health care is provided by more than one team in a shared process of care and a pedagogical-therapy (7) The present study is relevant because it allows the understanding of how the interrelations between Mental Health and Primary Care have been described and analyzed; by the scientific knowledge from the analysis of the previous publications that portray the practices in Mental Health, enabling the identification of the ways in which the public policies of Mental Health have been implemented in the practices carried out by Primary Care. It is also worth mentioning that the construction of a specific database on the theme will enable the identification of demands for future research, besides subsidizing the discussion of the theme. From the foregoing, the objective of the present study was to analyze the scientific production of the last 10 years (2006-2015), highlighting the practices in Mental Health in PHC implemented through public policies

II. METHODOLOGY

It is a research of integrative revision of literature, since it is proposed to analyze in-depth topic from the scientific production in the same previously published. The following steps were followed: elaboration of the guiding question, searching or sampling in the literature, data collection, critical analysis of the included studies, and discussion of the results and presentation of the integrative review. To conduct the review, the following guiding question was established: Are there publications that deal with the implementation of Public Policies in Mental Health in Primary Care in Brazil? The databases of A Scientific Electronic Library Online (SciELO), an electronic library that covers a selected collection of Brazilian scientific journals and Latin American and Caribbean Literature in Health Sciences (LILACS), were used as a research source. in a comprehensive way, the scientific and technical literature of Latin America and the Caribbean, in order to search for the publications made in the last 10 years. Inclusion criteria were the classification of articles and journals by Qualis from Capes-BRAZIL from A1 to B2 and qualitative and quantitative studies published in the period from 2006 to 2015. The exclusion criteria adopted were studies with content outside the proposed theme, analysis done by reading titles, abstracts and publications in full, repeated studies in the databases used for research, articles with paid publication and research in which the collection was not performed in Brazil

The instruments used for the selection of periodic studies were the following descriptors: Mental Health, Primary Care; Basic Attention and Public Policies. For better delimitation of the articles aimed at the searched theme, the following filters will be used: Full Text Only; Main subject; Country / Region as subject being only studies with collection carried out in Brazil; Language, being English Spanish and Portuguese; Year of Publication (2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015) and Subject of the Journal. The temporal cut made possible the identification, the mapping and the scientific production carried out on the subject. The results were systematized and analyzed based on the definition of the categories, marked by the descriptors, on which the interpretation of their meanings in the implementation of public policies on mental health in primary care was carried out.

III. RESULTS

In this integrative review, twenty - two articles were analyzed, meeting the exclusion and inclusion criteria previously cited to present an overview of the articles evaluated according to the theme. The exhibition of the selected articles is represented in figure 1 with a flowchart, self-explanatory of the step by step to arrive at the selected articles.

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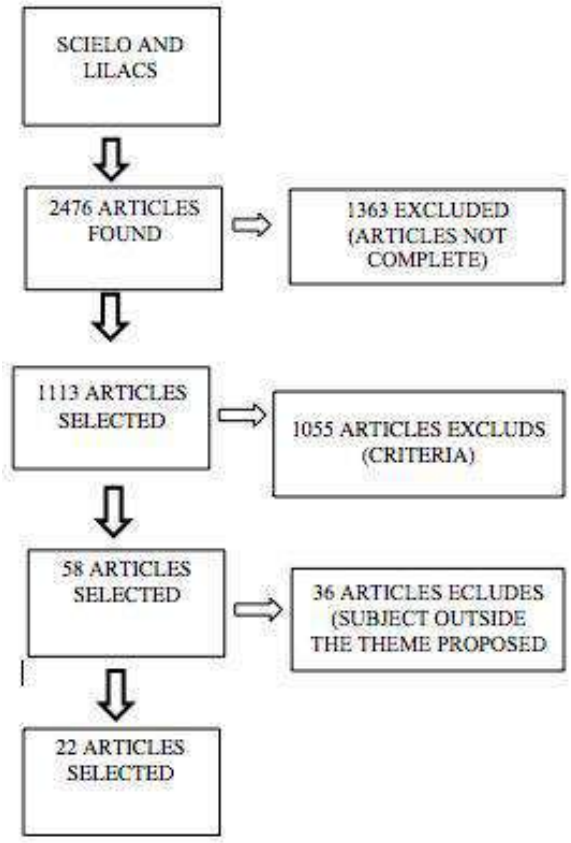

Fig.1: Flowchart of selected articles

The description of the articles selected by article title, authors, year of publication and periodical, is represented by the table 1 presented below.

Table 1. Description of articles by title, author, name and journal.

Number	Title	Author	Year	Journal
1	Reforma, responsabilidades e redes: sobre o cuidado em saúde mental	Martinho Braga; Batista e Silva	2009	Ciencia & Saúde Coletiva
2	Análise dos dispositivos de saúde mental em municípios do Vale do Paraíba	Maria Odete Pereira; Márcia Aparecida Ferreira de Oliveira	2010	Reben
3	Care for drug users in the perspective of family health professional	Jacó Fernando Schneider; Cristine Moraes Roos; Agnes Olschowsky; Leandro Barbosa de Pinho; Marcio Wagner Camatta; Christine Wetzel	2013	Texto Contexto Enfermagem
4	Avaliação da política de saúde mental a partir dos projetos terapêuticos de centros de atenção psicossocial	Vanda Maria da Rosa Jardim; Maria do Horto Fontoura Cartana; Luciane Prado Kantorski; André Luis; Alves de Quevedo	2009	Texto Contexto Enfermagem
5	Gestão e saúde mental: percepções a partir de um centro de atenção psicossocial	Rita Maria Heck; Valquíria de Lourdes Machado Bieleman; Teila Ceoli; Luciane Prado Kantorsk; Janaína Quinzen Wilhich; Fabieli Gopínger Chiavagatti	2008	Texto Contexto Enfermagem

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6	Participação das instâncias de controle social na Política de Saúde Mental da Bahia, 2001-2013	Tarcio de Almeida Oliveira; Carmen Fontes Teixeira	2015	Saúde debate
7	Saúde mental na atenção primária à saúde: estudo avaliativo em uma grande cidade brasileira	Rosana Onocko Campos ; Carlos Alberto Gama; Ana Luiza Ferrer; Deivisson Vianna Dantas dos Santos; Sabrina Stefanello; Tiago Lavras Trapé; Karime Porto	2011	Ciencia & Saúde Coletiva
8	Saúde Mental na Estratégia Saúde da Família: revisão da literatura brasileira	Luiz Gustavo Silva Souza; Maria Cristina Smith Menandro; Leandra Lúcia Moraes Couto; Polyana Barbosa Schimith; Rebeca Panceri de Lima	2012	Saúde Sociedade
9	Questionnaire study of primary care physicians' referral patterns and perceptions of patients with epilepsy in a Brazilian city, 2005.	Vanessa Teixeira Müller; Marleide da Mota Gomes	2007	Revista Panamericana de Saude Pública
10	A Atuação dos Psicólogos em Unidades Básicas de Saúde na Cidade de São Paulo	Auryana Maria Archanjo; Lilia Blima Schraiber	2011	Saúde Sociedade
11	Ações de saúde mental no Programa Saúde da Família: confl uências e dissonâncias das práticas com os princípios das reformas psiquiátrica e sanitária.	Monica Nunes; Vladia Jamilie jucá; Carla Pedra Branca Valentin	2007	Caderno de Saúde Pública
12	Estudo sobre práticas de cuidado em saúde mental na Atenção Primária: o caso de um município do interior do estado do Rio de Janeiro	Ailson Campos Junior; Paulo Duarte de Carvalho Amarante	2015	Saúde debate
13	Práticas em saúde mental na estratégia saúde da família: um estudo exploratório	Álissan Karine Lima Martins; Ângela Maria Alves e Souza; Neiva Francenely Cunha Vieira; Patrícia Neyva da Costa Pinheiro; Violante Augusta Batista Braga	2015	Revista de Pesquisa Cuidado é Fundamental
14	Parceria entre CAPS e PSF: o desafio da construção de um novo saber	Patrícia Santos de Souza Delfini; Miki Takao Sato; Patrícia de Paulo Antoneli; Paulo Octávio da Silva Guimarães	2008	Ciência & Saúde Coletiva
15	A práxis da Saúde Mental no âmbito da Estratégia Saúde da Família: contribuições para a construção de um cuidado integrado	Vladimir Andrei Rodrigues Arce; Maria Fátima de Sousa; Maria da Glória Lima	2011	Physis
16	Tecendo a rede de assistencia em saúde mental com a ferramenta matricial	Fernando Sérgio Pereira de Sousa; Maria Salete Bessa Jorge; Mardênia Gomes Ferreira Vasconcelos; Márcia Maria Mont'alverne de Barros; Paulo Henrique Dias, Quinderé; Luciana Gurgel Farias Gondim	2011	Physis
17	Psiquiatria no século XXI: transformações a partir da integração com a Atenção Primária pelo matriciamento	Sandra Fortes; Alice Menezes; Karen Athié; Luiz Fernando Chazan; Helio Rocha; Joana Thiesen; Celina Ragoni; Thiago Pithon; Angela Machado	2014	Physis
18	A Interlocução da Saúde Mental	Euzilene da Silva Rodrigues; Maria	2012	Saúde Sociedade

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	com Atenção Básica no Município de Vitoria/ES	Inês Badaró Moreira		
19	Saúde Mental na atenção básica à saúde de Campinas, SP: uma rede ou um emaranhado?	Mariana Dorsa Figueiredo; Rosana Onocko Campos	2007	Ciencia & Saúde Coletiva
20	Os CAPS e o Trabalho em Rede: Tecendo o Apoio Matricial na Atenção Básica	Edilane Bezerra; Magda Dimenstein	2008	Psicologia Ciencia e Profissão
21	Apoio matricial: dispositivo para resolução de casos clínicos de saúde mental na Atenção Primária à Saúde	Maria Salete Bessa Jorge; Fernando Sérgio Pereira Sousa; Túlio Batista Franco	2013	Reben
22	Saúde Mental na Atenção Basica: Sentidos Atribuídos pelos agentes Cominitários de Saúde	Raul Franklin de Moura; Carlos Roberto de Castro	2014	Psicologia Ciencia e Profissão

Of the twenty-two articles, four articles were published in 2007, three in 2008, one in 2011, one in 2010, four in 2011, two in 2012, two in 2013, one in 2014, four in 2015 and no articles were found in the year 2006. The journal with the largest number of publications was Ciência e Saúde Coletiva with four publications representing 18% of the total sample, Physis with three publications 14% of the sample, Texto and Contexto with three publications and also Saúde e Sociedade with three publications, the journals Psicologia Ciência e Profeissão and REBEn each published two articles representing 9% of the sample and the other journals published only one article.

Table 2 - Description of the studies included in the integrative review according to the title, objectives and results.

N°	Title	Objective	Results
1	Reforma, responsabilidades e redes: sobre o cuidado em saúde mental	To investigate the psychosocial technologies produced in this specific political, institutional and historical context, such as the mediation of social exchanges and the arbitration of conflicts.	In other words, psychosocial attention aims to increase the status and prestige of the madman in his social environment by multiplying social interactions.
2	Análise dos dispositivos de saúde mental em municípios do Vale do Paraíba	To Identify and analyze the relationship between the population as to the quantity and modality of existing mental health devices	High number of people residing in the participating municipalities are without assistance coverage
3	Care for drug users in the perspective of family health professional	To evaluate the service to drug users in the context of the mental health care network based on a Family Health Strategy in the city of Porto Alegre, RS	The results revealed (dis) connections of the service with other points of attention of mental health of the studied municipality, besides evidencing precariousness of strategies directed to the service of the users of drugs.
4	Avaliação da política de saúde mental a partir dos projetos terapêuticos de centros de atenção psicossocial	To evaluate the mental health policy in its accomplishment through the analysis of the therapeutic projects of Centers of Psychosocial Attention	It concludes by pointing out in the set of documents analyzed, proposals that are markedly aligned with the assumptions of the psychiatric reform and others that, in addition to the typical contradictions of a process under construction, present an authoritarian, disciplinary discourse against the presuppositions, including the

https://dx.doi.org/10.22161/ijaers.6743 *ISSN: 2349-6495(P) | 2456-1908(O)*

			normative apparatus of the mode of psychosocial attention.
5	Gestão e saúde mental: percepções a partir de um centro de atenção psicossocial	To evaluate the management of the mental health service of a municipality in the southern region of Brazil based on the perception of users, relatives and professionals linked to the Psychosocial Care Center.	The importance of a headquarters for the Center for Psychosocial Care, the physical presence of the secretary of health in the service activities and a recognition that the municipal management meets the demands of mental health.
6	Participação das instâncias de controle social na Política de Saúde Mental da Bahia, 2001-2013	To analyze the participation of the instances of social control of SUS-Bahia in the state policy on mental health	It was possible to infer that the conferences presented proposals consonant with the Psychiatric Reform; the Council, however, did not consolidate these proposals and was not propositive for the formulation and implementation of this policy at the state level
7	Saúde mental na atenção primária à saúde: estudo avaliativo em uma grande cidade brasileira	The present study aimed to evaluate the articulation between the primary care and mental health networks in regions of high social vulnerability of a large Brazilian city (Campinas - SP)	The matrix support was potent in defining flows, qualifying teams, and promoting joint and shared assistance. A strategic role of the community health agent was identified to identify potential offers and provide closer listening to the population. Health promotion practices are not yet consolidated. When the arrangements allow the insertion of the professionals in activities outside the walls, the users recognize and take ownership of the spaces, allowing actions that distance themselves from the traditional complaint-behavior
8	Saúde Mental na Estratégia Saúde da Família: revisão da literatura brasileira	To analyze the main themes of the Brazilian scientific literature on mental health in FHS	Stereotyped views on mental disorders, predominance of asylum logic, absence of records, flows, strategies, qualified support families and network integration.
9	Questionnaire study of primary care physicians' referral patterns and perceptions of patients with epilepsy in a Brazilian city, 2005.	Evaluate, in a sample of family doctors, their referral patterns, perceptions and attitudes toward patients with epilepsy, general knowledge about epilepsy, knowledge of support services in the Brazilian primary care network for patients with epilepsy, and opinions on specific initiatives to improve care	The respondents considered that neurologists should be the responsible for the diagnosis and the initial prescription of antiepileptic drugs, while the physicians of family should be held accountable for subsequent care
10	A Atuação dos Psicólogos em Unidades Básicas de Saúde na Cidade de São Paulo	To study the nurse's role in UBS	It reveals that the psychologist has an important role and its insertion in institutions in public health.
11	Ações de saúde mental no Programa Saúde da	Discuss the link between primary care network and health reform through mental health	Finding the complaint of professionals regarding the lack of practices in mental health in FHS

https://dx.doi.org/10.22161/ijaers.6743 *ISSN: 2349-6495(P) | 2456-1908(O)*

	Família		
12	Estudo sobre práticas de cuidado em saúde mental na Atenção Primária: o caso de um município do interior do estado do Rio de Janeiro	To Understand / problematize how the approach that emerged as demands on mental health in the practice of the physician in these health facilities	It was understood that the relationship that the physician assumes with the assisted community is very much linked to a clinical-institutional view that does not privilege some questions of identity, culture and social movements in the communities. And also the lack of practices aimed at the empowerment of the individual, about their condition of life, health and subjectivity.
13	Práticas em saúde mental na estratégia saúde da família: um estudo exploratório	To know the procedures, actions and behaviors adopted in Mental Health in the scope of basic care.	Prevalence of care procedures under a reduced vision of health, focusing on the individual and the illness, different from the proposal of integral and collective care of the community care model.
14	Parceria entre CAPS e PSF: o desafio da construção de um novo saber	To Report an experience between a CAPS and three PFS teams in the central region of SP.	The demand for assistance, the need for new proposals and innovative initiatives, and a differentiated approach to the patient, not to the disease, revealed great demand.
15	A práxis da Saúde Mental no âmbito da Estratégia Saúde da Família: contribuições para a construção de um cuidado integrado	To analyze the practices of Mental Health in the work of the family health strategy teams of Brazlândia, in the Federal District.	It revealed that the population finds great difficulty in accessing Mental Health care, low resolution in the scope of Family Health, prevalence of the biomedical model and also raised a debate about the qualification of the FHT teams.
16	Tecendo a rede de assistência em saúde mental com a ferramenta matricial	To Analyze the matriciamento as an articulating tool of the network of attention in mental health	Matrix support is a powerful strategy, as it enables network assistance in SUS. Interconnected by a reference team, signaling the paths that enable the connection of care networks in Mental Health.
17	Psiquiatria no século XXI: transformações a partir da integração com a Atenção Primária pelo matriciamento	To analyze the participation of psychiatry in the organization of APS centered mental health care within an integral health model.	It was revealed that primary care is a new field of action of psychiatry bringing important challenges for training and assistance in mental health
18	A Interlocução da Saúde Mental com Atenção Básica no Município de Vitoria/ES	To analyze the dialogue between mental health and basic care in progress in Vitório - ES	Transformation in the provided care, systematization of the matriciamento and beginning of the constitution of a network of CAPS and basic attention solid.
19	Saúde Mental na atenção básica à saúde de Campinas, SP: uma rede ou um emaranhado?	To Trigger the clinic's extension of referral teams and reorient the demand for Mental Health.	Matrix Support is an essential part for a transformation in mental health care

https://dx.doi.org/10.22161/ijaers.6743 *ISSN: 2349-6495(P) | 2456-1908(O)*

20	Os CAPS e o Trabalho em Rede: Tecendo o Apoio Matricial na Atenção Básica	To discuss the implementation of the proposal of matrix support in mental health according to CAPS workers in the municipality of Natal-RN	The matrix support is the instrument that comes within a set of fundamental strategies in the process of the construction and transformation of mental health care, of which CAPS is a fundamental point
21	Apoio matricial: dispositivo para resolução de casos clínicos de saúde mental na Atenção Primária à Saúde	To Understand the matrix support as a device for the resolution of clinical cases of mental health, in the scope of Primary Health Care.	The matrix suppor has the power to signal the paths for the construction of a particular model of health care that is articulated and synergistic with the principles and guidelines of SUS.
22	Saúde Mental na Atenção Básica: Sentidos Atribuídos pelos agentes Comunitários de Saúde	To study the senses attributed by the ACS to Mental Health and its implications in the daily practice, besides their perceptions about the actions of the PRMAS.	Centralization of mental health care in CAPS, mainly by medications, also reveals that residency plays a role of matricity and also the lack of preparation of ACS to deal with found cases.

According to their objectives, all twenty-three articles were able to respond successfully to what they had previously proposed. According to the table, practically all of the articles selected in theirs revealed that somehow mental health policies are not being put into practice as they should 22% of them explain explicitly why this non-functioning the other 82% only point and suppose the problems, but 100% cite great difficulties in the effective applicability of mental health in primary care. Another important point was that 22% of the articles point to matriciation as a very important piece in the care of mental patients, and 13% speak of the existence and still predominance of the biomedical model and even the total absence (4%) of a Mental health.

Table 3. Categories, description and articles by category.

Category	**Description**	**Articles**
Matrix Support	Conjunto de equipes multiprofissional atuando juntas na assistência holística do portador de distúrbio mental.	3, 4, 8, 9, 10,14, 16, 17,18, 19, 20, 21,22
Biomedical Model	A model of care focused on the disease and not on the individual.	12, 13
Importance of community health agent (ACS) and unprepared staff	The ACS as an actor involved in the implementation process of Mental Health policy and the need for professional preparation for a policy implementation effectively.	22, 05
Implementation of the Mental Health Policy	Compliance in the implementation and fulfillment of Mental Health Policy requirements	1,2,5,6,8,11,14,15 ,18,22

The grouping of the 22 articles into four distinct categories according to what was approached by each of them, and some articles considered more than one category in the categories, which may give scope for further discussions about the proposed theme

IV. DISCUSSION

Regarding to the focus of publications on the implementation of Public Policies in Mental Health in Primary Care in Brazil, four thematic categories emerged, as shown in Table 4. Category 1 consisted of articles that deal with "Matriciamento", with emphasis on the joint relationship of professionals from different areas and modalities of action, forming a multiprofessional group of assistance in the form of a care network. Matrizing brings with it a radical change in the vertical care model of health care systems for horizontal care, where all professionals are equally important for the recovery and reintegration of the individual into society. (16) (9) (10) (11) With the insertion first of some specialties, which could aggregate in the resolutiveness in the treatment of the individual with mental disorder, the matriciamento

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tool is fundamental importance for the implementation of the Mental Health Policy, since it assumes the role of key piece involving all fields of care for a holistic assistance of the individual. (12) (13) (14) (15)

Category 2 consisted of articles that address the "biomedical model", where most of them described that even with the changes proposed by Public Policies in mental health care, the biomedical model continues to be applied. The medical professional as the sole custodian of mental patient care continues to use drug therapy as the first treatment and / or intervention option, demonstrating the existence of a retrogression in some localities regarding Mental Health care in Primary Care. (16) (17) Some studies suggest that the biomedical model, although it exists, should not be put into practice today because its main focus is the disease, disorders and diseases that the individual carries with him, to the detriment of the biopsychosocial model whose focus is totally different of what is being applied. (16) (17) Thus, it is noticed that, according to the above mentioned about the biomedical model, that it makes difficult the implementation of the current Policies of assistance in Mental Health, since it plays a contrary role the ideas proposed since the Psychiatric Reform, acting in a misrepresented way not taking into account non-biomedical models. (18)

Regarding category 3, it addresses the importance of ACSs in the implementation of the Mental Health Policy, being the professional who is at the end of the service and has direct contact with the mental patient, as he also resides in the community and besides doing the search These new patients also follow up with regular and frequent visits. It was possible to observe in the study that the unpreparedness of the professionals can negatively impact the implementation of the Mental Health Care Policies, since they represent a significant gap in the care network. (19) According to Heck et al., Professional unpreparation reflects directly on care, because when the professional receives training he is able to exercise his functions in an appropriate way welcoming the mental patient, making him inserted in the context of primary care. (20) (21) And finally, the last category explored and evidenced in the studies is the category of implementation of public policies in mental health. Most of the articles showed that it was difficult for healthcare units to meet the demands of these patients, both for lack of preparation of the team, for the still permanent idea of the exclusively drug treatment offered by the psychiatrist, and for the inability of the network to absorb the great demand of patients. Unfortunately, some psychiatric hospitals are still in operation, even with the fight against the hospital-centered model of care, general hospitals are unprepared to absorb patients in outbreaks and the CAPS themselves are disposed in much smaller numbers than the population needs, as proposed by Portaria 336/2002. (22) (23) (24) (25) (26)

The ideas and prejudices rooted before the Psychiatric Reform, where many mental illnesses were banalized and / or stigmatized, even with their importance and influence on well-being, persist in the search for holistic care. This posture makes it difficult for the patient to seek the health service, as well as feel welcomed, understood and linked to the team, which makes care impossible (27) (24) (25) Despite this, it is possible to observe an example in which the implementation of mental health policy is being effective, as in a study carried out in São Lourenço do Sul, showing an articulated service, where there are workshops in which the users can be inserted, besides of interaction with external social spaces such as schools, agricultural activities and leisure spaces, inserting the user into the local community. In addition to this, the team is made up of several professionals from different levels of education and training, who have received training and preparation to deal with the patients, in order to integrate them into community life as well as their personal demands and wishes. (20) Despite the insipidity of most services accompanied by the studies, all pointed to the need for some factors for success in implementation, as articulation with other services and sectors; network work aimed at the care extended to the needs of users, because it is through it that it is possible to ban the hospital-centered model of care; commitment of municipal management to hire professionals, acquire medicines and structure physical spaces; training of the health team and co-responsibility of the teams involved in the matrix support. (20) (26)

V. CONCLUSION

Through this study, it was possible to identify 22 studies focused on the subject of Mental Health in Primary Care, which were categorized into 4 main themes, namely: Matriciamento, Biomedical Model, Importance of ACS and Implementation of Public Policies in Mental Health. The main practices in Mental Health highlighted are the matrix support, which in most studies is considered as an important tool for the effectiveness of the provision of mental health services in primary care, network articulation, co-responsibility of the teams involved in care, team and commitment of

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municipal management. It was possible to infer that the effective inclusion of mental health care in basic care is still an infrequent reality, and although it does not appear explicitly in many of the articles selected, psychiatric hospitals are still the destination of patients, favoring the permanence of the model biomedical / hospitalocentric. In spite of this, some articles reflect a discreet change regarding the resocialization of the user of mental health services and insertion of the same in primary care, pointing to the real possibility of the implementation of the PNSM in its entirety.

This study may contribute to the professionals perceive the gaps that still exist in the attention to the health of the mental patient, seeking solutions for improvement in the service, as well as specialization and qualification for such. It is hoped that this study will provoke in other researchers new questions about what is necessary to implement the PNSM in an integral, effective and resolutive way in primary care.

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Petri net Modelling of the Automatic Test System for Mobile Phone Battery

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Abstract *— Considering recent cases of mobile device battery incidents widely reported in the news and the internet, more and more companies are looking to develop not only safer and more reliable products, but also robust and automated manufacturing processes, seeking greater reliability and efficiency. Thus, the purpose of this research is to model a mobile phone battery test automation system using the Petri Nets (PN) graph and mathematics tool to automate the dipole alignment, voltage test and internal resistance, anode and cathode battery terminal cut, visual inspection of these and battery thickness selection in a mobile phone battery production line of a company in the Industrial Pole of Manaus (PIM). The Visual Object Net ++ v2.7a software was used for PN modeling and the present research is structured in detailed description of the automatic system components, flowchart, modeling and PN analysis. Considering this as a Discrete Event System (DES), the PN showed that it is fully possible to model the Automatic Testing System for Mobile Phone Battery. It was also demonstrated that the PN analysis by the mark enumeration method, through the coverage tree building and accessible markings graphs that the system has good properties of Reachability, Liveness and Boundedness, being fundamental in PN. It was also possible to verify that using this tool it is possible to obtain a high level of understanding of real progress and evolution of the system through the dynamic visualization of graphs related to the DES.*

Keywords *— **Battery, Modeling, Petri Nets (PN), Automatic, Discrete Event Systems, Automation.***

I. INTRODUCTION

Considering the recent cases of mobile device battery incidents widely reported by the newspapers and the internet, more and more companies are looking to develop not only safer and more reliable products, but also robust and automated manufacturing processes, seeking greater reliability and efficiency. Currently in a mobile phone battery production line of a factory located in the Manaus Industrial Pole (MIP), the manufacturing process is performed by manual and semiautomatic devices and equipment for tests execution and productive preparation of the battery. Among these tests the most important would be the open circuit voltage (OCV) test and the internal resistance (IR) test that were described by [1] which would present a strong correlation between capacity and impedance of the battery. Regarding the main production process, it is possible to list: the positive and negative pole alignment, the dipole terminal cutting according with the specified length by the battery developer, sample inspection by manual tool to verify the parallelism and the terminal length of the battery and lastly the cell thickness verification to classify it in a pre-defined group. Each process is performed separately and is executed by different collaborators; this production process leads to a high level of product manual interaction in the manufacturing environment that increases the operation cycle. Due to the shift changes (as it operates on a twenty-hour day and six-day-a-week basis) or inefficiency of the primitive solutions without the necessary robustness that a manufacturing process requires, the current production process can not keep the repeatability and reproducibility of the activities.

As explained by [2] [20] the battery cell stores the electrical energy as chemical energy between two electrodes, the anode and the cathode, separated by an electrolyte that transfers the ionic component resulting from the chemical reaction inside the cell and forces it out of the battery. The output is a discharge electrical current (I) and a voltage (V) during the

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time defined as Δt. The chemical reaction of a rechargeable battery must be reversible under the application of a charging voltage. The main critical parameters of a rechargeable battery are: safety, energy density that can be stored in a specific input power and output recovery, cycle, lifespan, storage efficiency and manufacturing cost.

When under overload or overheating the lithium ion batteries present a thermal leakage hazard that in the worst case could result in an explosion. Even if some electronic components with Positive Thermal Coefficient (PTC) would be applied as a safety measure, it is not possible to prevent internal short-circuit [3]. The lithium ion polymers applied in all of the rechargeable batteries of lithium ion used in mobile devices are composed of multiple cells arranged in series or in parallel. This arrangement must be shared with the whole production chain such as the cell manufacturers, battery assemblers and system integrators [4].

The research main purpose is to model a test system for mobile phone batteries which includes the innovation, automation and optimization of the production process. To apply a PN in any process is necessary to follow some steps such as: the description of the system components, system flowchart in order to build the PN, the modeling of the PN and lastly the analysis of the PN. The present research is justified due the application of models simulations to characterize the functioning of a system that may or may not exist and also by the financial relevance of the automation and optimization of the process [5].

The simulated environment is an alternative developed that reproduce the real system and enable the analysis and the understanding of the discrete events dynamics of the process. In order to model a test system for mobile phone battery it is necessary the prior understanding of the manufacturing processes correlation.

In other words, the interactions performed by its components, and how the interdependencies between states and links are related. Therefore, it is evident that the parts that compose the battery test system, have dynamic behavior defined by the discrete states changes as a result of instantaneous events that form a system type known as Discrete Event System (DES). Similarly, the network model proposed by Carl Petri modeled the communication between automatons, used at that time, to represent the DES [6].

The PN is considered as one of the most robust graphical and mathematical method used to model, analysis and design of discrete events systems [7]. The PN allows the direct and interpreted association of the functions and verification of the process evolution, making possible the mapping of the progress and performance of the system, and also control of the same. The PN presents two interesting features: firstly, it allows modeling and the visualization of behaviors with parallelism , simultaneity, synchronization and resource sharing; secondly, the theoretical result regarding the simulation of the PN is extensive [8]. The obtained models can be analyzed and validated by simulation according to the activities requirements and services of an industrial automation system and checked according to the PN characteristics [9].

The PNs excel in the current engineering due the following qualities: they capture the precedence relationships and structural links of real systems, are graphically expressed, conflicts and queues can be modeled, have mathematical and practical foundation, and support various specializations such as timing, color, stochastic, reliability and etc [10].

After the modeling and construction of the PN, it is necessary to verify and validate it. In order to analyze a marked PN it is necessary to verify the good properties, such as: Reachability, Liveness and Boundedness [11-13]. The method proposed by [11-13] to verify the good properties is based on the analysis by markings enumeration, checking if the PN is limited by the reachability tree building and then the design of the accessible markings graph in order to validate if the graph is strongly connected, in other words if all the nodes in pairs are connected by a path is possible to evaluate if the PN is resettable which means that the PN is capable of recovering from disruptive operating events, such as: interruptions by the operator or by the safety device. The vivacity is evaluated when it is possible to access every part of the PN without any type of blockage [10].

II. LITERATURE REVIEW

2.1 DISCRETE EVENT SYSTEM

A system can be defined as a set of elements that can be represented mathematically by a set of interdependent variables [14]. In the literature, such system is classified as static or dynamic, where the dynamic systems current outputs depend on the previous inputs values presented to the system and can be represented by differential equations [6]. Currently there are many Discrete Event Systems present in the contemporary civilization; it is possible to find DES occurrences in industries, in public related services, in bureaucratic processes, in real-time software and database, in manufactures, etc [10]. Figure 1 shows the macro classification of systems.

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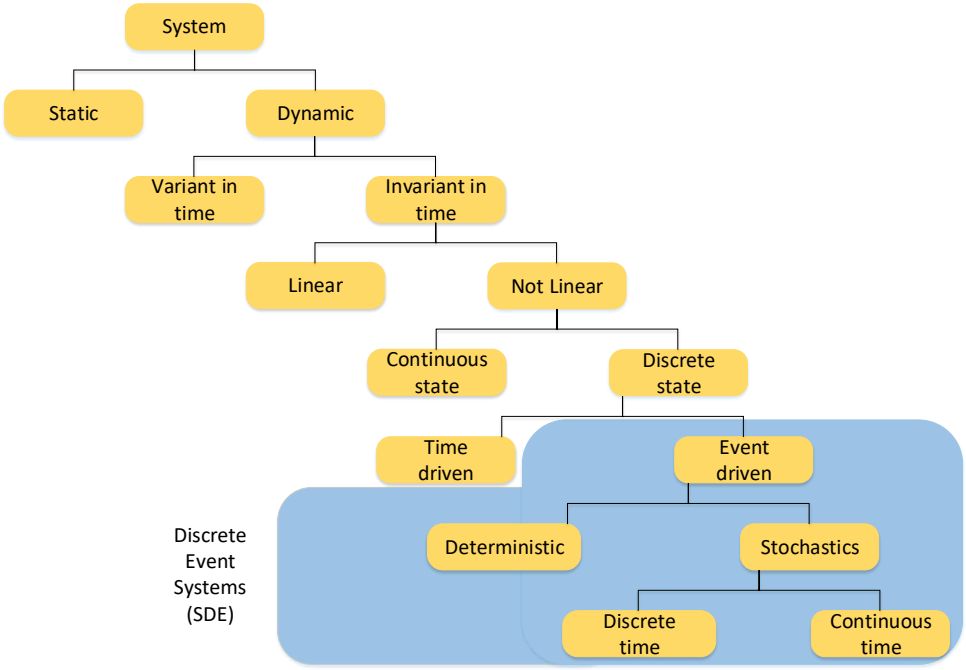

Fig.1 – Macro Classification of Systems.
Source: Adapted from Cassandras and Lafortune (2008).

2.2 PETRI NETWORK

The PN is a mathematical formalism which allows the graphic representation with a high level of abstraction, presented by Carl Adam Petri in his doctoral thesis in 1962, initially applied for performance evaluation and flow representation communication protocols [9]. An overview of the different approaches for solving a PN-based optimization problem can be found in [21] [22] [23].

2.2.1 PETRI NETWORK CONCEPTS (PN)

Definition 1. The PN structure is a quadruple $G = (P;T;I;O)$, where the model set of places is defined by $P = \{p_1, p_2,...,p_n\}$, and the set of transitions by $T = \{t_1, t_2,...,t_m\}$ where $I : P \times T \rightarrow Z^+$ is a function that represents weight of the arcs (flow relation) that reach the transitions and $O : P \times T \rightarrow Z^+$ is a function that represents the weight of the arcs that leave the transitions. Z^+ is the set of non-negative integers. The places p_n represent the possible states that the modeled system can assume and are described graphically by a circle. The transitions t_m are represented graphically by a horizontal bar, associating the places that precede the transition with the places that succeed them, being connected through the arcs which posses individual weights. The incidence matrix C represents the interactions between the places (i) and the transitions (j) where each element is defined as: $c_{ij} = O(p_i; tj) - I(p_i; tj)$. The marking function $M: P \rightarrow Z^+$ is the function that defines the network current marking [15] [16].

Definition 2. The Petri Network is a quintuple (P, T, A, W, m_0) wherein $P = \{p_1 \ldots p_n\}$ is a finite set of positions or places, $T = \{t_1 \ldots t_m\}$ is a finite set of transitions, A is a finite set of arcs that belongs to $(P \times T) \cup (T \times P)$, where $(P \times T)$ represents the arcs set from p_i to t_j, also defined as (p_i, t_j), and $(T \times P)$ represents the arcs set from t_i to p_j, or (t_i, p_j), W is a function that assigns a weight w (integer) to each arc and lastly m_0 is a vector whose i-th coordinate defines the marking number (tokens) of the p_i position, during the early stage of the network evolution [10], as shown in the figure 2.

- The T and P sets are disjoint, i.e., $T \cap P = \emptyset$.
- n = |P| is the cardinality of the P set, in other words is the position numbers of the PN.
- m = |T| is the transition number of the PN.

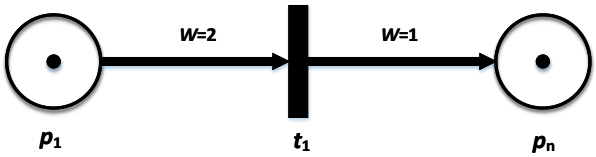

Figure 2 – Petri Network defined as a quintuple.
Source: Adapted from Moraes and Castrucci (2015).

III. MATERIALS AND METHODS

The materials used in this modeling and simulation are:

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- A notebook model Lenovo G40 with windows 10 operating system;
- Visual Object Net ++ v2.7a software for PN modeling.

The method is the set of systematic and rational activities that, with greater security and economy, that allows the objective achievement – valid and true knowledge – tracing the path to be followed, detecting the errors assisting the decisions of the scientist [17]. Thus, the methodology used to conduct this research will follow the steps as below:

1. Components detailed description, in order to show the operation of the automatic test system for mobile phone battery;
2. Build the flowchart to organize and synthesize the steps of the system operation;
3. Modeling of the PN with the objective to base the simulation with a robust mathematical tool, considering that in addition to being widely used in modeling, they are also used in verification and validation of control systems for discrete events;
4. PN modeling analysis to verify the good properties, such as: Reachability, Liveness and Boundedness, as shown in the figure 3 of the methodology flowchart.

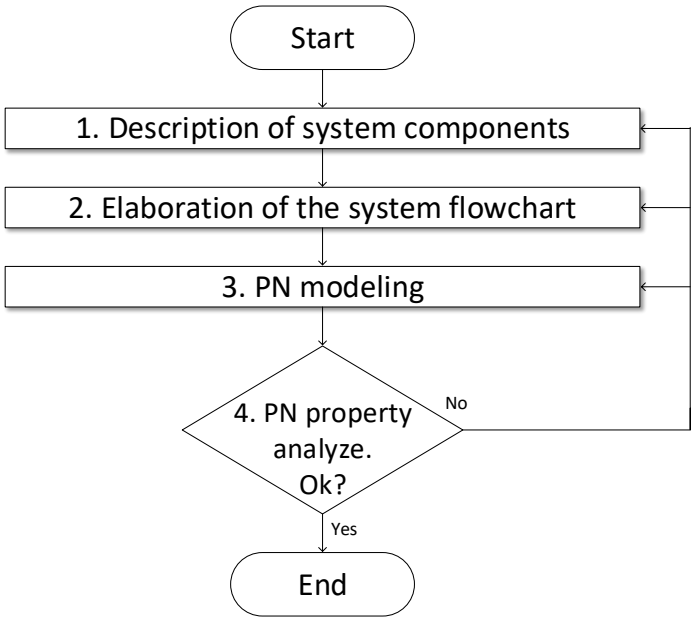

Fig.3 – Methodology flowchart.
Source: Authors (2018).

IV. RESULTS AND DISCUSSIONS

4.1 SYSTEM COMPONENTS DESCRIPTION

The components of the proposed automated test system for mobile phone battery are described below and shown in the figure 4:

a) Input conveyor with **M2** motor, **S1** sensor indicates the battery initial position on the input conveyor, sensor **S2** indicates the battery final position on the input conveyor, **Rm1** is the input conveyor handling robot;

b) Turntable **M1** motor with seven slots to house the parts, sensor **Sb1** indicates the part presence in the first slot and the sensor **Sb7** indicates the part presence in the last slot, sensor **Sb** indicates the turntable slots position;

c) The **C2** cylinder handles the battery terminal aligner;

d) The **C3** cylinder handles the execution of the open circuit voltage (OCV) and internal resistance (IR) measurement, besides there is a datamatrix code reader used to associate the measured results with battery serial number;

e) The **C4** cylinder handles the battery terminal cutter;

f) The **C5** cylinder handles the visual inspection using a camera to inspect the terminal cutting, after the inspection the serial number is read in order to associate the measured result;

https://dx.doi.org/10.22161/ijaers.6744 *ISSN: 2349-6495(P) | 2456-1908(O)*

g) The **C6** cylinder handles the battery cell thickness meter, after the inspection the serial number is read in order to associate the measured result;

h) The **C7** cylinder reads the serial number to inform both the data center and the **Rm2** robot the battery traceability, approved/ disapproved status and the measured thickness.

i) Output conveyor with **M3** motor, **S3** sensor indicates the battery initial position on the output conveyor, **S4** indicates the battery final position on the output conveyor, the **Rm2** robot is the output conveyor horizontal handler;

j) The **S5** sensor indicates if there is a battery in the defect area.

k) Front panel with **Auto/Manual** button, **emergency** button and **on/off** switch.

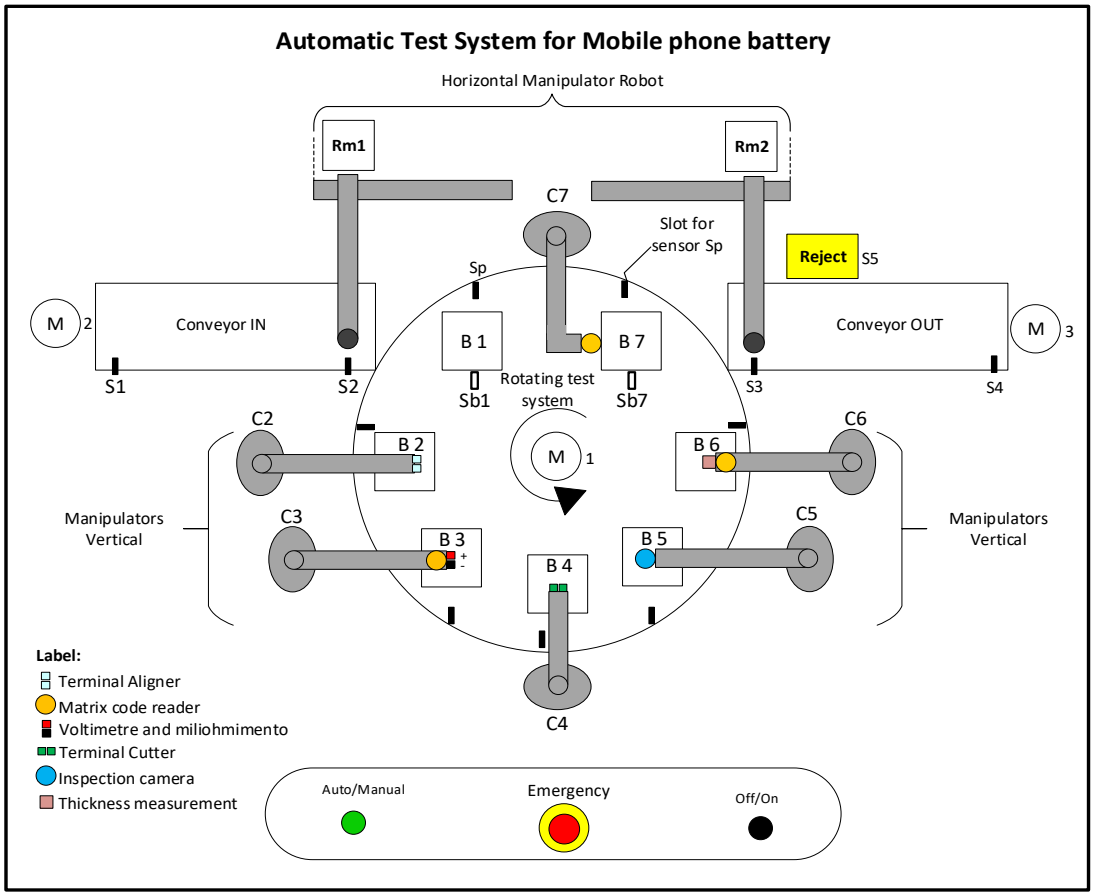

Fig.4 – Components of the automatic mobile phone battery test system.
Source: Authors (2018).

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The automatic mobile phone battery test system was designed to meet the prerequisite of non-human intervention during the production process, in other words, automatic operation. Considering that the system was previously loaded and in automatic mode which means that the on/off switch is in "on" position, the emergency button is normally closed and the automatic button is pressed is possible to affirm that the system is in the operation state. The loading process means that the battery must be placed over the input conveyor moved by the **M2** motor. After the battery is detected by the **S1** sensor, the input conveyor is activated until the battery is detected by the **S2** sensor, after the detection the conveyor stops and the **Rm1** horizontal handler robot picks up the battery and places it in the slot 1 of the turntable. When the **Sb1** sensor detects that a battery was placed in the first slot, the **Sp** sensor detects that the position 1 is under use and the **M1** motor is activated shifting the battery position from the first slot to the second slot where the **C2** cylinder perform the terminals alignment, in the next step the battery is shifted to the third slot and the **C3** cylinder performs the OCV and IR measurements reading the serial number to associate the measured results with the battery, in the fourth slot the **C4** cylinder performs the battery terminal cutting and in the fifth slot the **C5** cylinder performs the terminal cutting visual inspection reading the serial number to associate the inspection result with the battery, the last verification is conducted in the sixth slot where the C6 cylinder performs the battery thickness measurement due the gases generated by the initial electrical charge that dilates the battery, after the measurement the serial number is read and the result is associated with the battery. Next, the **Sb7** sensor detects the battery in the seventh slot and the **C7** cylinder performs the serial number reading to inform the manufacturing data center to verify if the battery is approved or disapproved, after the status confirmation the **Rm2** horizontal handler robot directs the battery to the defect área if the battery is disapproved and the S5 sensor is vacant or to the position of the **S3** sensor if the battery is approved and the **S3** sensor is vacant, if the S4 sensor is vacant the output conveyor **M3** motor activates and the battery is transported until the **S4** sensor detects it concluding the production cycle. It is important to emphasize that the described steps are discrete events and act in a concomitant way.

4.2 PETRI NETWORK

4.2.1 FLOWCHART PREPARATION

– The operation dynamics of the automation system described in the previous topic can be seen in the flowchart shown in figure 5.

The process steps are described in the flowchart, and from this flowchart it is possible to construct the PN graph. [18].

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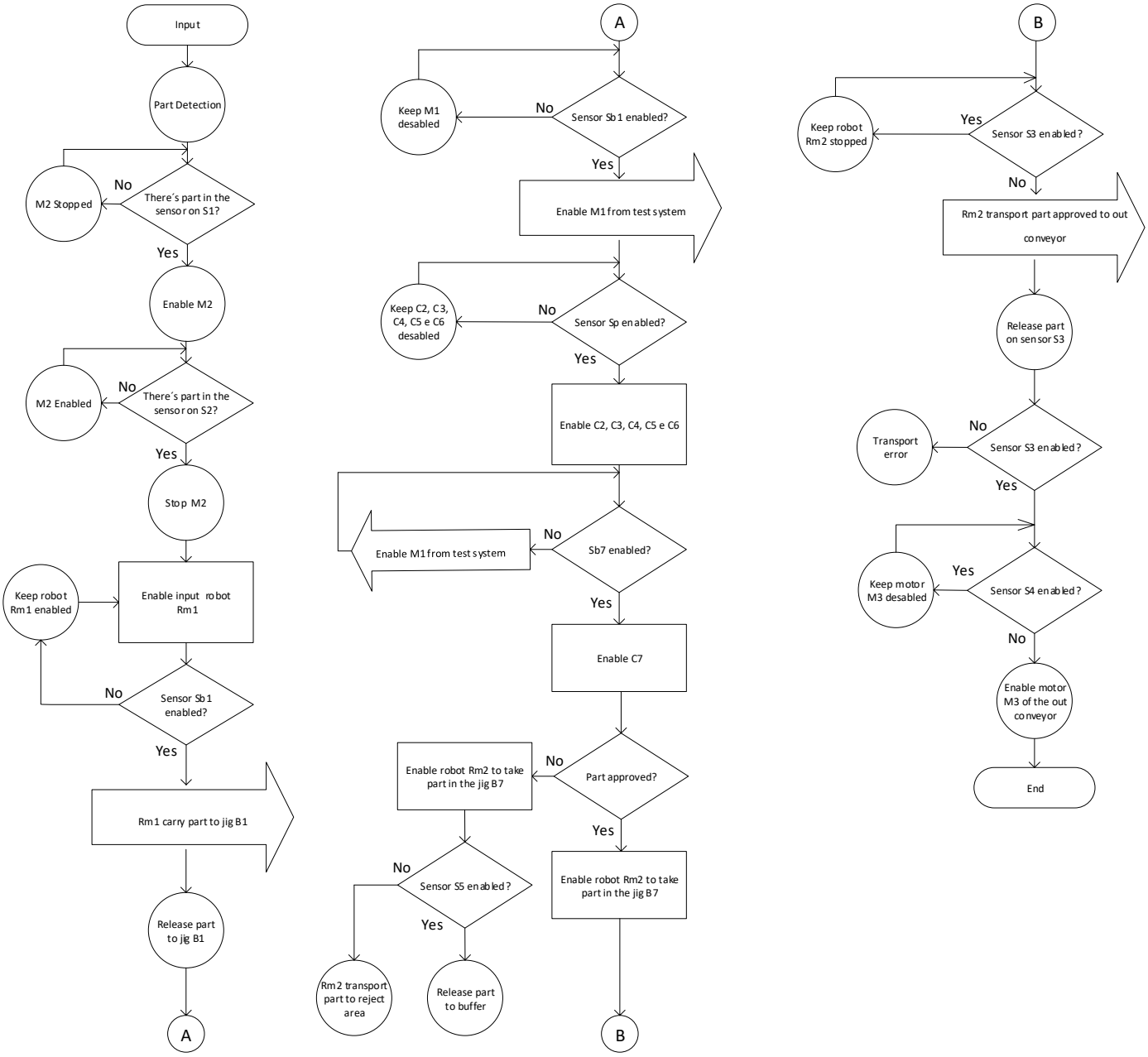

Figure 5 – Flowchart of the automated test system for mobile phone battery.
Source: Authors (2018).

In the figure 5 flowchart presentation, it is considered the use of a single part for the automation system dynamics and the previously loaded system, as detailed described in topic 4.1.

4.3 PN DEVELOPMENT

The PN design and modeling were developed following the assumptions that there should be an automatic input, automatic processing and automatic output, from which the following items were detailed:

- On/Off switch state, emergency Button state and Auto/Manual Button state – Control panel;
- Battery input process through conveyor;
- Battery process in the turntable;
- Output process through conveyor.

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4.3.1 PN DEVELOPMENT – CONTROL PANEL

The figure 6 shows the PN graphic representation of the front panel in charge to energize the system, the emergency protection system and the setting of the automatic manual operation mode. In the initial state the On/Off switch is in the On position, the emergency button is normally closed and the operation mode is in Auto, so all the records are previously loaded in the initial state. After initialization of the PN modeling dynamics, the place record **Aux-Energ** is activated by the arc that comes from the **T8** transition**,** after the system is energized the **Aux-AutoA** also is activated by the arc from the T8 transition, the **Aux-AutoA** position and the **Auto/Manual** state are loaded as a record by the arc from the **T6** transition, the system is triggered and the records position are changed to the **Aux-AutoB** auxiliary variable, in the next step the record will be connected to the input conveyor transition. This PN also includes the modeling graph that describes the emergency button activation as regulated for machines and equipments operations according to [19]. In this graph the emergency button was previously marked in the **Emergency** place and is limited by the inhibitory arc of the **T7** transition, once the emergency button is activated, the 24-place weight arc is activated to transfer the records to the **Aux-Emergency** position, taking into consideration the weighting, the arc weight will correspond to the transitions number that will be disabled in the emergency moment, in this way, following the machine safety regulatory rule (NR) the system will be stopped only recovering after the emergency release.

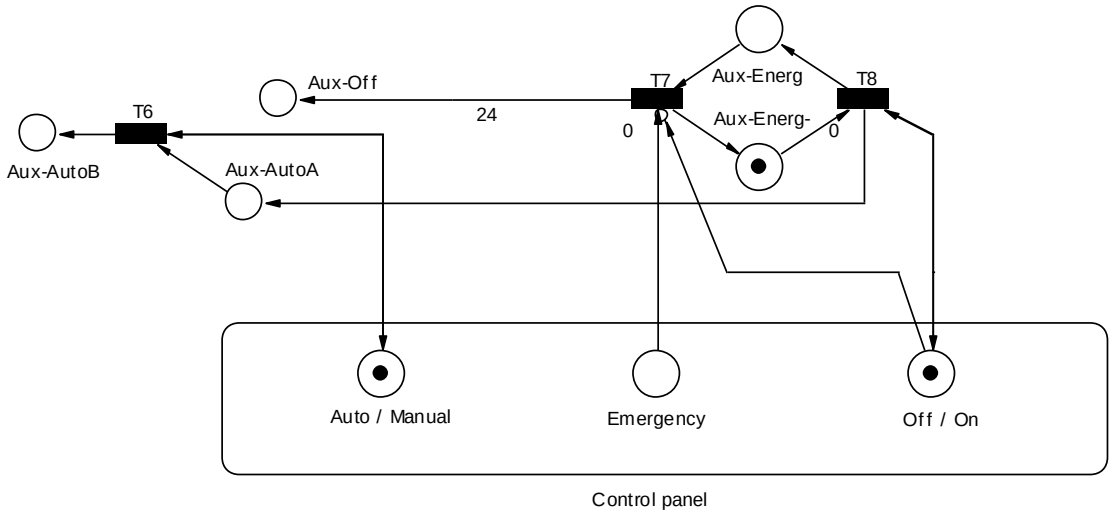

Fig.6 – Petri Network detail of the automatic mobile phone battery test system control panel.
Source: Authors (2018).

4.3.2 PN DEVELOPMENT – BATTERY INPUT PROCESS

The figure 7 shows the PN of the automatic input process of the battery using the conveyor, in this process the **T0** transition will be activated by the **Aux-AutoB** place that results from the control panel modeling and also by the markings that are in the **BufferConveyorIN** state. Considering that the first state of the conveyor is empty, represented by the place of the **S1** sensor, the arc from **T0** will transfer the record to the **T1** transition. The place of the **M2** motor, with the marking indicating that the motor is turned off, will receive the marking from the arc of the **T1** transition when the S1 sensor detects a battery, the marking of the **M2** motor changes and the conveyor is activated until the S2 sensor detects the battery and the conveyor stops due to the **M2** motor is turned off, after the S2 sensor detection, the arc from the T3 transition will activate the Rm1 place which represents the handling robot that transfers the battery to the first slot and the Sb1 sensor detects the presence of the battery in the turntable. The **Aux-CY_LB** place monitors the activation of battery processing cylinders and transfer the record to the **T5** transition, the **Aux-IN** place receives the record by the arc from the T5 transition and start the battery processing. All the inhibiting arcs can be directly controlled according to the emergency button graph using the **Aux-Off** place.

https://dx.doi.org/10.22161/ijaers.6744 ISSN: 2349-6495(P) | 2456-1908(O)

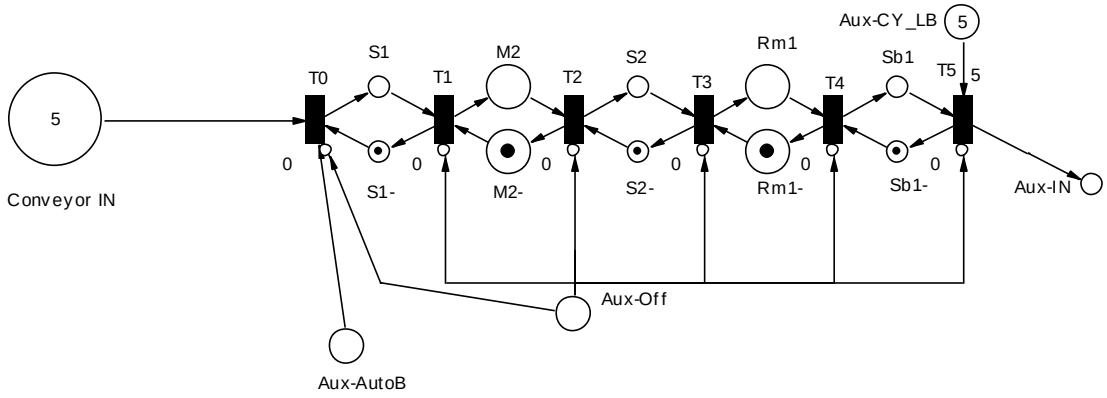

Fig.7 – Petri Network detail of the battery input process using a conveyor.
Source: Authors (2018)

4.3.3 PN DEVELOPMENT –BATTERY PROCESSING IN THE TURNTABLE

The figure 8 shows the PN of the battery processing in the turntable, considering that the **Aux-Y** place is marked with five records or batteries, the **T9** transition is triggered by the **Aux-Energ** place from the PN of the control panel, by the **Aux-IN** place from the PN of the battery input process and the marking from the **Sp** sensor that indicates the correct position of the turntable to start the turn to the cylinders position, the **M1** motor will be activated and the turntable also activates, so the **T10** transition activates the **Aux-X** place by 5-weight arc, due to the simultaneous activation of the 5 cylinders. Therefore, the cylinder **C2** (terminal aligner) will be activated by the marking from the **T21** transition, the cylinder **C3** (open circuit voltage and internal resistence) will be activated by the marking from the **T31** transition, the cylinder **C4** (terminal cutter) will be activated by the marking from the **T41** transition, the cylinder **C5** (cutting inspection) will be activated by the marking from the **T51** transition, the cylinder **C6** (battery thickness meter) and the cylinder C7 (datamatrix reader to verify if the battery is approved or disapproved) are activated by the marking from the **T61** transition, so the **Aux-Y** place Will receive 5 records from the **T22**, **T32**, **T42**, **T52** and **T62** transitions, and then transfers the marking to the **T12** transition which represents the first transition of the battery output process, however using a 5-weight arc, in this way is guaranteed that only one battery is removed from the turntable in each **M1** motor turn. The feedback of the cylinder drive and the motor drive **M1** is indicated by the arc from the **t22, t32, t42 e t52** transitions and from the **Aux-M1_LB** place, so any turn is avoided during the cylinder activation.

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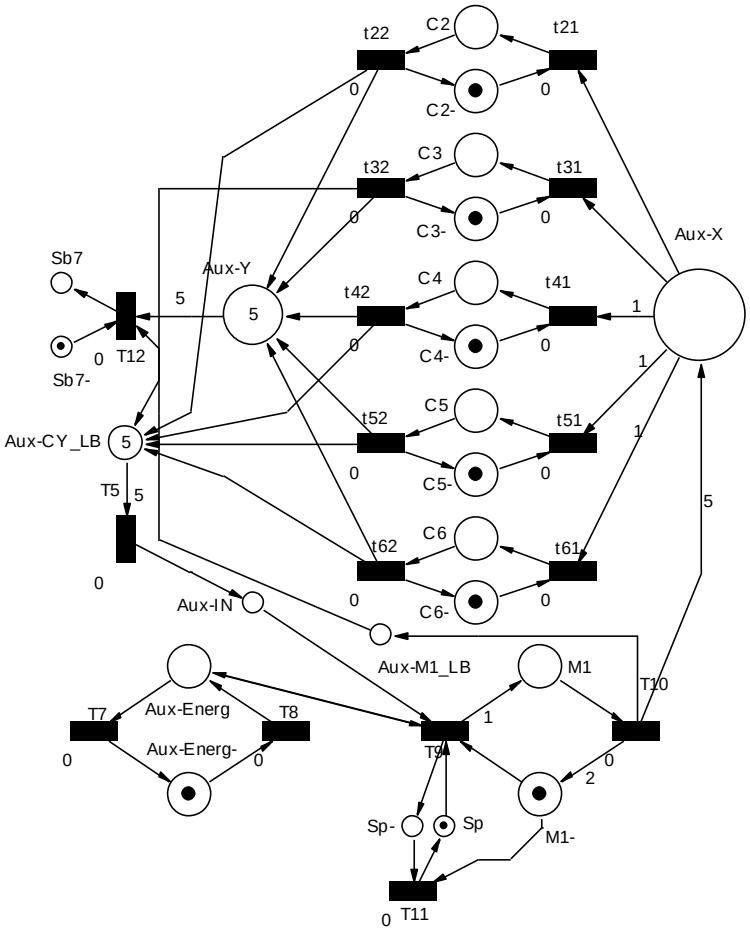

Fig.8 – Petri Network detail of the battery processing in the turntable.
Source: Authors (2018).

4.3.4 PN DEVELOPMENT – BATTERY OUTPUT PROCESS

The figur 9 shows the PN of the battery automatic output using a conveyor, in this simple graph the **T12** transition will be activated by the **Aux-Y** place through the 5-weight arc and the **Aux-M1_LB** place marked by the **M1** motor transition. After the **T12** transition is triggered, the **Sb7** position is marked which means that the battery is in the seventh slot and so the T13 transition is activated to trigger the **Rm2** place. The Rm2 represents the handling robot that removes the battery from the output slot and places it in the output conveyor or in the reject area, detected by the S5 sensor, depending on the battery status. The failure condition will occur when the **Aux-signal-failure** variable receives the transition from the datacenter, however if the battery is approved the **S3** place is marked by the **T15** transition which means that the battery is over the output conveyor, with the detection of the battery the **T16** transition is activated to mark the M3 motor place which activates the output conveyor. Following the **M3** motor activation the **T17** transition is triggered to mark the **S4** place, which represents the end-of-stroke sensor of the output conveyor, the **T18** transition activates the **Buffer Conveyor OUT** place, where the batteries processed are placed and finally the output inhibitor arc linked with the M3 motor that disables the conveyor while a battery is detected by the **S4** sensor.

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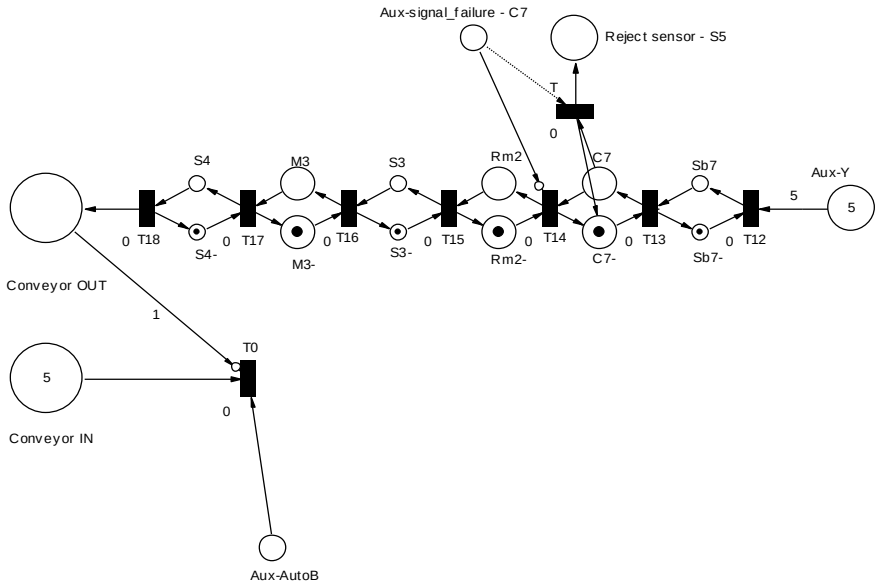

Figure 9 – Petri Network detail of the battery output process.
Source: Authors (2018).

4.3.5 PN DEVELOPMENT – FULL MODEL

The figure 10 shows the modeled and complete PN of the automatic test system for mobile phone battery. Considering the detailed view of the previous subsystems (control panel, battery input process, battery process in the turntable and battery output process) it was developed a mathematical model of oriented graphs that have two node types which are the position node and the transition node. The nodes are linked by the arcs molding a quintuple PN (**P, T, A, W, m_0**), where the **P** represents the positions, **T** represents the transitions, **A** represents de arcs, **W** represents the arcs weight and the $\mathbf{m_0}$ vector wich represents the *i-th* coordinate that defines the marks number of the initial position.

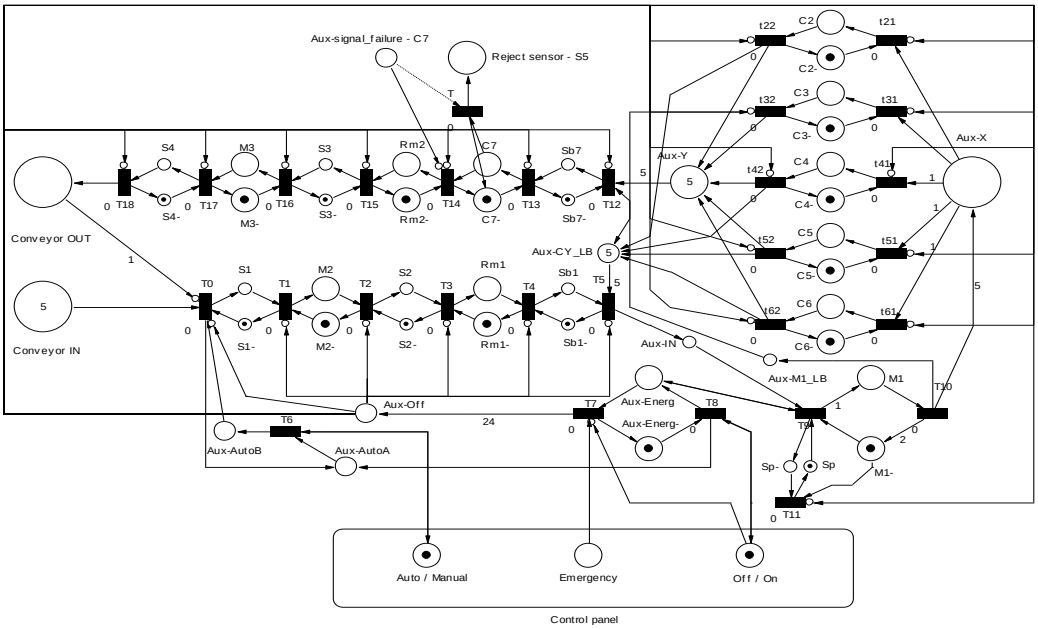

Fig.10 – Full Petri Network of the automated test system for mobile phone battery.
Source: Authors (2018).

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The table 1 presents the place states of the PN, it is possible to verify the sensors and actuators descriptions according to the detection and activation, for example S1 sensor that indicates the battery presence in the start positions of the input conveyor when activated turns to high logic level, while the M1- means that the turntable motor is off.

Table 1 - STATES label of the Petri Network shown in the figure 10.

State	Description	State	Description
Buffer-IN	Input conveyor buffer WITH marking	S4	S4 sensor of PRESENCE indication of the battery in the output conveyor end point.
S1	S1 sensor of PRESENCE indication of the battery in the input conveyor start point.	S4-	S4- sensor of ABSENCE indication of the battery in the output conveyor end point.
S1-	S1- sensor of ABSENCE indication of the battery in the input conveyor start point.	Sb1	Battery first slot PRESENCE sensor
S2	S2 sensor of PRESENCE indication of the battery in the input conveyor end point.	Sb1-	Battery first slot ABSENCE sensor
S2-	S2- sensor of ABSENCE indication of the battery in the input conveyor end point.	Sb6	Battery sixth slot PRESENCE sensor
S3	S3 sensor of PRESENCE indication of the battery in the output conveyor start point.	Sb6-	Battery sixth slot ABSENCE sensor
S3-	S3- sensor of ABSENCE indication of the battery in the output conveyor start point.	M1	ACTIVATED Turntable motor
M1-	DEACTIVATED Turntable motor	C4-	DEACTIVATED battery terminal cutter cylinder
M2	ACTIVATED input conveyor motor	C5	ACTIVATED terminal cutting inspection cylinder
M2-	DEACTIVATED input conveyor motor	C5-	DEACTIVATED terminal cutting inspection cylinder
M3	ACTIVATED output conveyor motor	C6	ACTIVATED battery thickness meter cylinder
M3-	DEACTIVATED output conveyor motor	C6-	DEACTIVATED battery thickness meter cylinder
Rm1	ACTIVATED Handler robot of the input conveyor	C7	ACTIVATED datamatrix reader cylinder
Rm1-	DEACTIVATED handler robot of the input conveyor	C7-	DEACTIVATED datamatrix reader cylinder
Rm2	ACTIVATED handler robot of the output conveyor	Buffer-OUT	Output conveyor Buffer
Rm2-	DEACTIVATED handler robot of the output conveyor	Auto	AUTOMATIC operation mode
C2	ACTIVATED terminal aligner cylinder	Manual	MANUAL operation mode
C2-	DEACTIVATED terminal aligner cylinder	Emergency	ACTIVATED emergency circuit
C3	ACTIVATED OCV meter and IR meter cylinder	Emergency WITH marking	DEACTIVATED emergency circuit
C3-	DEACTIVATED OCV meter and IR meter cylinder	Power On	ACTIVATED equipment power on
C4	ACTIVATED battery terminal cutter cylinder	Power Off	DEACTIVATED equipment power on

Source: Authors (2018).

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The table 2 presents the activated transitions by the markings from the PN states, it is possible to verify that the T1 transition detects the battery presence in the start point of the input conveyor and the T18 transition detects battery presence in the buffer_out of the output conveyor.

Table 2 - TRANSITIONS label of the Petri Network shown in the figure 10.

Transition	Description	Transition	Description
T0	System analysis of battery AVAILABILITY in the input conveyor	T15	System detection of battery PRESENCE in the START point of the output conveyor
T1	System detection of battery PRESENCE in the START point of the input conveyor	T16	ACTIVATED output conveyor M3 motor
T2	ACTIVATED input conveyor M2 motor	T17	System detection of battery PRESENCE in the END point of the output conveyor
T3	System detection of battery PRESENCE in the END point of the input conveyor	T18	System detection of battery PRESENCE in the BUFFER OUT of the output conveyor
T4	ACTIVATED Handler robot of the input conveyor	t21	System detection of battery PRESENCE for C2 cylinder activation
T5	System detection of battery PRESENCE in the SLOT 1 of the turntable	t22	ACTIVATED terminal aligner cylinder
T6	System detection that the AUTOMATIC operation mode is activated	t31	System detection of battery PRESENCE for C3 cylinder activation
T7	System detection that the EMERGENCY operation mode is activated	t32	ACTIVATED OCV meter and IR meter cylinder
T8	System detection that the equipment power on is ACTIVATED	t41	System detection of battery PRESENCE for C4 cylinder activation
T9	Verification transition of the turntable POSITION	t42	ACTIVATED battery terminal cutter cylinder
T10	ACTIVATED Turntable M1 motor	t51	System detection of battery PRESENCE for C5 cylinder activation
T11	System analysis of the M1- motor DEACTIVATED state	t52	ACTIVATED terminal cutting inspection cylinder
T12	System analysis of battery AVAILABILITY in the output conveyor	t61	System detection of battery PRESENCE for C6 cylinder activation
T13	System detection of battery PRESENCE in the SLOT 7 of the turntable	t62	ACTIVATED battery thickness meter cylinder

Source: Authors (2018).

4.3.6 PN ANALYSIS

For the PN analysis, it is necessary to check the good properties, which are, Reachability, Liveness and Boundedness. The proposed verification method of the good properties is based on the analysis by markings enumeration, analyzing if the PN is limited by the coverage tree building [11] [12] [13], for this it was elaborated the marking vectors M as presented in the table 3, they are originated by the PN STATES actions as presented by the table 1 and by the TRANSITION markings presented by the table 2. The marking vectors M are based on the following vector notation:

M=[Buffer-IN, S1, S1-, M2, M2-, S2, S2-, Rm1, Rm1 -, Sb1, Sb1-, Aux-IN, Sp, Sp-, M1, M1-, Aux-M1_LB, Aux-X, C2, C2-, C3, C3-, C4, C4-, C5, C5-, C6, C6-, Aux-CY_LB, Aux-Y, Sb6, Sb6-, Rm2, Rm2-, S3, S3-, M3, M3-, S4, S4-, Buffer-OUT]

The notation of the vector position in table 3 shows the progress of the PN according to the places marking which enables the transitions seen in bold in this table. In the M0 vector = [**1**01010101010100100010101010111010101010] it is possible to verify that the ***Buffer-IN*** position which represents the accumulated batteries in the start point of the input conveyor, is marked with the STATE "1" which means that there is available battery in the input conveyor. Soon after, it is observed in M1 vector = [**01**001010101010010001010101011101010101010] that

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the ***S1*** vectorial position is marked representing that the detection sensor of the battery in the start point of the input conveyor is activated by the ***T0*** transition. The same condition happens with the M8 and M9 vectors weighted with 5 transitions, signaling that there are initially marked pieces, the oriented arc coming from the vector position Aux-Y has weight 5, thus providing unit marking for the T12 transition at the start point of the output conveyor, in this way keeping the PN modeling coherent. Finally, the M15 and M16 vectors, S4- vector position and Buffer-OUT respectively, were enabled by the T17 and T18 transitions, depicting that the part traveled all the PN from the input conveyor, turntable processing and output conveyor to the buffer-out. In this way it is possible to state that this marked PN modeling of the automated test system for mobile phone battery is limited if it falls within the first good property, because if all the positions of a RP are k-bound, then the network is **k- limited**, being a **safe** PN if it is k-bounded with k = 1 according to [10].

Table 3 – Marking vectors M.

State	Marking vectors M	Activated Transition
M0	**1**0101010101010010001010101011101010101010	**T0**
M1	0**1**0010101010100100010101010111010101010	**T1**
M2	001**1**0010101010010001010101011101010101010	**T2**
M3	00101**1**0010101001000101010101110101010101 0	**T3**
M4	0010101**1**0010100100010101010111010101010	**T4**
M5	00101010**1**00100100010101010111010101010	**T5**
M6	0010101010**1** 1001000101010101110101010101 0	**T9**
M7	00101010101010011**1**0010101010111010101010	**T10**
M8	00101010101010010115010101011101010101010	**T21,T31,T41,T51,T61**
M9	00101010101001011**1**0**1**0**1**0**1**0**1**00101010101010	**T22,T32,T42,T52,T62**
M10	00101010101001011001010101011**1**01010101010	**T12**
M11	00101010101001011001010101011**1**0010101010	**T13**
M12	00101010101001011001010101011001**1**00101010	**T14**
M13	00101010101001011001010101011001011101010	**T15**
M14	00101010101001011001010101011001010**1**1010	**T16**
M15	00101010101001011001010101011001010101**1**00	**T17**
M16	00101010101001011001010101011001010101011	**T18**

Source: Authors (2018).

Following the enumeration marking analysis, since the marked network is limited, the second and third part of the analysis is to build the accessible markings graph as shown in the figure 11, in order to verify and certify that the graph is strongly connected [13], since there is a path between the initial marking ***M0*** and any marking ***Mj*** belonging to the graph vectors, in this way for all accessible markings there must be at least one tagged transition enabling the progress of the transition states. Thus, the marked PN has Liveness, since it is capable of recovering from operation disturbing events, such as interruptions by the operator or safety device [10] and also has a Boundedness characteristic, since all parts of the PN are accessible and it is ensured that there will be no blockage.

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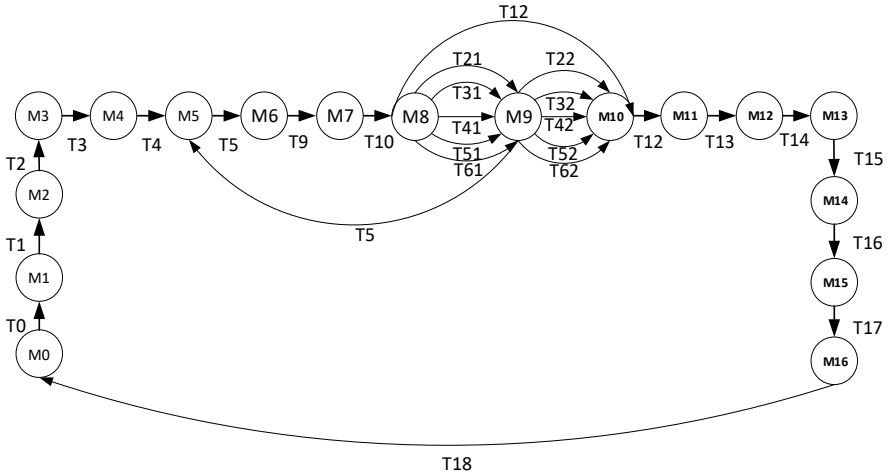

Fig.11 – Avaiable marking graph.
Source: Authors (2018).

V. CONCLUSION

The modeling research came from the restlessness in innovation pursuit and contribution of the automatic testing system development for lithium ion polymer battery used in mobile phone. Considering this as a DES, the PN showed that it is fully possible to model the automatic testing system for mobile phone battery and including the evaluation of a secondary scenario with fault treatment in the battery reject area.

It was demonstrated that the analysis of PN by the markings enumeration method, through the coverage tree building and accessible markings graph, has the good properties of Reachability, Liveness and Boundedness, being fundamental in the PN analysis. In addition, it is possible to obtain a high level of understanding of real progress and real system evolution through the dynamic visualization of discrete events graphs. This fact does not diminish the mathematical formalism inherent of the PN, which is also a distinct point from the developed model in this research.

The financial relevance proved to be interesting by analyzing at least two scenarios: the first one is related to the five to two manual processes optimization, one for the input process and another for the output process, thereby optimizing efficiency by 60%, estimated in USD 1,200 per monthly manual process, there will be an annual increase in efficiency of USD 138,000.00 per year, applied to three production lines currently present in this company; the second scenario considers that the application of the automatic test system for mobile phone battery integrated with all the related production process will represent a 100% efficiency increment because the previous process will provide parts to the automatic system and the later process will receive the parts processed by the automatic test system, thus increasing efficiency by USD 234,000.00 per year. In addition, the process innovation allows greater assertiveness in the repeatability and reproducibility indicator. Finally, the pertinence in the continuity of the system development with the migration of this modeling results to machine algorithms and also the application of this technique in researches which includes concurrent events and logical conflicts.

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Use of Simple Linear Regression Models to Analyze the Contribution of Non-linear Loads in the Harmonic Distortions of Voltage in an Electric System Bus: Case Study

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Abstract *— A new harmonic data distribution window was developed, through the collection of data from the distribution network, in a medium voltage substation of level 13.8 kV. The objective of this article is to obtain a study on the energy for the consumer units (UCs), for a minimum period of 7 consecutive days according to the PRODIST, electrical system. The harmonics are not as harmful for firms as for power distribution company. A technique developed of this article is a linear regression technique, which is a construction of parametric models and a mathematical analysis. This is an article published and applied in the practice of case studies of harmonic analysis of electric energy distribution systems through linear regression analysis, obtaining great results in the study, thus validating an applied technique in harmonic analysis of electric power distribution systems.*
Keywords *— **Linear Regression, Quality Power, Harmonic Distortions, Non-linear loads.***

I. INTRODUCTION

It is undisputed that the dispersed use of non-linear electric charges in residential, commercial and industrial class consumers is contributing significantly to the increase in voltage harmonic distortion in electrical systems, as can be seen in electrical systems worldwide. [1] states that worldwide power supply is becoming a source of harmonic currents with pollution caused by modern electronic equipment, causing interference with communication systems, generating extra losses of electrical energy in the wiring, overload in transformers or in the electrical systems themselves, and besides that, causes the conduction of a high level of reactive power, thus adding more charges on electric bills to consumers due to this pollution.

According to [2], with the intention of maintaining a harmonious coexistence between sensitive equipment and equipment, it is necessary to establish limits and standards to control such talents or phenomena. They are: Institute of Electrical and Electronic Engineers (IEEE) in the United States, International Electrotechnical commission (IEC), Europe and Proceedings of Distribution of National Electrical Energy (PRODIST) in Brazil.

The standards cited above define the reference values for the electric power quality indicators, for example, the PRODIST module defines indicators limited for voltage harmonic distortion, which restrict the levels of harmonic distortion of voltage in the electric net within a limit that would not cause damages to the quality of the electric energy, thus not affecting the operation of the electrical devices, electronics and equipment connected to the electric net. A good prevention for possible voltage distortions in the electrical system is make the dealership perform a constant monitoring in the electrical net in order to identify suspect loads that may be contributing significantly to the harmonic distortion of voltage at some points or specific feeders of interest to the electric system. Therefore, the dealership need to use methodologies that help them in identifying which non-linear loads between the loads connected to the grid are most significant for increasing the harmonic distortions of voltage at specific points in the electrical system or PCC. In the case of this article the contribution of a feeder to the harmonic distortion of a busbar system of an electric system is

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analyzed, thus allowing the implementation of a specific treatment for the consumers served by this feeder seeking corrective actions to alleviate the problem that the harmonic currents cause in the electrical system, which are the violations of the voltage harmonic distortion indicators in the electrical systems.

It is important to emphasize that although there are documents that contemplate subjects related to reference values, measurement procedures, protocols, etc., there are still few researches with applications of methodologies to quantify the percentage of contribution to harmonic distortions of tension to be attributed to dealership and customer in Brazil, as well as there is no norm for current harmonic distortion in Brazil, and once a violation of the reference values of the current norms has been found, the use of a methodology to identify the percentages of contribution of each of the parties, both of electric power dealership and consumers, thus assigning responsibilities to both. Thus, this paper suggests a methodology of analysis, with the construction of parametric regression models called simple linear regression, using harmonic voltage magnitude at the point of interest and magnitude of harmonic current in each feeder under study. This analysis is performed using the statistical metric R-squared (R^2) to evaluate the relevance of the respective correlation model.

The structure of this article is as follows: in Section 2, the mathematical model of the electric network is formulated and the linear regression method is presented; In Section 3, the methodology proposed to estimate the harmonic contribution of the feeder of the electric system under study is formulated; in Section 4, this methodology is applied in a case study of an actual electrical system; and Section 5, the main conclusions of this article are presented.

II. MATHEMATICAL MODEL OF THE DISTRIBUTION NETWORK

According to [3], a distribution network can be represented by the matrix impedance matrix in (1), such as:

$$E^h = Z^h . I^h \quad (1)$$

where E^h is the n-dimensional complex harmonic voltage vector of order *h*, with magnitude V^h and phase angle θ^h; I^h is the n-dimensional vector of complex harmonic current injections of order *h*, with magnitude I^h and phase angle φ^h; Z^h is the complex matrix of harmonic impedance of order *h*.

Analyzing that it is desirable to determine the contribution of the harmonic current I^h_{fAl} of phases A, B and C of three feeders of an actual electric system for harmonic distortion of voltage in a bus ***i*** of the electric system, can be written as:

$$E^h_i = Z^h_{ifAl} . I^h_{fAl} + \sum_{k=1}^{n} Z^h_{ik} . I^h_k \quad (2)$$

In which,
h – harmonic order
Al - Feeder
f – phases of the feeders ***Al***
Or, optionally, as:

$$E^h_i = E^h_{ifAl} + E^h_{iB} \quad (3)$$

In which $E^h_{ifAl} = Z^h_{ifAl} . I^h_{fAl}$ is the harmonic distortion of voltage due to the current of the feeder I^h_{fAl}; $E^h_{iB} = \sum_{k=1}^{n} Z^h_{ik} . I^h_k$; The harmonic distortion of background voltage due to other non-linear loads connected to the feeders that are not being monitored. Assuming that the electric net under study can be considered a linear net, then in equation (2) the term $Z^h_{ifAl} . I^h_{fAl}$ represents the harmonic distortion due to the non-linear loads connected to the feeder *Al* monitored, while the term sum represents the background contribution due to other non-linear loads connected in unmonitored feeders. However, in a power grid it is often not valid due to the magnetic saturation of reactors and transformers, which can also introduce harmonic distortions of voltage E^h_i.

In equation 2, the contribution of each harmonic current I^h_{fAl} to the harmonic voltage E^h_i can be exactly determined if the transfer impedance Z^h_{ifAl} is known for each operational condition, which is not trivial to obtain this information in electrical systems real. Thus, direct application (2) is not a trivial task since it is necessary to have a detailed description of the connected non-linear elements in the electrical network, requiring simultaneous measurements of voltage and current magnitudes and phases in the feeders under study. Often utilities measure only the harmonic magnitudes of voltage and current, that is, V^h_i and I^h_{fAl} which in this case, the most practical and direct way of obtaining an indication of the contribution to the harmonic distortion of voltage is E^h_i due to the harmonic current injected into the feeder *Al* $(I^h_{f,Al})$ is identifying a regression model to express a correlation between V^h_i and I^h_{fAl}. It is well known that statistical models do not necessarily represent a causal relationship, but if they present a high correlation between two

https://dx.doi.org/10.22161/ijaers.6745 *ISSN: 2349-6495(P) | 2456-1908(O)*

variables, it means that one variable can explain the behavior of the other. Considering this characteristic, statistical model will be developed to evaluate the relationship between E_i^h and I_{fAl}^h of each phase of the electrical system feeder under study using parametric simple linear regression model.

2.1. MODEL OF SIMPLE LINEAR REGRESSION

The simple linear regression model is used to describe the relationship between a response variable (V_i^h) and a quantitative explanatory variable (I_{fAl}^h) and takes the form of a straight line through the scattering of points that arise when the values of variables are plotted in relation to the values of the explanatory variable. This model can be represented by equation (4) [3]. According to [4], the most common method to find the regression line is the least squares. This method calculates the better fit line for the observed data, minimizing the sum of the squares of the vertical distances from each point to the line.

$$V_i^h = \beta I_{f,Al}^h + \alpha + \epsilon \tag{4}$$

Where V_i^h is the magnitude of the harmonic voltage of order h in bus i; I_fAl^h is the magnitude of the harmonic current injection of order h in phase f of the feeder Al; β and α are the first order slope and intercept parameters; ε is the model error, which is characterized by a Gaussian distribution with mean zero and variance equal to σ^2. In equation (4), when the harmonic current I_fAl^h, is zero, α represents the background harmonic voltage, which is considered constant during the analysis period.

The least squares principle uses (5) and (6) to calculate the regression parameters β and α, respectively, as [5].

$$\beta = \frac{\sum_{i=1}^{n}(V_i^h - \overline{V}^h)(I_{fAl}^h - \overline{I}^h)}{\sum_{i=1}^{n}(I_{fAl}^h - \overline{I}^h)^2} \tag{5}$$

$$\alpha = \overline{V}^h - \beta\overline{I}^h \tag{6}$$

Where $\overline{V}^h$ and $\overline{I}^h$ are mean values for V_i^h and I_{fAl}^h.

Once the regression model is constructed using simple linear regression, it is necessary to evaluate this model through the analysis of the variance, in order to certify if the regression model obtained is adequate to explain the relation between the dependent variable and the independent variables. The analysis of variance is a statistical tool that, through statistical inference techniques, analyzes two main assumptions: the null assumption, which means the possibility of the parameter β (slope of the line) is null; and the alternative assumption, which means that the same parameter can not be null [6].

In the analysis of variance, three essential parameters are obtained: the total sum of squares (SS_{Total}), the sum of squares of error (SS_{Res}) and the sum of squares of regression (SS_{Reg}). These parameters are calculated by equations (7), (8) and (9), respectively.

$$SS_{Total} = \sum_{i=1}^{n}(V_i^h - \overline{V}^h)^2 \tag{7}$$

$$SS_{Reg} = \sum_{i=1}^{n}(\hat{V}_i^h - \overline{V}^h)^2 \tag{8}$$

$$SS_{Res} = \sum_{i=1}^{n}(V_i^h - \hat{V}_i^h)^2 \tag{9}$$

In which:

$\hat{V}_i^h$ – is the estimated value of the variable V_i^h by the regression model;

$\overline{V}^h$ – is the hope of the variable V^h;

V_i^h – is the value of the variable V^h used to construct the regression model.

III. MATERIALS AND METHODS

As mentioned briefly in the introduction, the main objective of this work is to present a parametric regression model applied in the analysis of the contribution of harmonic currents injected into a feeder of an electric system for harmonic distortions of voltage in the electric network. The technique used in the methodology of this article is the simple linear regression technique, which has as a characteristic the construction of parametric models and simple mathematical calculation. The metric used to validate the models is the coefficient of determination R^2. With the parameters, SS_{Total}, SS_{Res}, SS_{Reg}, the value of the reliability indicator of the constructed model, known as the determination coefficient R^2, is calculated. According to [7], the coefficient of determination R^2 is the ratio of the total sum of the squares of the dependent variable to the independent variables in the model, according to equation 10. The coefficient of determination R^2 is used to measure the correlation intensity between the response and the independent variables in a regression model and based on the R^2 value, one can reject the regression model or not.

$$R^2 = \frac{SS_{Reg}}{SS_{Total}} = \frac{\sum_{i=1}^{n}(\hat{V}_i^h - \overline{V}^h)^2}{\sum_{i=1}^{n}(V_i^h - \overline{V}^h)^2} = 1 - \frac{SS_{Res}}{SS_{Total}} \tag{10}$$

Where $\hat{V}_i^h$ is the estimated value obtained by the linear method V_i^h while $\overline{V}^h$ is the mean value for the time series of measurements. The correlation intensity associated

https://dx.doi.org/10.22161/ijaers.6745 *ISSN: 2349-6495(P) | 2456-1908(O)*

with the R^2 value is presented in table 1. [8] explains, if R^2 = 0%, indicates that the model does not explain any variability of the response around its average, while R^2 = 100% means that the model explains all the variability of the response data around its average.

Table 1. Correlation Intensity R^2.

Value of R^2	Correlation intensity
0,00	Null
(0,00 – 0,09)	Low
0,09 – 0,36)	Moderate
(0,36 – 0,81)	High
(0,81 – 0,98)	Very high
1,00	Perfect

Source: Authors, (2019).

As can be seen in Table 1, the higher the R^2, the stronger the correlation intensity and the more adequate the regression model to represent the data. The use of R^2 can identify where the main harmonics are, but can not quantify the harmonic contribution of these harmonic sources. This calculation can be obtained by calculating the harmonic percentage impact for each harmonic source and the respective precedents as in [9]. The use of the linear regression technique is justified by the computational simplicity in the creation of the models, since the simplicity of such models helps to ensure that the constructed regression models are easy to interpret, thus obtaining a faster response time. The procedures adopted to collect data from the electric system are shown in figure (1).

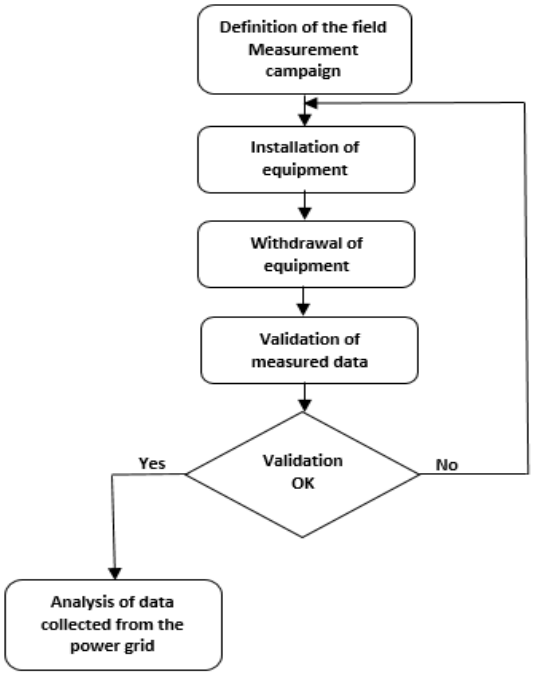

Fig.1: Design the search.

Source: Authors, (2019).

3.1. DEFINITION OF THE FIELD MEASUREMENT CAMPAIGN

This paper was based on field-synchronized measurement campaigns on a feeder and bus of the electrical power system under study, using a properly calibrated DHT Energy Quality Analyzer, which will measure the levels of harmonic distortions present in the signal. The objective is to analyze the impacts of the harmonic currents injected in this feeder to the harmonic distortions of voltage in a bus of the electric system. Measuring time: 7 days. Intervals of each measurement: 10 minutes.

3.2. INSTALLATION OF EQUIPMENT

The energy quality analyzers were installed in medium voltage.

The power quality analyzers were installed in the medium voltage substation booth using the secondary CT and TPS. The power quality analyzer remained installed for a minimum of 7 continuous days, according to PRODIST module 8 / ANEEL.

3.3. WITHDRAWAL OF EQUIPMENT

The removal of the equipment was always performed on the eighth day of monitoring, so the energy quality analyzer monitored for 7 (seven) complete days and at least up to the 25th harmonic order according to the [10].

3.4. ANALYSIS OF DATA COLLECTED FROM THE POWER GRID

The analyzes of the data collected were performed respecting the limits for total and individual harmonic distortions described in [10], [11] and [12], and applying the simple linear regression technique, seeking the correlation between the harmonic currents injected into the feeders and the distortion harmonic in a bus of the electric system under study. In the next sections, the proposed methodology is applied to the data of a feeder and a bus of an actual electrical system, presented as case study. A case study will be performed, which consists of analyzing the harmonic impacts of the feeder under study for harmonic distortion of voltage in the bus. The analysis to be presented will focus on the third, fifth and seventh harmonics only thus covering the three harmonic sequences, positive, negative and zero.

IV. RESULTS

The results were obtained through a case study carried out in the electric system of an electric power utility. In order to evaluate the methodology proposed previously, a study was made in a feeder and a bus of the electrical system in order to determine the influence of some nonlinear loads on the harmonic distortion of the busbar under study, as shown in figure (2).

https://dx.doi.org/10.22161/ijaers.6745 *ISSN: 2349-6495(P) | 2456-1908(O)*

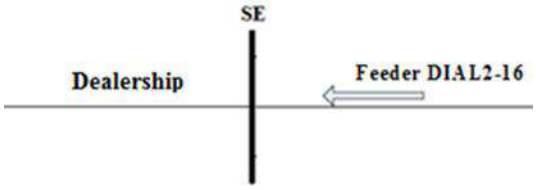

Fig.2: Identification of the harmonic impact of the feeder under study in a common bus of a substation.
Source: Authors, (2019).

During the studies in the system, tensions and harmonic currents were obtained in the study feeder, which allowed the construction of regression models that described the relationship between these quantities.

The analyzes were carried out with measurements collected in the period from May 15, 2017 to May 22, 2017. During this period a measurement campaign was carried out in the substation of voltage level 13.8 kV of the power distribution company under study, in which two QEE analyzers to perform simultaneous measurements at the following measuring points: DITF4-04 transformer; and DIAL2-16 feeder.

Figure (3) shows the single line diagram of the substation under study and the location of the energy quality analyzer installation points (blue circle points) for this measurement campaign, totaling two simultaneous measurement points. The purpose of installing the QEE analyzer on the DITF4-04 transformer is to monitor the harmonic voltage on the DIBR2-03 (green circle) bar. These analyzes sought to evaluate the correlation between the harmonic currents of order 3a, 5a and 7a of the DIAL2-16 feeder and the harmonic voltages of the same order in the DIBR2-03 (13.8 kV) bar of this substation and thus covering the three sequences, zero (3rd), negative (5th) e positive (7th).

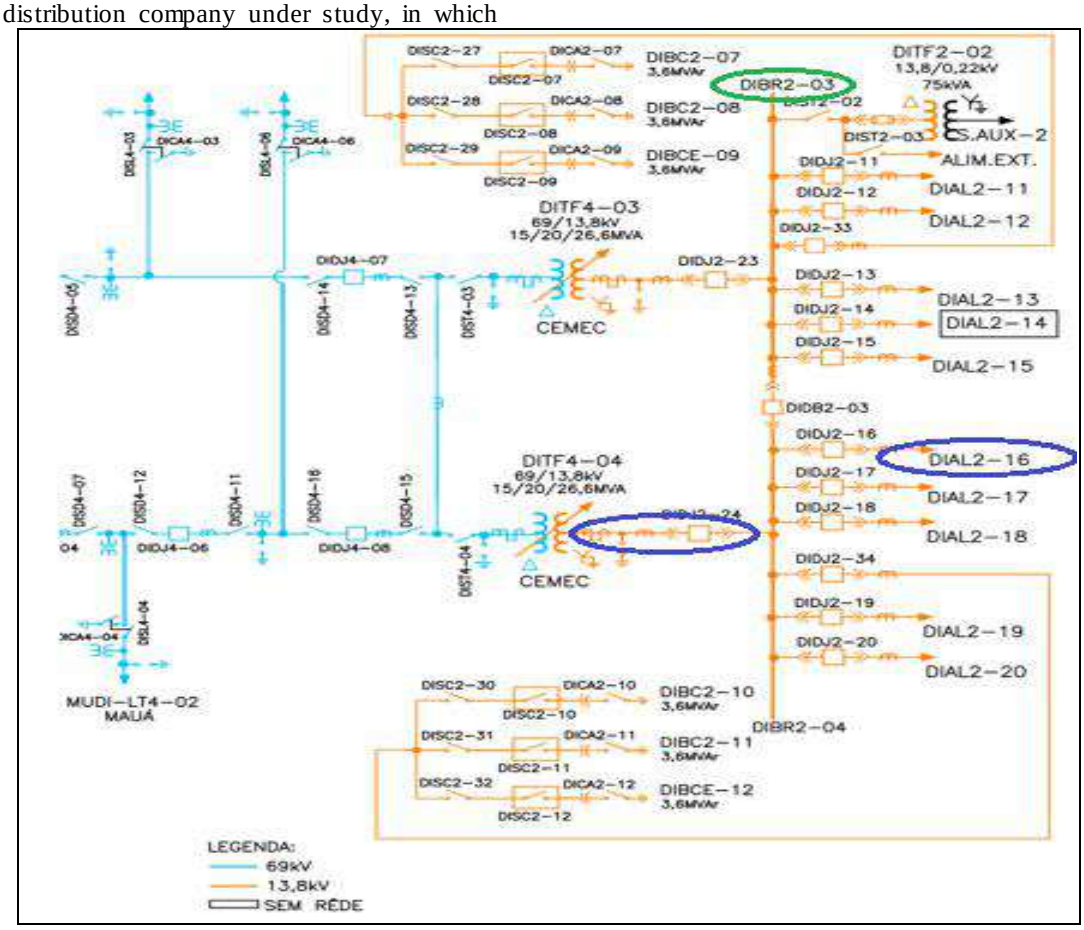

Fig.3: Single-line diagram of substation points under study.
Source: Authors, (2019).

4.1. CASE STUDY

The case study presents the harmonic impact study between the harmonic current of orders 3rd, 5th e 7th of the DIAL2-16 feeder and the same order harmonic voltage of the DIBR2-O3 bar, see figure 3.

4.1.1. IMPACT ANALYSIS BETWEEN THE HARMONIC CURRENT OF THE 3RD ORDER OF THE DIAL2-16 FEEDER AND THE HARMONIC VOLTAGE IN THE SAME ORDER ON THE DIBR2-03 BAR

https://dx.doi.org/10.22161/ijaers.6745 *ISSN: 2349-6495(P) | 2456-1908(O)*

Based on the field measurement data, Table 2 shows the percentage impact of the 3rd order harmonic current on the DIBR2-03 bar of phases A, B and C of the DIAL2-16 feeder in relation to the background (VBG - unmeasured feeders) using the linear regression technique. Analyzing the values of the metric R^2, it is observed that the phases A and B present high intensity of correlation and low intensity of correlation in phase C whose R^2 is 0,043. Table 2 indicates that phase A is responsible for about 37% of the harmonic distortion impact on the DIBR2-03 bar caused by the harmonic currents injected into the DIAL2-16 feeder in relation to the VBG, phase B is responsible for about 100% in relation to VBG and phase C is responsible for about 12% in relation to VBG.

Table 2. Load Porch, Coefficient of determination and Impact factor.

Load Porch - Morning and Afternoon			
STARTING TIME		FINAL TIME	
00:00:00		14:00:00	
METRICS	PHASE A	PHASE B	PHASE C
R^2	00,526	00,385	00,043
Impact Factor (%)			
VOLTAGE	PHASE A	PHASE B	PHASE C
VT	37,225	104,527	12,367
VBG	62,775	-04,527	87,633

Source: Authors, (2019).

The simple linear regression models between the harmonic currents of the 3rd order and the same order of harmonic voltage of the DIBR2-03 bar in phases A, B and C are shown in Figures 4, 5 and 6, respectively.

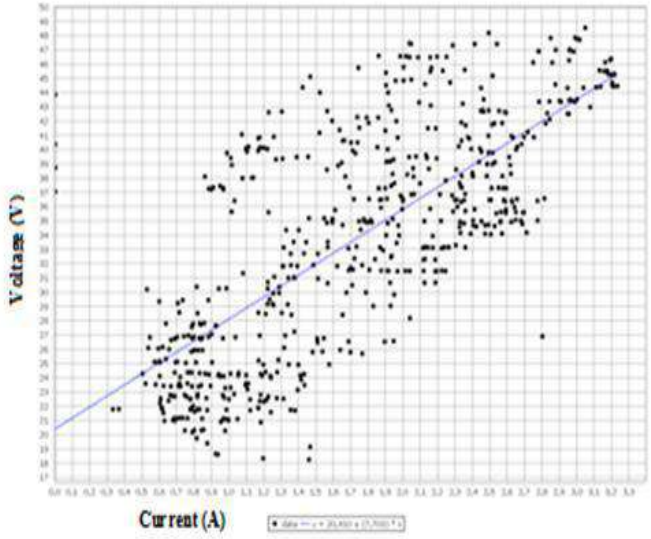

Fig.4: 3rd harmonic of PHASE A.
Source: Authors, (2019).

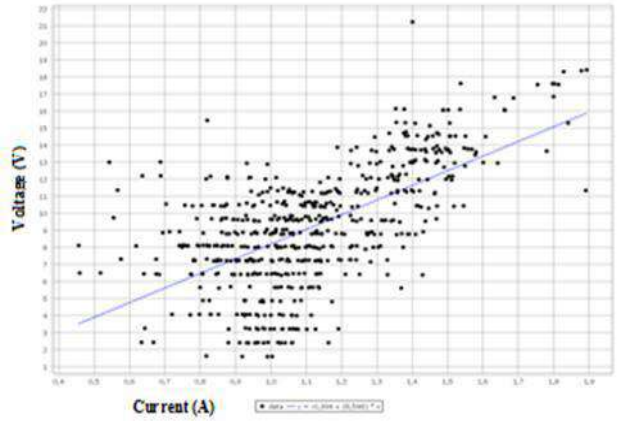

Fig.5: 3rd harmonic of PHASE B.
Source: Authors, (2019).

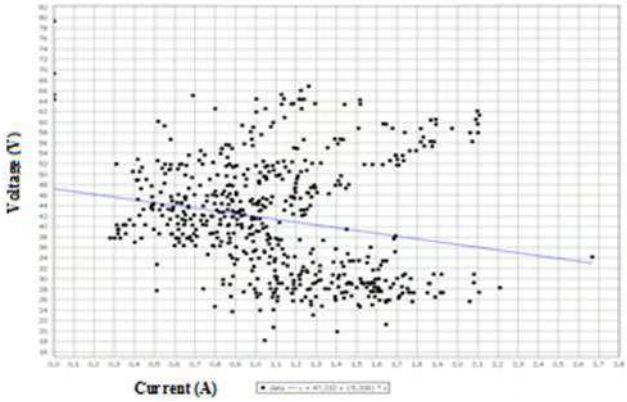

Fig.6: 3rd harmonic of PHASE C.
Source: Authors, (2019).

The regression models of Figures 4, 5 and 6 are represented by equations 11, 12 and 13 respectively.

$$V_{A,16}^{3h} = 20{,}410 + (7{,}703).I_{A,16}^{3h} \quad (11)$$

$$V_{B,16}^{3h} = -0{,}394 + (8{,}598).I_{B,16}^{3h} \quad (12)$$

$$V_{C,16}^{3h} = 47{,}232 + (-5{,}338).I_{C16}^{3h} \quad (13)$$

4.1.2. ANALYSIS OF IMPACT BETWEEN THE HARMONIC CURRENT OF THE 5TH ORDER OF THE DIAL 2-16 AND THE HARMONIC VOLTAGE OF THE SAME ORDER IN THE DIBR2-03 BAR

Based on the field measurement data, Table 3 presents the percent impact of the 5th order harmonic current on the DIBR2-03 bar of phases A, B and C of the DIAL2-16 feeder in relation to the VBG using the linear regression technique. Analyzing the values of the R^2 metric, it can be observed that the phases A and C have zero correlation intensity and very high correlation intensity in phase B whose R^2 is 0.875. Table 3 indicates that phase B is responsible for about 72% of the harmonic distortion impact on the DIBR2 - 03 bar caused by the harmonic

https://dx.doi.org/10.22161/ijaers.6745 *ISSN: 2349-6495(P) | 2456-1908(O)*

currents injected into the DIAL2 - 16 feeder in relation to the VBG and the impacts of phases A and C are lows close to zero.

Table 3. Load Porch, Coefficient of determination and Impact factor.

Load Porch - Morning and Afternoon			
STARTING TIME		FINAL TIME	
00:00:00		14:00:00	
METRICS	PHASE A	PHASE B	PHASE C
R^2	00,000	00,875	00,000
Impact Factor (%)			
VOLTAGE	PHASE A	PHASE B	PHASE C
VT	00,575	72,239	00,619
VBG	99,425	27,761	99,381

The simple linear regression models between the 5th order harmonic currents and the same order of harmonic voltage of the DIBR2-03 bar in phases A, B and C are shown in Figures 7, 8 and 9, respectively.

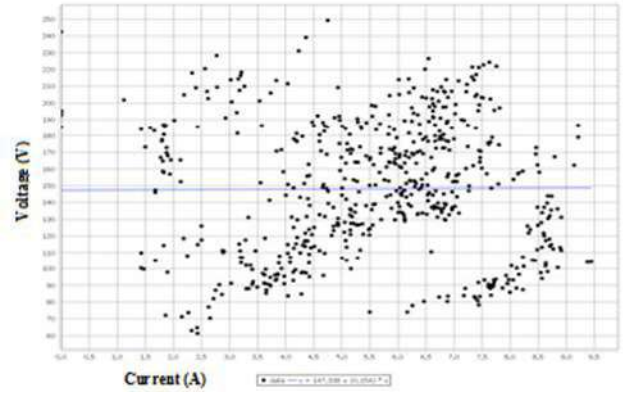

Fig.7: 5th harmonic of PHASE A.
Source: Authors, (2019).

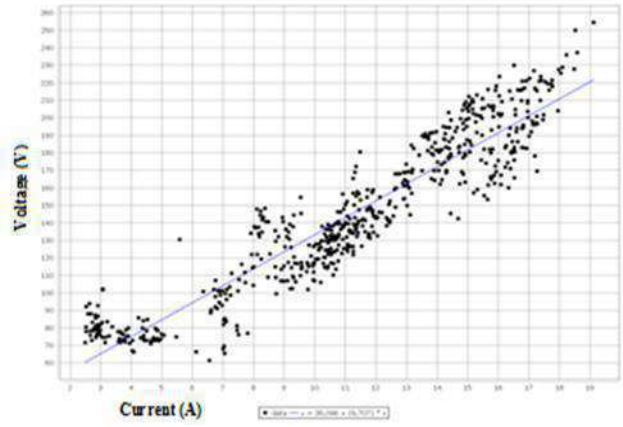

Fig.8: 5th harmonic of PHASE B.
Source: Authors, (2019).

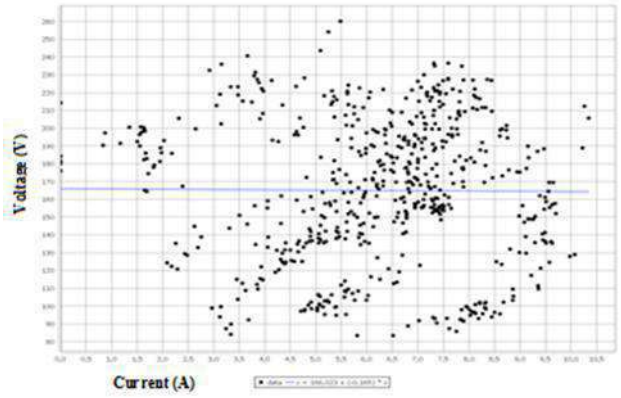

Fig.9: 5th harmonic o f PHASE C.
Source: Authors, (2019).

The regression models of Figures (7), (8) and (9) are represented by equations 14, 15 and 16 respectively.

$$V_{A,16}^{5h} = 147,338 + (0,154).I_{A,16}^{5h} \quad (14)$$

$$V_{B,16}^{5h} = 36,096 + (9,707).I_{B,16}^{5h} \quad (15)$$

$$V_{C,16}^{5h} = 166,023 + (-0,165).I_{C,16}^{5h} \quad (16)$$

4.1.3. ANALYSIS OF IMPACT BETWEEN THE HARMONIC CURRENT OF THE 7TH ORDER OF THE DIAL2-16 AND THE HARMONIC VOLTAGE OF THE SAME ORDER IN THE DIBR2-03 BAR

Based on the field measurement data, Table 4 presents the percentage impact of the 7th order harmonic current on the DIBR2-03 bar of phases A, B and C of the DIAL2-16 feeder in relation to the VBG using the linear regression technique. Analyzing the values of the R^2 metric, it is observed that the phases A have low correlation intensity, phase B presents very high correlation intensity whose R^2 is 0.896 and in phase C it presents high intensity of correlation. Table 4 indicates that phase A accounts for about 12% of the harmonic distortion impact on the DIBR2-03 busbar caused by the harmonic currents injected into the DIAL2-16 feeder in relation to the VBG, phase B is responsible for about 96% in relation to VBG and phase C is responsible for about 56% in relation to VBG.

Table 4. Load Porch, Coefficient of determination and Impact factor.

Load Porch – Morning and Afternoon			
STARTING TIME		FINAL TIME	
00:00:00		14:00:00	
METRICS	PHASE A	PHASE B	PHASE C
R^2	00,057	00,896	00,581
Impact Factor (%)			
VOLTAGE	PHASE A	PHASE B	PHASE C
VT	12,307	96,059	56,726
VBG	87,693	03,941	43,274

Source: Authors, (2019).

https://dx.doi.org/10.22161/ijaers.6745 *ISSN: 2349-6495(P) | 2456-1908(O)*

The simple linear regression models between the harmonic currents of the 7th order and the same order of harmonic voltage of the DIBR2-03 bar in phases A, B and C are shown in Figures 16, 17 and 18, respectively.

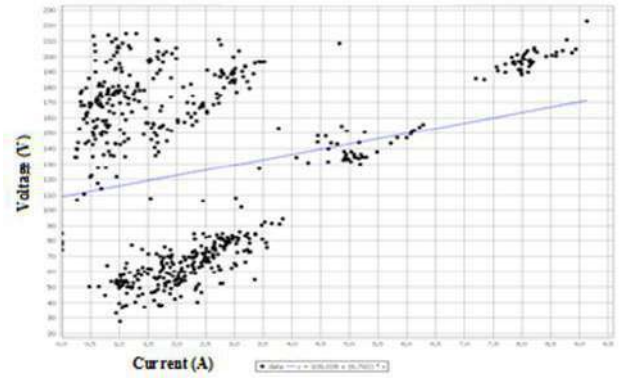

Fig.10: 7th harmonic of PHASE A.
Source: Authors, (2019).

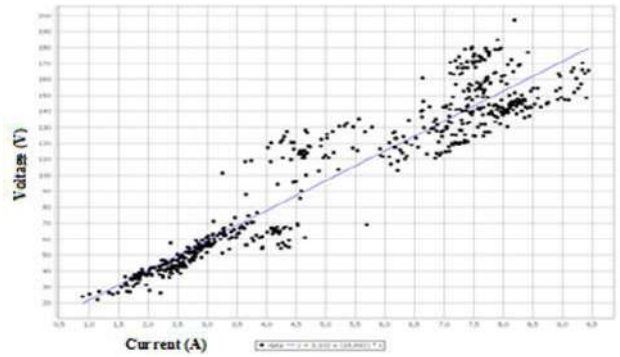

Fig.11: 7th harmonic of PHASE B.
Source: Authors, (2019).

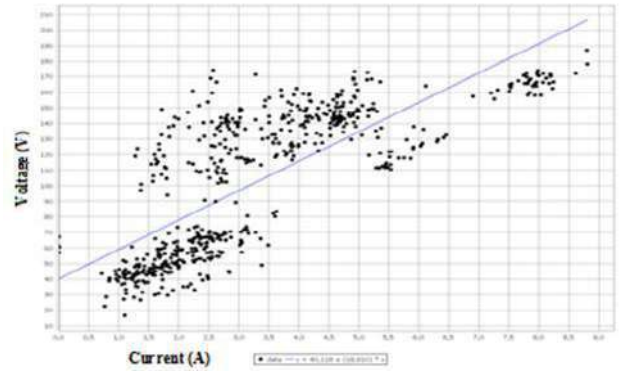

Fig.12: 7th harmonic of PHASE C.
Source: Authors, (2019).

The regression models of Figures 10, 11 and 12 are represented by equations 17, 18 and 19 respectively.

$$V_{A,16}^{7h} = 109{,}028 + (6{,}792).I_{A,16}^{7h} \quad (17)$$

$$V_{B,16}^{7h} = 3{,}102 + (18{,}692).I_{B,16}^{7h} \quad (18)$$

$$V_{C,16}^{7h} = 40{,}118 + (18{,}910).I_{C,16}^{7h} \quad (19)$$

V. RESULTS AND DISCUSSION

In this topic it is measured out the contributions of the feeder studied for the increase of harmonic distortion of voltage in the DIBR2-O3 bar. In the case study 1, the contribution of the DIAL2-16 power supply to the harmonic distortion of the DIBR2-03 bar was analyzed during the analysis, and it was verified that the phases A and B of the 3rd order harmonic current are strong contributors to the voltage harmonic distortion in the DIBR2-03 bar and phase C of the 3rd harmonic has low contribution, phase B of the 5th harmonic is a very strong contributor to the increase in distortion in the DIBR2-03 bar, phases A and C of the 5th harmonic has very low contribution close to zero, and that phases B and C of the 7th harmonic are strong contributors to voltage harmonic distortion in the DIBR2-03 bar and phase A of the 7th harmonic has very low contribution close to zero.

Table 5 presents the occurrence of the contribution in the increase of the voltage harmonic distortion in the busbar DIBR2-03 in the orders 3a, 5a and 7a caused by the phases A, B and C of the feeder DIAL2-16. In red the repetition of occurrences in the three harmonic orders.

As can be seen in table 8, the contribution of phase B of the feeder 16 occurs in the three harmonic orders analyzed with strong contributions, causing malfunction in the loads sensitive to the three harmonic sequences in phase B.

Table 5. Contribution in the increase of the voltage harmonic distortion in the busbar DIBR2-03.

Contribution to the harmonic distortion of the voltage in the busbar DIBR2-03	AL 16		
	PHASES		
3rd harmonic	A	B	C
MF			
F	X	X	
M			
B			X
MB			
NC			
5th harmonic	A	B	C
MF		X	
F			
M			
B			
MB	X		X
NC			
7th harmonic	A	B	C
MF			
F		X	X
M			

https://dx.doi.org/10.22161/ijaers.6745 *ISSN: 2349-6495(P) | 2456-1908(O)*

B			
MB	X		
NC			

Where:
MF – Very Strong
F – Strong
M – Moderate
B – Low
MB – Very Low
NC – No Contribution

VI. CONCLUSION

This paper presents a study on the investigation of harmonic sources in electric power distribution systems through the application of simple linear regression analysis in feeders of an electrical system under study.

Using the simple linear regression technique, the harmonic impacts of nonlinear loads of a feeder on a bus of the electric system were analyzed. The analyzes were carried out through field measurement campaigns for a period of 7 consecutive days. With the data collected from this measurement campaign it was possible to perform a correlation analysis between the harmonic currents injected at the feeder and the harmonic distortion of voltage in the bar of the electric system under study through the simple linear regression technique.

The models constructed were satisfactory for the analysis of the harmonic impacts in the chosen feeder and when the model did not indicate harmonic impacts generated by the harmonic currents injected in the feeder under study, but indicated harmonic impacts generated by the background.

With these analyzes it was possible to create a profile of the DIAL2 - 16 feeder to then mitigate the harmonic distortion of voltage in the DIBR2-03 bus under study, caused by the impacts of the harmonic currents of this feeder, and, in addition, a report of the analysis of the harmonic impacts performed, which serves as a diagnostic document of the feeder studied; thus obtaining a better management of the electric system, motivating the inclusion in energy pricing of the effects of the harmonic content of the nonlinear loads that pollute the power system.

In this way, this article presented and applied in the practice with case study actions for analysis of harmonic impacts in electric energy distribution systems through the construction of mathematical models using simple linear regression analysis, obtaining excellent results in the studies carried out, thus validating the technique applied in analysis of harmonic impacts in electric energy distribution systems.

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Brazilian Commercial banks and their Economic and Financial indices based on "Baseleia, traditional and Banking"

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Abstract**—** *The conjuncture of the Brazilian banking financial system directly influences the economy of the country, where financial institutions, specifically those of banking activities, act as financiers of consumption and investment, which seek to obtain the Best possible results in its activities, not only for the satisfaction of its shareholders, but also by the social impetus they provide. This paper intends to demonstrate a financial analysis of the five largest publicly traded Brazilian commercial banks, according to net income at the end of the 2015 year, aiming to develop a comparative study between the indices of Basel of the banks selected in contrast with the analysis of the traditional economic and financial indices and banking. The study is characterized as an exploratory research, with documentary bibliographical basis and is defined by the quantitative approach. It can be concluded that the Basel index in conjunction with the analysis of the traditional financial indices of profitability and of the financial indices of profitability and profit, assist in the verification of tendency to profitability. It is evident that the application of the indices studied that reveal the performance of financial institutions, aiming at the commitment to maintain and administer their resources in a responsible and competent manner, ressaving that the Basel Index and indexes Exclusive use of companies in the studied sector.*
Keywords**— risk. Banks. Traditional and banking financial indices.**

I. INTRODUCTION

Nowadays the economic situation of the country has been causing concerns to all individuals, because of the direction in which our economy has been taking in recent times, whether employers or employees, all are with the same goal of securing their company or their Job.

In view of this fact, organizations inserted in a market increasingly imposed by austerity, should be concerned with maintaining their profitability and profitability, striving to maintain their survival, not only to satisfy their owners Shareholders, but by the social impetus that companies provide.

Within the scope of business management, a company may prove to be more profitable than another, but the aggregate risk may also be higher and compromise its solvency.

People, both physically and legally, need resources to meet their investment and capital needs, belonging to banks to provide these resources, playing their role as financial intermediator.

Banks are institutions that should always evaluate and take risks, demonstrating a safe and balanced condition, acting responsibly before their employees, community, government and shareholders.

In view of the above, financial institutions, specifically those of banking activity, according to their levels of demand for loans, end up covering greater exposure to credit risks, with the possibility that unexpected factors and Adverse effects may result in an economic loss due to failure to comply with the obligation established in a contract.

In addition to the risk monitoring, it is important to observe the data of the financial statements of these institutions, transforming them into information through the analysis of financial indicators, such as measures that introduce a trend of performance, Pointing out potential strengths and weaknesses of the Organization, arousing the attention of those interested in the aspects that require greater appreciation.

II. THEORETICAL FOUNDATION

In 1930, the BIS (*Bank for International Settlements*) was created, the Bank of International Settlements, which fosters cooperation between the central banks in search of the monetary and financial stability of countries (bcb, 2016).

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In 1988, BIS created the Basel Agreement, with the aim of creating minimum capital requirements for financial institutions as a way to cope with credit risk (BCB, 2016).

Basel I ended up having a different fate than the one foreseen by the Committee. Instead of being adopted only by more advanced countries and having its validity limited to international banking, the agreement has become the main pillar of domestic prudential regulation in more than 120 countries. In other words, the requirement of capital proportional to risk-weighted assets became the centerpiece of prudential regulation in a large number of countries, applied indistinctly to the entire banking system (ANBIMA, 2010).

In 2004, there was a revision of the Basel agreement, known as Basel II, aiming to seek a more accurate measure of the risks incurred by internationally active banks (BCB, 2016).

This agreement was directed to large banks, based on three complementary pillars:

Pillar 1 – Capital requirements for credit, market and operational risk;

Pillar 2 – Review by supervising the process of assessing the capital adequacy of banks, and;

Pillar 3 – market discipline.

Faced with the global financial crisis initiated in 2007, the insufficiency of Basel I and II was demonstrated as an impediment to the excessive leverage of banks, which allied to the low quality of capital and the low liquidity margin presented the fragility scenario of International banking system.

Therefore, as part of a continuous improvement of financial institutions, in 2010 the Basel III was created, aiming to improve the capacity of financial institutions to absorb shocks from the financial system itself or the Other sectors of the economy, reducing the risk of financial crisis transfers to the real economy (BCB, 2016).

Table 4: Basel accord.

BASEL ACCORD		
1988	**2004**	**2010**
Basel I	**Basel II**	**Basel III**
Objective: to create minimum capital requirements for financial institutions as a way to cope with credit risk.	**Objective:** to seek a more accurate measure of the risks incurred by internationally active banks.	**Objective:** to aim at improving the capacity of financial institutions to absorb shocks from the financial system itself or from other sectors of the economy, reducing the risk of transfers of financial crises to the real economy .

Source: Elaborated by the author.

BACEN adherence to the standards recommended by the Basel Committee was evaluated at the end of 2013 through the "*Regulatory Consistency Assessment Programme*" (RCAP). The rules in force in Brazil were considered adherent in terms of BIS, that is, the capital standards established in Brazil meet the minimum requirements internationally in force.

In summary, the Basel index is presented by the following calculation:

Basiléia index = PR/RWA

Being:

PR – Reference equity;

RWA – Risk-weighted assets.

The PR is calculated as follows:

PR = level I + level II

Being:

Level I – composed of the Principal Capital (deduced from Prudential adjustments, where the tax credits are considered shares in Treasury and other instruments of own issuance, accounts receivable and equity valuation) and supplementary Capital (participation of non-controllers in instruments issued by subsidiaries and eligible for the complementary capital of the conglomerate);

Level II – primarily includes subordinated debts (excess of provisions in relation to expected loss), subject to prudential limitations.

Table 6: Calculation of PR.

PR	
LEVEL I	**LEVEL II**
Principal Capital (deduced from Prudential adjustments) and supplementary Capital	Subordinated debts, subject to prudential limitations.

Source: elaborated by the author.

https://dx.doi.org/10.22161/ijaers.6746 *ISSN: 2349-6495(P) | 2456-1908(O)*

The RWA is calculated considering at least the sum of the following plots:

King = Kingcpad+ KingCam transfert+ Kingjur+ Kingcom+ kingACS+ Kingopad

Being:

RWACpad – portion concerning exposures to credit risk;

RWACAM – Share of gold, foreign currency and assets subject to exchange variation;

RWAJur – Parcel of exposures subject to the variation of interest rates, interest coupons and price coupons and classified in the trading portfolio;

RWACOM – Parcel for exposures subject to commodity price variation (commodities);

RWAACS – Parcel for exposures subject to stock price variation and classified in trading portfolio;

RWAOpad – a portion concerning the capital calculation required for operational risk.

In the regulation there is no minimum percentage requirement regarding credit risk, market risk and operational risk within the RWA.

In summary, the RWA can be demonstrated in:

RWA = Credit Risk + Market risk + Operational risk

Table 7: Calculation of the RWA.

RWA		
CREDIT RISK	**MARKET RISK**	**OPERATIONAL RISK**
RWACPAD	RWACAM, RWAJUR, RWACOM, RWAACS	RWAupwards

Source: elaborated by the author.

The following table shows the basis of calculation of the Basel index:

Table 1: Table demonstrating the basis of calculation of the Basel index.

Calculation Base Basel III Index
Reference Equity level I Equity Prudential adjustments **Reference Equity level II** Subordinated debt
Reference Equity (a)
Credit risk Market risk Operational risk
Risk-weighted Asset-RWA (b)
Basel Index (A/b)%

Source: elaborated by the author.

Based on the objective of the Basel Agreement, which is to create minimum capital requirements for financial institutions as a way of addressing credit risk, the next item is the referential to risk.

2.1 TRADITIONAL AND BANKING FINANCIAL INDICATORS

Silva (1998, p. 214) says that "financial indicators are relationships between accounts or account groups of financial statements, which aim to provide us with information that is not easy to be viewed directly in the statements Financial statements ".

"The analysis of the financial statements is devoted to calculating indexes, in order to evaluate the past, present and projected performance of a company" (BLATT, 2001, p. 61).

The banking and traditional financial indicators assist in the provision of information that is not directly visualized in financial statements and also, through these indices can be calculated the performance of the company in relation to the past, Gift and designed. The following

https://dx.doi.org/10.22161/ijaers.6746 ISSN: 2349-6495(P) | 2456-1908(O)

are detailed in the traditional and banking financial indices.

Oliveira et al (2010, p. 4) states that "the analysis of the financial statements by indices consists of the confrontation between the various groups or accounts and the result in a way that establishes a logical relationship and enables the measurement of the economic situation and Financial contribution of the company ".

The traditional financial indicators enable a logical relationship of the company and assist in the measurement of the economic and financial situation of the company.

The analysis carried out by the banks through their accounting statements may be limited in relation to the quality of information, but it aims to verify in the balance the position of assets, liabilities and shareholders ' equity.

The evaluation indicators can assist in performance trend analysis, indicating strengths and weaknesses, thus facilitating the analyst in relation to more accurate assessments or requiring greater evaluation. Thus, the bank financial indicators with their identifications and formulas are followed.

III. METHODOLOGY

The methodology is to be applied in order to delineate the way in which the research will be developed so that the proposed results are obtained.

COmo Method The applied research, being performed the practical application of the study verifying whether there is a direct relationship between the analysis of Basel indices and the traditional and banking financial indices that indicate a tendency of profitability in Financial institutions studied.

The main objective is to develop a comparative study between the Basíleia indexes of the selected banks in contrast with the analysis of the traditional and bank indices, in order to identify whether there is a direct relationship between these indices that Profitability trend in the financial institutions studied.

This work will be developed through bibliographic research, which according to Cervo and Bervian (2002 apud GUTH and PINTO, 2007) put that "the bibliographic research seeks to explain a problem based on theoretical references published in documents".

It will be based on books, articles, and other publications related to the proposed theme, serving as a basis for support for the development of the proposed case study.

For Raupp and Beuren (2003 apud GUTH and PINTO, 2007) "The case study can be characterized by a concentrated study of a single case".

The case study will cover the survey of data from the financial statements of Banks Itaú, Bradesco, Banco do Brasil, Santander and Banrisul, which stand out for their representativeness in the commercial banking segment.

The use of the Basel index and the traditional and banking financial indicators will be sought, demonstrating the behavior of financial economic information, through the application of its statistical techniques.

Therefore, this work presents itself as an exploratory research, of documental bibliographical character and of quantitative approach, and according to the authors exposed this methodology is the most appropriate for the development of the study.

Following this, we present the description and analysis of the data.

IV. DESCRIPTION AND ANALYSIS OF THE DATA

The description and analysis of the data will be given through a case study, where the financial statements of the five largest publicly traded Brazilian commercial banks that earned the highest net profits in the year 2015 were used in the sample, according to With data provided by banks to BM & FBovespa, being the object of study the comparative analysis of the Basel index in contrast with the traditional and banking financial indices of these institutions in the mentioned period, verifying whether there is a relationship Of these indexes that indicate profitability trend.

4.1 Largest Brazilian commercial banks

According to the Econoática website (2016), the profit of the 294 Brazilian publicly traded companies in the year 2015 fell by 19.5%, the banking sector had a growth of 28.3% in the same period.

Based on this information, we sought a survey of the financial data of the institutions of which stand out for their representativeness in the commercial banking segment, where both the profits of the five largest banks totaled more than 70.9 billion At the end of 2015, according to the report of the Central Bank of Brazil.

Table 2: Five largest publicly traded Brazilian banks according to net income (in thousands of reais):

https://dx.doi.org/10.22161/ijaers.6746 *ISSN: 2349-6495(P) | 2456-1908(O)*

Ranking	Bank	Net income	Participation
1	ITAU	26.156.000,00	**36,89%**
2	Bradesco	18.237.905,00	**25,72%**
3	BANK OF BRAZIL	15.798.039,00	**22,28%**
4	santander	9.833.826,00	**13,87%**
5	Banrisul	880.218,00	**1,24%**
TOTAL NET INCOME		**70.905.988,00**	**100,00%**

Source: elaborated by the author. Adapted from the financial statements found in BM & FBovespa.

It is observed that Banco Itaú is currently the bank with the best result, being its participation of 36.89% of the sum of the five largest net bank profits in 2015.

The analysis of the financial statements of the selected banks comprises the year ended in 2015. In the first moment, the analysis of the Basel indices will be performed, followed by the analysis of the traditional indices and after the analysis of the bank indices presented by the studied banks.

The following are the balance sheet and the result statements of the selected banks:

Table 3: Balance sheets and income statements of the selected banks.

Active					
Values in thousands of Reais	**ITAU**	**Bradesco**	**BANK OF BRAZIL**	**santander**	**Banrisul**
TOTAL ASSETS	**1.276.415.000,00**	**1.026.703.522,00**	**1.388.864.529,00**	**605.394.528,00**	**68.103.613,00**
CURRENT ASSETS	**750.877.000,00**	**729.899.537,00**	**1.122.603.416,00**	**516.294.712,00**	**60.591.697,00**
Available	18.544.000,00	72.091.764,00	18.046.717,00	89.143.353,00	9.725.474,00
Interbank Liquidity Applications	284.929.000,00	277.318.899,00	364.341.734,00	120.882.571,00	20.593.698,00
Credit operations	447.404.000,00	380.488.874,00	740.214.965,00	306.268.788,00	30.272.525,00
NON-CURRENT ASSETS	**525.538.000,00**	**296.803.985,00**	**266.261.113,00**	**89.099.816,00**	**7.511.916,00**
Long-term realizable	516.997.000,00	291.299.550,00	258.849.166,00	86.916.288,00	7.149.398,00
Asset	8.541.000,00	5.504.435,00	7.411.947,00	2.183.528,00	362.518,00
Passive					
Values in thousands of Reais	**ITAU**	**Bradesco**	**BANK OF BRAZIL**	**santander**	**Banrisul**
TOTAL LIABILITIES	**1.276.415.000,00**	**1.026.703.522,00**	**1.388.864.529,00**	**605.394.528,00**	**66.103.613,00**
CURRENT LIABILITIES	**353.702.000,00**	**293.903.391,00**	**422.936.785,00**	**312.494.370,00**	**38.698.329,00**
Deposits	292.610.000,00	293.095.696,00	366.762.440,00	296.769.851,00	35.524.404,00
Cash deposits	61.092.000,00	807.695,00	56.174.345,00	15.724.519,00	3.173.925,00
NON-CURRENT LIABILITIES	**922.713.000,00**	**732.800.131,00**	**965.927.744,00**	**292.900.158,00**	**27.405.284,00**
Long-term liabilities	808.654.000,0	641.885.369,0	879.697.750,00	209.368.404,	20.929.597,

https://dx.doi.org/10.22161/ijaers.6746 *ISSN: 2349-6495(P) | 2456-1908(O)*

	0	0		00	00
Equity	114.059.000,00	90.914.762,00	86.229.994,00	83.531.754,00	6.475.687,00
INCOME STATEMENT					
Values in thousands of Reais	**ITAU**	**Bradesco**	**BANK OF BRAZIL**	**santander**	**Banrisul**
Financial intermediation revenues	147.789.000,00	127.048.252,00	182.368.871,00	69.870.200,00	9.666.650,00
Financial intermediation expenses	-75.064.000,00	-71.412.210,00	-136.620.920,00	-38.533.089,00	-6.553.228,00
Net revenue from financial intermediation	**72.725.000,00**	**55.636.042,00**	**45.747.951,00**	**31.337.111,00**	**3.113.422,00**
Other Operating income/expenses	-54.460.000,00	-46.032.459,00	-35.610.447,00	-34.552.829,00	-2.069.044,00
Result before IR and CS	**18.265.000,00**	**9.603.583,00**	**10.137.504,00**	**-3.215.718,00**	**1.044.378,00**
Income tax and social contribution	7.891.000,00	8.634.322,00	5.660.535,00	13.049.544,00	-164.160,00
Net income	**26.156.000,00**	**18.237.905,00**	**15.798.039,00**	**9.833.826,00**	**880.218,00**

Source: elaborated by the author.

Table 3 showed the balance sheet and the results of the chosen banks, where only the accounts used to perform the analysis were contemed.

Based on these demonstrations, the Basel index presented by each institution appears below.

As mentioned in the theoretical framework, the Basel index is based on the objective of creating minimum capital requirements for financial institutions at risk.

Below is the calculation of the Basel index of each bank selected in the study:

4.2 Basel Index of the studied banks

Table 4: Calculation of the Basel index of the studied banks.

Values in thousands of reais **Calculation Base Basel III Index On 31/12/2015**	**ITAU**	**Bradesco**	**BANK OF BRAZIL**	**santander**	**Banrisul**
Reference Equity level I	**101.001.000,00**	**77.506.951,00**	**95.713.963,00**	**5.278.504,90**	**6.145.573,00**
Equity	100.955.000,00	88.906.644,00	84.976.920,00	4.784.017,90	6.082.833,00
Prudential adjustments	46.000,00	-11.399.693,00	10.737.043,00	494.487,00	62.740,00
Reference Equity level II	**27.464.000,00**	**25.318.399,00**	**39.837.233,00**	**518.206,50**	**1.243.602,00**
Subordinated debt	27.464.000,00	25.318.399,00	39.837.233,00	518.206,50	1.243.602,00
Reference Equity (a)	**128.465.000,00**	**102.825.350,00**	**135.551.196,00**	**5.796.711,40**	**7.389.175,00**
Credit risk	679.593.000,00	556.440.558,00	785.773.084,00	36.355.897,00	34.689.482,00
Market risk	14.252.000,00	18.670.132,00	18.346.766,00	2.300.969,00	1.011.989,00
Operational risk	28.623.000,00	37.106.557,00	36.389.090,00	1.874.328,00	5.835.041,00
Risk-weighted Asset-RWA (b)	**722.468.000,00**	**612.217.247,00**	**840.508.940,00**	**40.531.194,00**	**41.536.512,00**

https://dx.doi.org/10.22161/ijaers.6746 *ISSN: 2349-6495(P) | 2456-1908(O)*

Basel Index (A/b)	**17,78%**	**16,80%**	**16,13%**	**14,30%**	**17,79%**

Source: elaborated by the author based on the financial statements of the selected banks.

The financial indices presented for the calculation of the Basel index are determined in the consolidated form, applied to the institutions belonging to the Prudential conglomerate, which covers not only the financial institutions but also the administrators of Consortium, payment institutions, companies that carry out operations or directly or indirectly assume credit risk and investment funds in which the group of undertakings has substantially retained risks and benefits, as Normalized by the BCB.

In an analysis of the Basel Index, Banco Banrisul presented the highest index, being 17.79%, followed by Banco Itaú, which presented an index of 17.78%, being only 0.01 percentage point more than the antecedent. This demonstrates that these institutions achieved the highest coverage of equity on the risk compared with the other banks studied.

Next, the traditional indexes applied to the studied banks are presented.

4.3 Traditional indices applied to the studied banks

Table 5 shows the traditional indexes applied to the studied banks, enabling the economic and financial measurement of these institutions.

Table 5: Traditional indices applied to the studied banks

Bank	**LIQUIDITY INDICES**			**INDICES OF CAPITAL STRUCTURE**				**PROFITABILITY INDICES**			
	ILC	**Ilg**	**Or**	**PCT**	**this**	**IPL**	**IRNC**	**Ga**	**ML**	**Three**	**TRPL**
ITAU	2,12	1,09	0,05	1019,08%	30,43%	7,49%	0,93%	5,70 %	35,97 %	2,05 %	29,76 %
Bradesco	2,48	1,09	0,25	1029,30%	31,41%	6,05%	0,75%	5,42 %	32,78 %	1,78 %	25,09 %
BANK OF BRAZIL	2,65	1,06	0,04	1510,65%	32,47%	8,60%	0,77%	3,29 %	34,53 %	1,14 %	22,43 %
santander	1,65	1,16	0,29	624,75%	59,88%	2,61%	0,75%	5,18 %	31,38 %	1,62 %	13,34 %
Banrisul	1,57	1,14	0,25	920,80%	64,90%	5,60%	1,32%	4,57 %	28,27 %	1,29 %	15,73 %

Source: elaborated by the author based on the financial statements of the selected banks.

The results of the analyses by the traditional indices will be presented by means of graphs for assistance in interpreting these indices. Banco do Brasil presented the highest rate of current liquidity, demonstrating a greater capacity to pay its commitments in the short term. Banco Santander presented the highest overall liquidity index, demonstrating greater capacity to pay for its short-and long-term obligations, related to the others. Besides also having the highest rate of immediate liquidity, demonstrating greater availability to immediately pay off their short-term debts.

In an analysis of the index of immobilization of shareholders ' equity, Banco do Brasil demonstrated that it has the highest index, which entails less availability of own resources, resulting in the increase in dependence on third-party capitals to finance the Its current assets, which justifies its higher rate of participation of third-party capital.

Banco Banrisul, presented the highest debt composition index, with 64.90% of its indebtedness in the short term, in addition to the presentation of the higher rate of imoblization of non-current resources, which indicates the percentage of its resources not Currents applied in the permanent asset, being unfavorable in relation to the other banks, considering that, this index the lower the better.

In an analysis of the indices of profitability, Banco Itaú is evidenced with the best indexes, presenting a better return in relation to the invested capital. Portrayed through the largest generation of sales from its asset base; Higher net margin presented in 35.97%, that is, higher net result produced by net sales; Higher rate of return on investments, being the only one among the institutions analyzed that presented a profitability index in relation to the investment of more than 2.00% and; Higher rate of return on shareholders ' equity, presenting the highest

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remuneration of the investment made by shareholder partners.

The results of the analysis by the bank indices will be presented below.

4.4 Bank indices applied to the banks studied

Table 6 shows the banking indices of solvency and liquidity applied to the studied banks, enabling the measurement of the performance trend of these institutions.

Table 6: Bank indices applied to the banks studied

Bank	SOLVENCY AND LIQUIDITY INDICES				
	Home	HIM	IED	CGP	On
ITAU	0,30	4,97	152,90%	- 411.479.000,00	35,05%
Bradesco	89,26	432,60	129,82%	- 205.889.223,00	37,06%
BANK OF BRAZIL	0,32	6,81	201,82%	- 180.031.119,00	53,30%
santander	5,67	13,36	103,20%	- 5.568.062,00	50,59%
Banrisul	3,06	9,55	85,22%	- 1.036.229,00	44,45%

Source: elaborated by the author.

The results of the analysis by the bank indices will be presented by means of graphs for assistance in interpreting these indices.

Banco Bradesco presented a relevant voluntary fit index compared to the other banks, being the institution that represented the highest immediate financial capacity to cover the withdrawals against the deposits to be seen at the closing date of the year Social, besides also presenting a significant index of immediate liquidity, matching with a greater availability of negotiation of its applications at any time.

The Bank of Brazil presented the highest rate of loans/deposits, and for each R $1.00 of resources captured by the institution in the form of deposits was Lent R $2.02; Noting that the cost of funding is usually lower than the borrowing cost, which directs better results. Besides this index, the Bank of Brazil also presented the highest rate of participation of loans, which reveals the percentage of 53.30% of its total asset applied in credit operations.

In relation to its own working capital index, Banco Itaú presented a significant negative index, which expresses high risk to the institution, that is, it relates its higher risk to a higher return compared to other banks.

The Bank of Brazil presented the lowest rate of financial independence that indicates the proportion between the shareholders ' equity and the total investments made in the asset, which relates to the higher leverage index indicating that the total asset of the bank is 16.11 times Greater than the capital invested, also related to the higher rate of immobilization of equity that indicates how much the bank applied in its permanent asset in relation to its shareholders ' equity.

The capital/Depositor ratio index was highlighted by Banco Itaú, which obtained the highest index, revealing a greater application of its own capital as a means of funding, being applied R $0.39 of own resources for each R $1.00 of deposits in capture. The results of the profitability and profitability indices are presented as shown in table 8:

Table 8: Profitability and profit rates.

Bank	INDICES OF PROFITABILITY AND PROFITABILITY								
	RPL	Ride	ML	MF	Cmc	RMOC	The	JP	IE
ITAU	22,93%	2,05%	17,70%	11,58%	25,65%	11,58%	11,58%	5,88%	36,85%
Bradesco	20,06%	1,78%	14,36%	12,37%	24,36%	12,37%	12,37%	6,96%	36,23%
BANK OF BRAZIL	18,32%	1,14%	8,66%	13,13%	37,25%	13,13%	13,13%	9,84%	19,53%
santander	11,77%	1,62%	14,07%	11,54%	12,98%	11,54%	11,54%	6,36%	49,45%
Banrisul	13,59%	1,29%	9,11%	14,19%	18,45%	14,19%	14,19%	9,91%	21,40%

Source: elaborated by the author.

As well as in the analysis of the traditional indices (TRPL, TRI and ML), Banco Itaú also presented the largest banking indices related to return on shareholders ' equity, return on total investment, and net

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margin, evidencing greater Profitability over the invested capital.

Banco Banrisul had the largest financial margin, indicating that for each R $1.00 of assets there was a 14.19% return on its financial intermediation, which relates to the same average return rate of credit operations and the same index of Profitability of assets.

In relation to the efficiency index, Banco Santander stands out for the highest index in relation to the other banks, indicating a worse productivity, that is, its operating expenses represent 49.45% of its financial intermediation revenue, far beyond the Other institutions analysed.

4.5 Comparative comparison of the indices of the studied banks

The analysis of the Basel, Tradional and bank indices, interpreted the information obtained by these indices, verifying the performance of the five largest publicly traded Brazilian commercial banks, with regard to the trend of Profitability, since it seeks to meet not only the satisfaction of its shareholders, but also of society as a whole, because they are companies of an important economic sector in the country that work.

Table 14 shows the comparison of the indexes of the studied banks:

Table 14: Comparative of the indices of the studied banks.

Bank	INDEX TYPOLOGY	RELEVANCE INDEX	WHAT PRESENTS
Itaú	Basel	Basel	Increased equity coverage over risk.
	TRADITIONAL INDICES	Asset turnover	Greater effectiveness in generating sales from your asset base.
		NET margin	Highest net result produced by net sales.
		Rate of return on investments	Greater profitability of assets in the period.
		Rate of return on PL	Greater remuneration of the investment made by the shareholder.
	BANK INDICES	Own working Capital	Greater own resource by financing active operations (high risk related to higher returns).
		Capital/Depositors ratio	Greater application of its own capital as a means of capture.
		Return on PL	Greater remuneration of the investment made by the shareholder.
		Return on Total Investment	Greater result of the business opportunities driven by the bank.
Bradesco	BANK INDICES	Volunteer Fitting	Increased immediate financial capacity to cover withdrawals against cash deposits.
		Immediate liquidity	Increased availability of trading for your applications at any time.
BCO DO BRASIL	TRADITIONAL INDICES	Current liquidity	Greater capacity to pay commitments in the short term.
		Immobilization of PL	Higher percentage of PL in the permanent asset.
		Participation of third-party capitals	Greater dependence on third-party capital and the need for external resources.
	BANK INDICES	Loans/Deposits	Higher uptake with lower cost for providing loans yields better results.
		Participation of loans	Highest percentage of assets applied in credit operations.
		Financial independence	Lower proportion of the PL on the total investments made in the asset.
		Leverage	Total bank assets are 16.11 times greater than the capital invested.
		Self-equity immobilization	How much was applied in its permanent asset in relation to PL.

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santander	Basel	Basel	Lower equity coverage on the risk.
	BANK INDICES	Efficiency	Higher index indicates worse productivity.
Banrisul	Basel	Basel	Increased equity coverage over risk.
	BANK INDICES	Financial margin	Greater profit in financial intermediation.
		Average return on credit operations	Increased financial revenue from credit operations applied in credit operations.
		Profitability of assets	Greater revenue in financial intermediation over total bank assets.

Source: elaborated by the author.

Banco Itaú, in the analysis carried out in relation to the Basel index, obtained the second highest result, being 17.78%, only 0.01 percentage point behind Banco Banrisul that showed the highest Basel index, this demonstrates that these institutions reach Greater coverage of equity on the risk. In the traditional indices, referring to the profitability index, Banco Itaú was evidenced with the best indexes, presenting better returns in relation to the invested capital (higher generation of sales from its asset base; higher net margin; higher Rate of return on investments and higher rate of return on equity). In the bank indices, in relation to the Working capital index itself, it presented a significant negative index, which expresses high risk for the institution, that is, it relates its higher risk to a higher return. In the analysis of the index capital/depositors ratio was evidenced, because it obtained the highest index, revealing a greater application of its own capital as a form of uptake. Finally, it also obtained the highest bank indices related to the return on shareholders ' equity, return on total investment, and net margin, evidencing greater profitability over the invested capital.

At Banco Bradesco, a relevant index of voluntary fit was presented, being it the solvency and liquidity index, which represented a greater immediate financial capacity to cover the withdrawals against the deposits at the time of closing the year Social, in addition to presenting a significant index of immediate liquidity, matching with a greater availability of trading of its applications at any time.

The Bank of Brazil's analysis showed the highest rate of current liquidity, demonstrating that it has a greater capacity to pay its commitments in the short term. In relation to the index of immobilization of shareholders ' equity, it has shown that it has the highest index, which entails lower availability of own resources, resulting in increased dependence on third-party capitals to finance its assets Which justifies its higher rate of participation of third-party capital. In bank indices, Banco do Brasil presented the highest rate of loans/deposits, and for each R $1.00 of resources captured by the institution in the form of deposits was lent R $2.02; It is observed that the cost of funding is usually lower than the borrowing cost, which directs better results. In addition to these indices, Banco do Brasil also presented the highest lending participation index, which reveals the percentage of 53.30% of its total asset applied in credit operations. It also presented a lower rate of financial independence that indicates the proportion between equity and total investments made in the asset, which relates to the higher leverage index indicating that the total asset of the bank is 16.11 times greater than the Capital invested, also related to the higher index of equity immobilization, which indicates how much the bank has applied in its permanent asset in relation to its shareholders ' equity.

Banco Santander, in analysis of the Basel index, obtained the lowest index of the studied banks, presenting 14.30%, thus demonstrating that it reached a lower coverage of the shareholders ' equity on the risks compared to the other banks analyzed, However, taking into account the limits required by the regulation. In relation to the efficiency index, it obtained the highest index, indicating a worse productivity, that is, its operating expenses represent 49.45% of its revenue from financial intermediation, far beyond the other institutions compared.

Finally, Banco Banrisul presented the highest index in relation to the calculation of the Basel index, making up the index of 17.79%, demonstrating that it achieves greater coverage of equity on the risk. It also presented a greater financial margin, indicating that for each R $1.00 of asset, there was a return of 14.19% in its financial intermediation, which relates to the same average return rate of credit operations and with the same profitability index of Active.

V. FINAL CONSIDERATIONS

The objective of this work was to develop a comparative study between the Basel indices of the five largest publicly traded Brazilian commercial banks, such

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as Itaú, Bradesco, Banco do Brasil, Santander and Banrisul, according to net income End of 2015, in contrast with the analysis of the traditional and banking indices.

In order to achieve the proposed objective, initially, a bibliographical survey was carried out on the topic, with terraces on the issues related to work, after analyzing the Basel indices and the financial indices And banking, developing a comparative study between these indexes applied to the selected banks.

The research problem was based on the study of economic and financial indices in commercial banks, the theory in practice was applied, estimating the probability that the application of the traditional and banking financial indices could demonstrate the Existence of a direct relationship between them, which indicates a tendency of profitability.

The results indicate through the application of the traditional indices of liquidity, which was highlighted for Banco Santander, which stood out by two indexes (ILG and ILI) and, by the application of bank indices of solvency and liquidity, there was emphasis on the bank Bradesco and Banco do Brasil, which stood out also by two indices (EV, LI and IED, PE respectively), however, these indexes did not indicate evidence of profitability trend, as proposed.

By applying the traditional indices of capital structure and the application of bank indices of capital and risk, the Bank of Brazil was evidenced by five indices (PCT, IPL among the traditional and ICP, L and IF among the bank), demonstrating greater Dependence on third-party capitals, that is, low financial independence, however, these indices also did not indicate evidence of profitability trend, as proposed.

During the development of the proposed study, it was perceived that Banco Itaú reached the highest net income among the institutions studied, being R $26,156,000,000.00. In an analysis of the Basel index, which measured the percentage of assets required to cover the risks, Banco Itaú, despite having a 0, 1% index lower than Banco Banrisul that obtained the highest percentage, stood out in this regard, presenting 17.78% index. When the traditional indices of profitability and the bank indices of profitability and profits were applied, Banco Itaú was unanimous in the best traditional indices (GA in 5.70%, ML in 35.97%, TRI in 2.05% and TRPL in 29.76%) And it was highlighted in three bank indices (RPL in 22.93%, ML in 17.70% and RIT in 2.05%), with higher return on shareholders ' equity, higher return on total investment, and higher net margin. The tendency of higher profitability obtained is evidenced through these indices.

Although the traditional indices of liquidity and capital structure and; Of the banking indices of solvency and liquidity and capital and risk, produce an important role in providing information on the performance of a company, are expendable in terms of investigating the trend of profitability, because the response of the relationship of Basel indices and the traditional and banking indices that aimed at profitability trend proved through the application of the indices of profitability and profit.

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Development of a low-cost System for Water Quality Monitoring: Bibliographic Review

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Abstract *— This work presents a practical application of a water monitoring system using the internet concept of things - Iot. The integrated water quality monitoring system for decision support, this proposal is a theoretical study for use in the Federal Institute of Tocantins by professors and researchers in the area of Agronomic Engineering. This new development paradigm allows us to integrate low-cost sensors into embedded systems, thus creating a clustering of interconnected physical objects, embedded in electronics, software, sensors, and network connectivity, coupled with its low cost, this implementation demonstrates the feasibility of monitoring using low-cost systems. In summary, the initial application will be carried out in hydroponics and fish-culture systems, thus, we can gauge the integrated monitoring and decision support system, demonstrating the viability of the use to support the producer, researcher or even the environmentalist in the collection and analysis of efficient decision-making. The second step will be the development of the prototype.*

Keywords *— **Internet of Things, Water Monitoring, Automation, Multiparameter.***

I. INTRODUCTION

There are several methods and tools used to test water quality. The conventional method commonly used to carry out the tests is to manually collect samples by sending them to a laboratory, or performing tests in situ, with devices, manually or automatically annotating the collected data. As a result, we implemented a system that measures the quality of water in real time through electronic sensors, and this data is stored and sent to an online system for decision making.

Several physical-chemical variables are necessary to monitor water quality for agricultural production purposes, as shown by the work of [1, p. 58]. The development of new technologies for monitoring and control of the aquatic environment, has become an important tool to aid decision making. Our work aims to develop a mobile, multi-parameter system that provides real-time information of the environment for decision making.

Embedded systems are taking more and more space in academic productions. Due to their cost-effectiveness and the high variety of sensors available in the market, these systems are in increasing demand by researchers and technology enthusiasts. As a result, this ecosystem of embedded hardware and software received the Internet nickname of things, or IoT (Internet of Things), as it is commonly known.

The need for automatic monitoring, through electronic sensors, has become a growing reality. The benefits of using interconnected systems, IoT are numerous, from the cost to the automation of a process. In addition, the wireless sensor networks (WSNs), which provide a wide range of applications for control and monitoring, can be cited as an example of the work of [2], which developed a network of sensors for monitoring the quality of water to the logo of the River Avon in England and that is making this data available online for eventual decision making.

II. JUSTIFICATION

Several devices are developed for monitoring water quality. Taking into account the low cost of embedded systems, these can be developed to facilitate the collection and analysis of data, automatically, through electronic sensors. In the construction of a prototype for this purpose it is necessary to take into account its cost, since it must be, more in account than the one existing in the market, or at least with more functionalities, adding value to the product.

When it comes to this type of system, the bridge between an idea and a viable end product lies in the design of a functional prototype. In order to carry out this project there are several steps to be followed, from the choice of the components, taking into account their need and the niche to be met, structuring and testing with the purpose of identifying problems and correcting them.

For the reason exposed, our research is justified by a guiding question, that throughout the trajectory of the research, we will analyze. It is feasible to develop a system, using embedded hardware, with initial application in a system of monitoring the water quality and that has a

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lower cost than those found in the market, to meet the demand of research institutes or producers in the area of hydroponics and fish culture.

III. ANALYSIS OF PREVIOUS WORK

For reasons and development of the previous studies, researches were done referring to works already completed and that resemble the theme chosen. However due to the constant technological innovations, we carried out a systematic search in the period corresponding to 2013 to June 2019. The search terms used had the objective of finding works related to the topic with greater relevance.

The databases where the research was carried out were: ScienceDirect - Elsevier, where 1706 results were returned, of which 5 (five) were related to the proposed theme, according to the pre-established criteria, of which two (2) with the theme. In the capes - Cafe journal, we find fourteen articles, where only one is directly related to the topic. In the IEEE Explorer database, we found 703 articles, of these, 8 (eight) articles were selected, having relation with the proposed work, among which 2 (two) articles that resemble the proposed work. All the articles that brought the internet context of things, with a view to the monitoring of water quality were included in our research, below a syntax of how were the criteria for inclusion of the articles.

The methodological procedures used in the search of articles published in periodicals were: the choice of journals, the language and the period. Thus, the chosen language was English, the search was between: 2013 to June / 2019, it is emphasized that the research was carried out in the months of May and June of 2019. It has a different database, repeated studies, the were not included. For the criterion of exclusion of the bibliographic study, only works that deal, integral or relative, of the theme, which is the use of water quality monitoring systems, using the internet concept of things, were considered.

Table 1: works found Iot and water

AUTHOR	TITLE
Dan e Jan, 2017	Real-time water quality monitoring systemusing Internet of Things
Almeida, 2018	Projeto e desenvolvimento de laboratório móvel para monitoramento ambiental dos níveis de temperatura e humidade baseado em internet das coisas (iot)
Chen, Y; Han, D, 2018	Water quality monitoring in smart city: A pilot project
Salunke, P; Kate, J, 2017	Advanced smart sensor interface in internet of things for water quality monitoring
Vijayakumar, N. Ramya, R 2015	The real time monitoring of water quality in IoT environment
MOPARTHI, N. R.; MUKESH, CH.; VIDYA SAGAR, P; 2018	Water Quality Monitoring System Using IOT
YAURI, R.; RIOS, M.; LEZAMA, J; 2017	Water quality monitoring of Peruvian Amazon based in the Internet of Things
MANJU, M.; KARTHIK, V.; HARIHARAN, S.; SREEKAR, B; 2017	Real time monitoring of the environmental parameters of an aquaponic system based on Internet of Things

Given the above and analyzing in a summarized form the selected articles in (Table 1) there is an inclination on the part of the researchers to develop prototypes for use in research. Most of the works suggest the feasibility of using the Iot for water monitoring, for example the work of [9] - [14] in which the authors work with proposal, consequently there was no application in real production environment, only proposal or tests bench. Differently from the work of [2], [15] where tests were carried out in loco, in the monitoring of water quality, the two in Rivers located in their region of the research, the first to verify the quality of the water for consumption and the following to research directly linked to psychology.

IV. THE INTERNET OF THINGS IN SURVEYS

Much is discussed about the ubiquity that computing systems are taking, its interconnectedness and omnipresence, Mark Weiser, published an article in 1991 in Scientific American, where he tried to explain what those things would be. Specialized hardware and software elements, connected by wires, radio waves or infrared, will soon be so ubiquitous that no one will notice its presence [16], it seemed only the dream of a scientist, but it was the beginning of the birth of the Internet of Things - (IoT).

The Internet of Things comes every day, becoming more popular in the medium of Information and Communication Technology (ICT). The general concept of what is internet of things is still much discussed in academia. The Institute of Electrical and Electronics

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Engineers - IEEE, describes the term "Internet of Things" as: a complex, adaptable, self-configuring network that interconnects "Things" to the Internet through the use of standard communication protocols. These interconnected things have physical or virtual representation of the digital world, ability to detect / act, with programming capability being solely identifiable and containing information, including relevant identity, status, location or business, social or private information. [17, p. 73].

These "things", the author continues, offer services, with or without human intervention, through the exploration of unique identification, data capture and ability to act. In this way the system is easily used through the use of intelligent interfaces and is available anywhere, anytime, and for anything, Minerva, Biru and Rotondi, (2015).

In this way, we can infer that the Internet of Things is generally understood as a connection of things in a network, that is, of physical objects, connected to the Internet that provide data. With the expansion of Iot, a new market vision emerges, as it leads to an improvement in the automation process, minimizing errors and operating costs.

By relating in this research, the area of water quality monitoring to the Iot system, which is relatively new and incipient in research. The work of [18] considers the relevance in the use of automated monitoring of water resources, due to productivity gain and lower cost, the authors propose a low-cost system for the study and application of this technology in sanitation plants.

As a proposal, the work of [9] corroborates with our work, since, the proposal of the work is the development of a mobile equipment for monitoring the environment, showing the relevance in the development of these low-cost systems, giving greater importance in the monitoring of water resources for better environmental control.

Already the work of [2] demonstrated the feasibility in performing the data collection of water quality has real time, using electronic sensors. As a pilot project, the sensors were placed along the Avon River, which cuts off the city of Bristol in England, thus collecting information for environmental monitoring is being done autonomously and automatically, integrated into the urban water management system better management of water resources.

It is important to highlight that, for the authors already mentioned, the network of sensors, allied to the Internet, is a more efficient method for collecting environmental data, especially in relation to water quality monitoring, along the rivers and river basins that provide water for consumption.

In this sense, the work of [8] emphasizes that the use of a wireless sensor network in detriment of the conventional collection forms, has been gaining space in the most deferential means. The authors' work compares and evaluates different architectures proposed by several authors in terms of parameters, monitoring and architectures.

In his work, [6] underscores the low cost and reliability of a network of sensors for monitoring, real-time water quality. As well as the work of [10], [19] they have developed, with the use of sensors, a system for real-time monitoring of pollution of water resources, which therefore only demonstrates the researchers' concern to develop general purpose platforms for this purpose.

V. CONCLUSION

The conclusion we reached with this review study is feasibility in the development of low cost it is possible to notice similarities and differences in the reflections of the authors who are concerned about this topic, the common loop presented is that they deal with water quality monitoring automatically, through sensors. [20], in his work, emphasizes that the advancement of the internet of things must result from synergistic activities conducted in different fields of knowledge, in this sense, several are the surveys that are favorable to the development of new products and techniques using monitoring systems in real time and low cost, with Iot. Our future proposal is the development of a low-cost system for monitoring air and water quality, specially developed for the researcher and agricultural producer.

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Study of the efficacy of the membranes produced on a laboratory scale for filtration: a proposal to improve the water quality of the hydrographic sub-basin of Ribeirão das Pedras, Diamantina, MG (Brazil)

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Abstract— *Population expansion and technological development generate an increase in the use of natural resources, especially water resources, and, as a consequence, the amount of waste and chemical residues dumped into the effluents increases. With the end of the garimpo in the town of Diamantina, the spring that cuts through the city has notoriously had its flow reduced and its slopes visibly diminished and devastated by erosion, which reminds us of the need to install recovery and preservation programs. Among the pollutants, we can highlight the heavy metals, which cause great concern because of their toxicity. The present work sought to use the membrane filtration process. For this purpose, membranes were prepared using the chitosan biopolymer. The membranes were tested for the capacity to absorb metal ions. Water samples were collected from the hydrographic subbasin Ribeirão das Pedras, located in the city of Diamantina, MG, Brazil. The membranes were efficient, and the detection of possible improvements in the formulations, as well as sample collections, should be performed during other periods of the year.*
Keywords—***Adsorption, Biopolymer, Chitosan.***

I. INTRODUCTION

Areas that present "symptoms" such as the absence or reduction of vegetation cover, deposition of litter, and erosion, among others, are considered to be degraded because the lack of recovery of areas degraded by mining and panning, disorderly urbanization and lack of sanitation has caused a decrease in the amount of drinking water. A more sustainable and economically viable way to treat this resource must be sought (PEREIRA, 2004) [1].

The Ribeirão das Pedras sub-basin is particularly important because it is the source of water for the city of Diamantina (APA Pau de Fruta - COPASA, in the upper part of this sub-basin). After feeding the water catchment dam, the main course crosses two country clubs and the drainage network in the middle course crosses the entire length of the Biribiri State Park. It then flows into the Pinheiro River near the homonymous locality. However, some of the sources are in the vicinity of the headquarters of the districts of Sopa and Guinda, which discharge their sewage and other wastes into waterways of the system, in addition to collecting residues from areas degraded by diamond mining (NEVES; HORN; FRAGA, 2008) [2].

The impact of human activity is a matter of concern, and it is currently a controversial subject. It is no longer possible to implement a project or discuss any plan without considering the impact on the environment. In the case of a region degraded by mining activities, work to

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maintain the natural form or return to these characteristics is important. Thus, projects aimed at the recovery of these áreas with the expansion of environmental technologies aimed at the recovery of degraded áreas are possible. There are a number of methods for the treatment and recovery of degraded areas, especially for river basins (CHU, 2002) [3] .

Among the technologies with a possibility for use are precipitation, reduction, stabilization/solidification, membrane filtration, ion exchange and adsorption. Some are effective, but not financially viable (CHU, 2002) [3]. In this context, Förstner & Wittmann (1979) [4] and Salomons & Förstner (1984) [5] were studied concentrations of heavy metals and their amendments by processes of precipitation, complexation, biological assimilation and adsorption, observed that these contaminants accumulate in sediments over time. In this way, sediments are an important reservoir of metal concentration in the evaluation and diagnosis of environmental quality in a basin (TRINDADE *et al.*, 2018) [6]. Among these methods, adsorption is one of the most efficient in the removal of heavy metals (CHU, 2002) [3]. And, the membrane filtration process stands out because it is a simple and accessible process, which is based on the retention of metal ions on its surface (RIVAS *et al.*, 2011) [7].

Compared with traditional separation technologies, membrane technology has the advantages of high separation efficiency, low energy consumption, and simple operation (SHI. YUAN; CAO, 2001) [8] .
Membrane separation technology, wich uses natural, artificial and selective membranes, can isolate, grade, and enrich gas or water by means of two-component or multicomponent systems ZHENG, 1999 ([9] cited by WANG *et al.*, 2012 [10]).Thus, several low-cost adsorbents have been developed to evaluate the capacity for removal of these heavy metal ions (BAJLEY *et al.*, 1999) [11], as well as membrane filtration techniques utilizing natural polymers.

Among the natural polymers that can be used in the membrane filtration process to assist in the water and effluent treatment process, chitosan, a natural polymer obtained from the deacetylation of chitin found in insect carapaces, can be included. Crustaceans are easily obtained in residues from the fishing industry. In addition to having several applications, it is characterized by its efficiency in the removal of heavy metals with the advantage of being low cost, non-toxic, biocompatible and biodegradable (DALLAN, 2005) [12]. Therefore, chitosan has been widely investigated for the removal and recovery of metal ions from industrial effluents. This material possesses amino and hydroxyl groups, which are quite reactive and make it a polymer of great industrial interest. Studies on the adsorption of heavy metals by chitosan, mainly for the Cd, Cr, Cu, Ni, Pb and Hg ions, can be found in the literature (NGAH; ENDUD; MAYANAR, 2002) [13] .

The biopolymers, such as chitin (KURITA, T. SANNAN, Y. IWAKURA, 1979[14]; BARAN; BICAK; BAYSAL, 2007 [15], starch (ZHANG; CHEN, 2002 [16]) and chitosan (NGAH; ENDUD; MAYANAR, 2002[13] ; VIEIRA; BEPPU, 2003[17]) are among these low-cost adsorbents that are especially important because of their chemical structures, physicochemical characteristics, chemical stability, high reactivity and selectivity for metal ions. Chitosan also has the property of moldability in various forms (films, spheres, microspheres, membranes, etc.), and it has different surface area-to-mass ratios that maximize the adsorption capacity and minimize the effects of loss of charge and clogging of the bed in adsorption columns. The literature describes several studies on the removal of heavy metals, such as copper, lead, cadmium, zinc, mercury, among others, in monocomponent systems using chitosan in its natural and crosslinked (VIEIRA; BEPPU, 2003) [17].

The objective of this study was to determine the efficiency of chitosan-based membranes for the removal of possible contaminants, heavy metals, present in water samples collected in the Ribeirão das Pedras hydrographic subbasin, Diamantina, MG, Brazil. The samples were subjected to measurements of pH, conductivity, turbidity, hardness, chloride, COD and atomic absorption analyses. Subsequently, vacuum filtration tests were performed using the four different membrane formulations produced on a laboratory scale. Tests were performed before and after filtration to evaluate the efficiency of chitosan membranes for the removal of metallic ions. Thus, the four chitosan-based membrane formulations were characterized for filtration capacity by employing the SEM and atomic absorption analyses.

II. MATERIAL AND MÉTHODS

2.1 Material

During the preparation of the membranes, the following materials were used: chitosan (Sigma), cellulose acetate (Sigma), glacial acetic acid (Synth), succinic acid and NaOH (Synth).

2.2 Methods

Water samples were collected from the subbasin of Ribeirão das Pedras, Diamantina, MG, Brazil for

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thefiltration tests. For this purpose, characterization tests were performed on the water samples used in the filtration and on the membranes produced on a laboratory scale.

2.2.1 Characterization of the samples collected in the subbasin of Ribeirão das Pedras

The samples collected at points 1 to 7 were submitted to physicochemical analysis: pH, conductivity, turbidity, hardness, chloride, COD and atomic absorption. All of the analyses were performed in triplicate.

pH analysis - The hydrogen ion potential (pH) was measured using the mPA 210 pHmeter.

Conductivity analysis - The conductivity was measured by the Conductivity Meter (Lutron brand Cd-4303), and the results were expressed in µS/cm.

Turbidity analysis - Turbidity was measured with the Multiprocessor Turbidimeter (Hanna Instruments -HI 9370), and the results were expressed in UNT.

Hardness analysis - The hardness analysis was determined by triplicate, and the results were expressed in mg/L.

Chloride analysis – The chloride concentration was determined by triplicate, and the results were expressed in mg/L.

COD Analysis - The Chemical Oxygen Demand (COD) was measure by triplicate, and the results were expressed in mg/L.

Atomic Absorption Analysis - Absorption analysis on a flame atomic absorption spectrometer was carried out on a Spectrum 50B model Varian® spectrometer, and the results were expressed in ppm.

2.2.2 Preparation of filter membranes

For the preliminary study of the efficiency of chitosan-based membranes, four formulations of chitosan-based membrane were prepared: MQ1, MQ2, MQA and MQE. The commercial membrane, named COM, was also used as a parameter for comparison, as is shown in Table 1.

Table 1. Formulation data, method and acronym of membranes

Formulation	Method	Acronym
Comercial	Comercial	COM
1% Chitosan + 1%Acetic acid	Dispersion	MQ1
2% Chitosan + 1% Succinic acid	Dispersion	MQ2
1% Chitosan + 1% Cellulose acetate	Dispersion	MQA
2% Chitosan + 1% Acetic acid	Stretch	MQE

The formulations were prepared by two methods: a dispersion method and a stretching method (Table 2). The dispersion method consisted of total solubilization of the chitosan biopolymer and distribution of the filmogenic solution in disposable petri dishes. The stretching method consisted of immersing the membranes in 5% NaOH (m/m) solution after the drying step and then accommodating them to manual stretching and exposing them to drying. Both methods were based on the distribution of the filmogen solution in disposable petri dishes and drying in a forced circulation chamber at 40 °C for 12 hours.

Table 2. Methods of formulation of the membranes produces

Membrane	Method
MQ1	In 100 mL of 1% aqueous acetic acid solution, 1 g of chitosan was dispersed and then kept under continuous stirring (100 rpm) for 60 minutes or until complete solubilization.
MQ2	In 100 mL of a 1% aqueous succinic acid solution, 2 g of chitosan was dispersed and then kept under continuous stirring (100 rpm) for 60 minutes or until complete solubilization.
MQA	In 100 mL of 1% acetic acid solution, 1 g of chitosan was dispersed and then kept under continuous stirring (100 rpm) for 60 minutes or until complete solubilization. Simultaneously, the mixture of 1 g of cellulose acetate in acetone, also maintained under continuous stirring (15 minutes), was prepared. Then, the two solutions were distributed in the same beaker and maintained under continuous agitation until complete solubilization.
MQE	In 100 mL of 1% acetic acid solution, 1 g of chitosan was dispersed and then kept under continuous stirring (100 rpm) for 5 hours or until complete solubilization. The solution was then distributed into Petri dishes and dried in a forced circulation oven (50 °C) for 24 hours. After this period, the membranes were immersed in 5% (m/m) NaOH.

2.2.3 Characterization of filter membranes

The MQ1, MQ2, MQA and MQE membranes were characterized by MEV micrographs and by the retention capacity for possible metal ions in the filtration operation.

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The quantity of ions retained in the membranes was determined by the atomic absorption analysis.

2.2.4 Filtration analysis

For the vacuum filtration, the membranes were cut into 4-cm diameters and subjected to filtration, first with the commercial membranes, and then with the chitosan membranes. The water samples used in the filtration stage were collected in the sub-basin of Ribeirão das Pedras, Diamantina, MG, Brazil. A 1000-mL water sample was used for each filtration test. The filtration tests were performed with the use of a bench microfiltration/ultrafiltration (MF/UF) unit manufactured by PAM Membranas Selectivas Ltda.

2.2.5 Analysis by Scanning Electron Microscopy (SEM)

The samples were cut into small squares, affixed to cylindrical stubs, metallized for 40 minutes, and then subjected to scanning electron microscopy analysis using the CamScan-3200 LV Shimadzu-Japan equipment.

III. RESULTS AND DISCUSSION

3.1. Location of sample collection

Water samples were collected at seven distinct points, of the hydrographic sub-basin of the Ribeirão das Pedras, Diamantina, designated: 1 through 7 (Fig. 1 - 8).

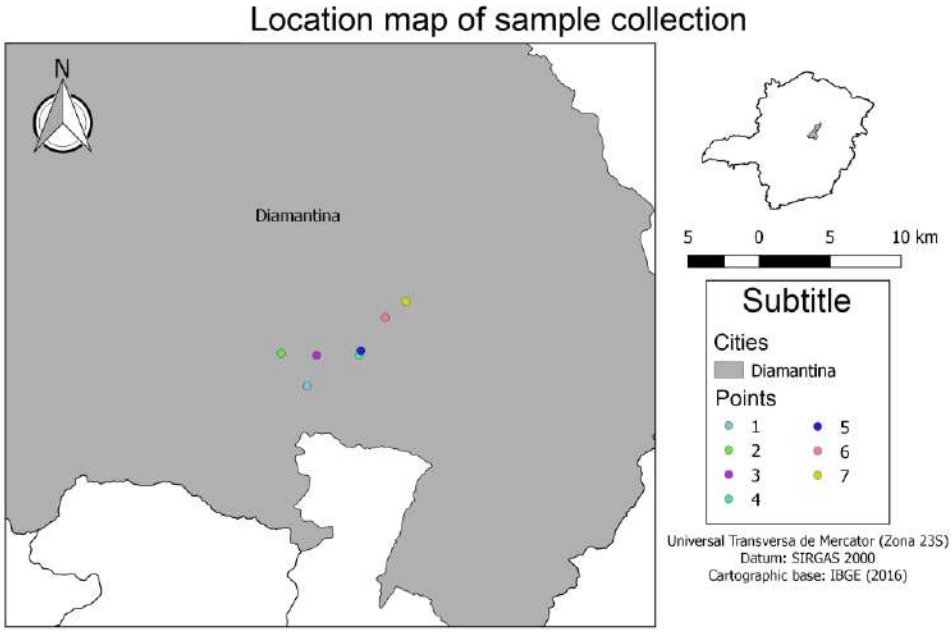

Fig. 1. Location map of sample collection

Fig. 2. Point 1 of collection of the water samples from Ribeirão das Pedras, Diamantina, MG, Brazil

3.2. Visual characterization of the samples

The samples collected in the sub-basin of Ribeirão das Pedras, in Diamantina, MG, in addition to the basic characteristics of Latitude, Longitude, Depth, Temperature, Bed, Aspect, Color, and Fluxo, were also classified according to the visual characteristics, as follows:

• Point 1 - At the collection point 1, the presence of algae, insects, mud and fish was observed. It was also verified that there was a tardigrade in a bog at the point of collection.

• Point 2 - At the collection point 2, the presence of fish, tadpoles, reeds and mosses was verified. The collection point was situated between a ciliary forest in the form of isolated capons.

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Fig. 3. Point 2 of collection of the water samples from Ribeirão das Pedras, Diamantina, MG, Brazil

Fig. 4. Point 3 of collection of the water samples from Ribeirão das Pedras, Diamantina, MG, Brazil

Fig. 5. Point 4 of collection of the water samples from Ribeirão das Pedras, Diamantina, MG, Brazil

• Point 3 - At point 3, a fillet of water was observed inside the bed with a width of 1.5 m of river bed. There was a predominance of gravel bars and the presence of vegetation.

• Point 4 - The collection point was made in the COPASA Pau de Fruta dam, a dam below the level of the dyke, where there was fine sandy material.

Fig. 6. Point 5 of collection of the water samples from Ribeirão das Pedras, Diamantina, MG, Brazil

Fig. 7. Point 6 of collection of the water samples from Ribeirão das Pedras, Diamantina, MG, Brazil

Fig. 8. Point 7 of collection of the water samples from Ribeirão das Pedras, Diamantina, MG, Brazil

• Point 5 - In point 5, suspended flocs were observed in the watercourse with rocky outcrops in the bed, which formed small, isolated pools on the side, in addition to the presence of tufts and grasses on the margins. It should be noted that said point is located just below the highway bridge.

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• Point 6 – The sample from point 6 was collected in the main well of the Toca waterfall, where gravel bars were detected at the outlet of the waterfall, in direct contact with quartizite and shale.

• Point 7 - Collection point 7 was located in a well of clean water, in a water course barred by a rock outcrop and a sand side bar at the exit of the well (downstream), with the presence of fish and vegetation on the banks. To facilitate the identification and analysis of the parameters, annotations were made on the samples collected for each collection point, such as: Latitude; Longitude; Depth; Temperature (T); Bed; Aspect; Color and Flow (Table 3).

3.3 Physicochemical characterization of the samples

The samples collected in the subbasin of Ribeirão das Pedras were analyzed for pH, Conductivity Turbidity, Hardness, Chlorides and COD. The pH of all the samples was slightly acidic. The conductivity of sample 6 was high, when compared to the other samples. The turbidity of sample 1 was the highest. There were no differences in the hardness, chloride and COD of the samples analyzed (Table 4).

Table 3. Characteristics of collection points

Parameter	Sample						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Latitude (E)	639233	637321	639810	642806	642948	644574	646001
Longitude (N)	7979376	7981613	7981551	7981689	7981981	7984365	7985562
Depth (cm)	30 - 40	10 - 40	25-35	30 - 350	10 – 50	10 - 500	30 - 200
T (ºC)	18.9	20.2	16,5	21.3	22	19	20.1
Bed (m)	0 – 1.8	5	8	0.20x0.20	1 – 5	0.20x0.20	6x5
Aspect	Clear	Clear	Clear	Clear	Clear	Cloudy	Clear
Color	Yellow	Transparent	Cristaline	Cristaline	Cristaline	Cristaline	Cristaline
Flow	Still	Slow	Fast	Contained	Slow	Medium	Medium

Table 4. Physicochemical characterization of water samples

Parameters	Samples						
	1	**2**	**3**	**4**	**5**	**6**	**7**
pH	5.44	5.91	6.00	5.98	6.61	6.64	5.69
Condutivity (µS/cm)	4.60	2.40	15.5	1.20	21.6	17.80	3.20
Turbidity (UNT)	3.55	0.44	0.82	0.59	1.80	0.74	1.52
Hardness (mg/L)	1.23	0.50	0.50	0.40	0.60	0.63	0.70
Chloride (mg/L)	0.30	0.20	0.30	0.30	0.30	0.20	0.20
COD (mg/L)	3.05	3.10	3.06	3.03	3.10	3.37	3.00

There were no alterations in the pH values measured in the water samples collected in Ribeirão das Pedras, Diamantina, MG. Thus, the values were in accordance with the Resolution 357/05 of CONAMA (CONAMA, 2005) [18], which establishes the limits between 5 and 6 for pH. Figueiredo *et al*. (2014) [19] in their research conducted in the Rio Doce basin, detected mean values of pH were 6.9, 6.6 and 7.2 in the observed years, respectively, which shows a medium close to neutrality. However, several biological and physico-chemical processes can influence the observed pH range.

The higher the dilution of the solutes, the lower the electrical conductivity Poch (1999) [1] in turn, relates the changes of salinity to the lithological nature of the land, on which, or within which, the waters percolate. In addition, it also takes into account the influence of domestic and industrial effluents. In the present study, points 3, 5 and 6 presented higher values of conductivity, (15.5, 21.6 e 17.8 µS/cm), respectively. These values are concomitant with the highest pH values (6.0, 6.61 and 6.64), respectively, indicating the non-dilution of the solutes.The conductivity is dependent on the concentrations of ions present in the aquatic environment, which in turn is influenced by T and pH [20] (WETZEL, 2001). This fact may have been highlighted in section 4, with a lower conductivity reading (1.24 µS / cm).

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Under natural conditions, hardness is a chemical characteristic of water from dissolution of calcareous rocks or other minerals containing calcium and magnesium (CORDEIRO *et al*., 2012) [21]. In the present work, even if samples were collected at points that make up a hydrographic basin, composed of rocky regions, only point 1 (1.23 mg / L), being the highest hardness value found among the other collection points (Table 4). The hardness values observed were within the allowed values, according to the Article 16 of Ordinance 518/04 (BRASIL, 2004 [22]) of the Ministry of Health, which establishes a maximum of 500 mg/L of hardness for drinking water.

The parameters of color and turbidity are highly correlated in environments where there are high concentrations of iron [23] (MESQUISA *et al*., 2016). This fact can justify the behavior of collection point 1, with turbidity values 3.55 UNT (Table 4), yellow color and still flow (Table 3).

In this job, the turbidity of all the collection points were within the legal limits because CONAMA 357/05 establishes limits that cannot exceed 40 UNT (CONAMA, 2005) [18] and the Ordinance 518/04 of the Ministry of Health establishes a maximum of 5 UNT for water potability (BRASIL, 2004 [22]).

According to Article 16 of Ordinance 518/04 of the Ministry of Health and Article 14 of Resolution nº 357/05, the maximum concentration of chlorides present in the water is 250 mg/L. Chloride is a major ionic constituent of groundwater and its presence is directly related to point sources and diffuse anthropogenic contamination and the geological and geochemical characteristics of the area aquifers (BAHIA *et al*., 2011) [24]. Thus, all the samples were within the legal limit (CONAMA, 2005 [17]; BRASIL, 2004 [22]). Thus, the samples collected at points 1, 2, 3, 4, 5, 6 and 7 did not present discrepant values. Therefore, the results indicate that the samples can be classified as waters of unpolluted rivers and do not violate resolutions of CONAMA or the Ministry of Health.

3.4 Scanning Electron Microscopy (SEM)

SEM analyzes were performed on all the membranes (COM, MQ1, MQ2, MQA and MQE) at 500X magnification. As shown in Fig. 8-11, the texture of each of the membranes produced could be visualized, and the relationship between the analyses performed in the present work regarding the filtration time to which they were submitted could be compared.

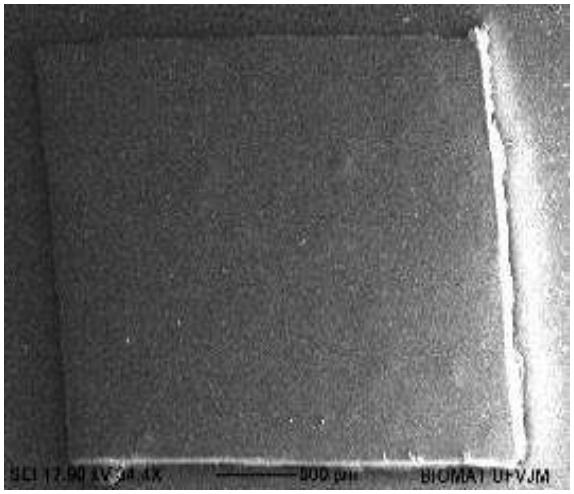

Fig. 9. MEV (plane view) of MQ1 membranes

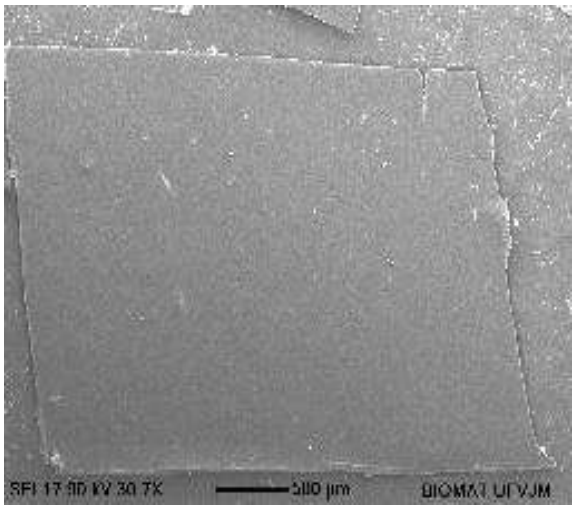

Fig. 10. MEV (plane view) of MQ2 membranes

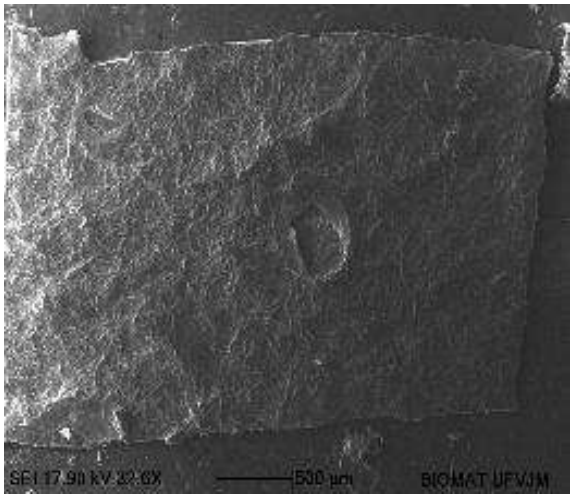

Fig.11. MEV (plane view) of MQA membranes

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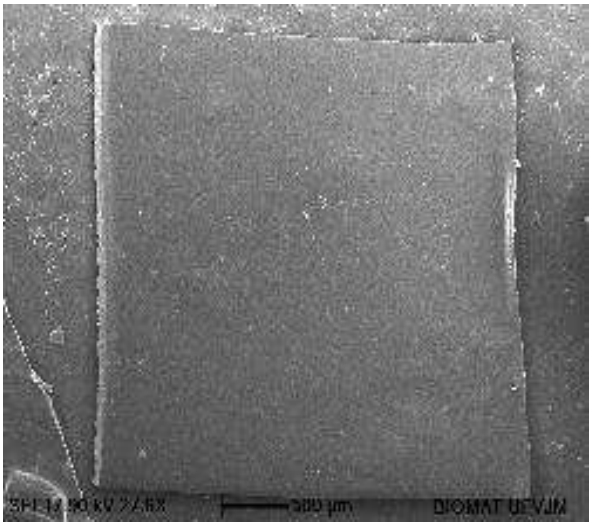

Fig. 12. MEV (plane view) of MQE membranes

As shown in Fig. 8-11, a basically uniform structure could be observed for the samples MQ1, MQ2 and MQE; however, the structure of the MQE sample was more uniform than those of samples MQ1 and MQ2, in which the formation of small reliefs and cavities could be seen, possibly related to inadequatr solubilization of the filmogenic solution or deficiencies in the drying step. The MQA sample had a distorted surface, with cavities and reliefs visible to the naked eye. However, it was the sample that presented the best distribution and interweaving of the fibers, and it was the sample most visually similar to the commercial sample (Fig. 12).

3.5 Atomic absorption analysis

The atomic absorption analysis was performed on the samples collected in the sub-basin of Ribeirão das Pedras, Diamantina, MG. The samples 1-7 were analyzed before and after the filtration step. As shown in Figure 14, a higher concentrations of copper and manganese ions, respectively, were found in samples 1 and 6. The presence of iron was detected in all the samples (1-7).

changes in the samples filtered with the other membranes; there were small changes in the concentration of copper ions in Point 1, which had higher concentrations of this metal. The largest reduction (62.5%) was observed for the MQE membrane, whereas a reduction of 37.5% was found for the other membranes.

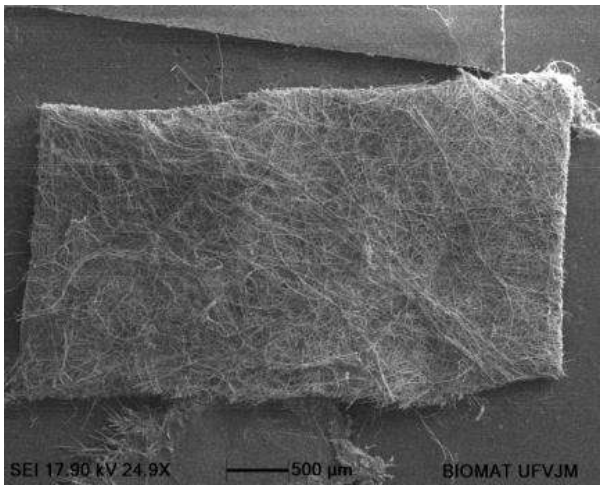

Fig.13. SEM (plane view) of COM membranes

As can be seen in Figure 15 and 16, no changes in the concentrations of heavy metals were found in the samples filtered with the COM membrane. There were. The greatest decrease in concentration of the iron ion, mean 31.5%, was obtained with the MQE membrane, where as smaller average reductions were obtained with the other membranes (MQ1 - 13.2%, MQ2 - 19.1% and MQA - 14.9%). The role of chitosan in increasing the adsorption capacity of metals is emphasized because the membranes with the best results were those made with 2% chitosan, to the detriment of those with only 1% chitosan.

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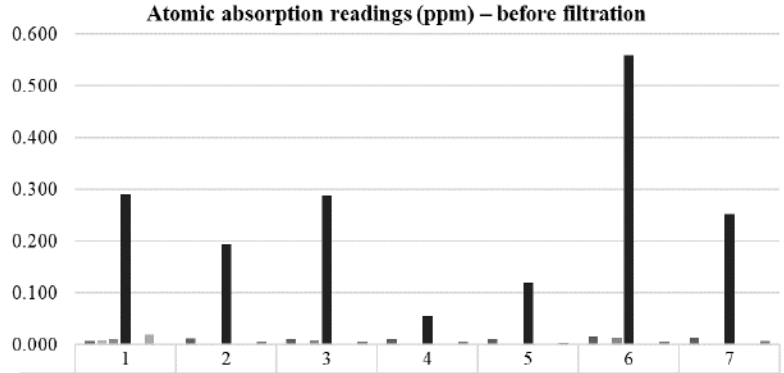
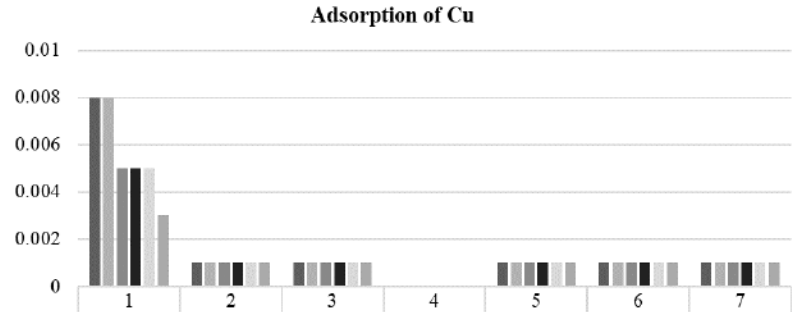


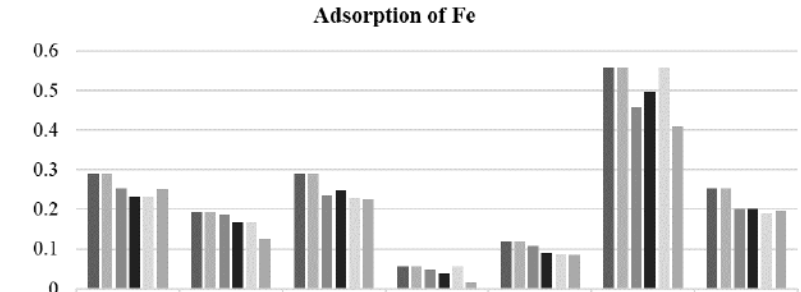
	1	2	3	4	5	6	7
Zn	0.007	0.012	0.010	0.010	0.010	0.016	0.014
Cu	0.008	0.001	0.001	0.000	0.001	0.001	0.001
Mn	0.010	0.002	0.009	0.001	0.001	0.014	0.001
Fe	0.289	0.193	0.288	0.055	0.119	0.558	0.252
Cd	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ni	0.019	0.000	0.000	0.000	0.000	0.002	0.000
Pb	0.000	0.004	0.005	0.004	0.003	0.004	0.007

Fig.14. Results of the atomic absorption analysis of the samples collected in the subbasin of Ribeirão das Pedras



	1	2	3	4	5	6	7
Antes	0.008	0.001	0.001	0.000	0.001	0.001	0.001
COM	0.008	0.001	0.001	0.000	0.001	0.001	0.001
MQ1	0.005	0.001	0.001	0.000	0.001	0.001	0.001
MQ2	0.005	0.001	0.001	0.000	0.001	0.001	0.001
MQA	0.005	0.001	0.001	0.000	0.001	0.001	0.001
MQE	0.003	0.001	0.001	0.000	0.001	0.001	0.001

Fig.15. Adsorption of Copper



	1	2	3	4	5	6	7
Antes	0.289	0.193	0.288	0.055	0.119	0.558	0.252
COM	0.289	0.193	0.288	0.055	0.119	0.558	0.252
MQ1	0.253	0.188	0.235	0.048	0.109	0.458	0.201
MQ2	0.233	0.168	0.248	0.038	0.089	0.498	0.200
MQA	0.232	0.168	0.228	0.055	0.088	0.558	0.189
MQE	0.250	0.126	0.225	0.015	0.085	0.408	0.196

Fig.16. Adsorption of Iron

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IV. CONCLUSION

It is necessary to make collections in different periods of the year because the results obtained with the analysis of the water samples collected in mid-August were compared with the standards required by ordinance No. 518/2014 (BRASIL, 2004 [22]) and nº 2914/2011 (MS, 2011) of the Ministry of Health and resolution nº 357/2005 (CONAMA, 2005) [18] and nº 430/2011 (CONAMA, 2011) [25] of CONAMA, and all the samples were within the established standards.

The efficacy of the membranes made with the chitosan biopolymer was also confirmed because of the increase in the capacity for adsorption of metals. The membranes with the best results were those made with 2% chitosan, whereas less efficient absorption was obtained with the membranes prepared with only 1% of chitosan or with the commercial membrane that does not possess chitosan in its composition. However, new experiments are underway to increase the resistance of the membranes.

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Comparative Examples of Logistic Platforms (LP) in the World

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Abstract *— This article deals with the main characteristics of interest in the research, emphasizing the types of infrastructure, the intermodal logistics platforms (LPs) and their LP expansion plans located in the three most important continents of the world, by volume of cargo handling and geographical situation: the American, the European and the Asian. The objective of the paper is to address the selection criteria of LPs whose importance is to note that most platforms in the world are linked to seaports, because of their importance in global trade relations. The methodology applied for the study was the analysis of infrastructures of the ILPs: Rotterdam, Barcelona - ZAL (Spain), Le Havre (France), United States of America: Long Beach, Los Angeles, New York and in Asia, as well as in Hong Kong (China), Singapore (Singapore) and Tokyo (Japan), data collection and analysis have made it possible to understand the importance of these ILPs for the movement of loads to various parts of the world. The comparative results evidenced the importance in the economic strategy of these ILPs such as: types of infrastructure, intermodality systems and expansion plans space productivity, vehicle traffic limitation, economic performance, size and classification. The types of infrastructure mainly characterize the main terminals of dry and liquid loads. The intermodality system reinforces the integration of transport modes, increasing the synergy required for the movement of cargoes in these LPs.*

Keywords *— **Comparative Examples, Logistic Platforms in the World, Intermodal Logistics Platform.***

I. INTRODUCTION

This article intends to address the main characteristics of interest in the research, emphasizing the types of infrastructure, intermodality systems and plans to expand Logistics Platforms (LPs) located in the three most important continents of the world, in volume of handling of load and geographical situation: the American, the European and the Asian [1] [2].

Before addressing the choice criteria of LPs it is important to note that most platforms in the world are linked to seaports, because of their importance in global trade relations [3] [4].

Indispensable for a port are [5] [6]:

• Presence of deep water channels (ideal depth varies with the draft of the vessels);
• Protection against wind and waves;
• Access to roads and / or railways.

Handled cargo ports should have access to a vast rail network linking the port to other agricultural and / or industrial regions, thus allowing the disposal of various products to other regions of the country and the world [7-9].

The choice of LPs in the world was based on two important criteria: the annual movement of containers and the strategic geographical position of the platform. Regarding the annual movement of containers, the choice was based on the ranking presented by AAPA World Port Rankings, based on 2005 [10-12]. Regarding the second criterion, the strategic geographical position, the choice was divided into continents, ie three platforms in the European, three in the American and three in the Asian, all related to its strategic geographical position in each chosen country. The continents were chosen taking into account the movement of cargo distributed in the world, that is, the largest cargo volumes are operationalized in the Asian, American and European continents, according to the ranking presented previously [13-15].

The three ports chosen from the European Logistics Platform were: the port of Rotterdam in the Netherlands, the port of Barcelona (ZAL) in Spain and the port of Le Havre in France [16-18]. Already the three ports chosen from the American Logistics Platform were: the port of Los Angeles, the port of Long Beach and the port of New York / Jersey all in the United States [17] [19].

The three ports chosen for Asian LP were: the Singapore port in Singapore, the Hong Kong port in China and the port of Tokyo, Japan. Table 1 summarizes

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the UEOs (unit equivalent to one containers of 20 feet) in the years 2002 and 2005 and their respective variations in the world ranking taking into account the nine LPs chosen in the study.

Table 1 - Summary of the UEOs (container) movements.

Logistics Platforms	Year	UEOs (millions)	Position Ranking	Year	UEOs (millions)	Position Ranking
Rotterdam	2002	6,5	7°	2005	9,2	8°
ZAL	2002	1,46	44°	2005	2,07	45°
Le Havre	2002	1,72	37°	2005	2,10	38°
Los Angeles	2002	6,10	8°	2005	7,48	10°
Long Beach	2002	4,52	11°	2005	6,71	12°
New York	2002	3,74	15°	2005	4,78	17°
Hong Kong	2002	19,14	1°	2005	22,42	2°
Singapure	2002	16,94	2°	2005	23,19	1°
Tokyo	2002	2,71	20°	2005	3,59	22°

Source: [20].

Table 2 presents the ranking of the fifty largest Logistics Platforms in the world, based on the year of 2005, in order to improve the contextualization of the arguments mentioned above.

Table 2 - Handling of container base year 2005

RANKING	PLATFORMS	COUNTRY	TEUs Millions
1	*Singapore*	*Singapore*	23,192
2	*Hong Kong*	*People's Republic of China*	22,427
3	*Shanghai*	*People's Republic of China*	18,084
4	*Shenzhen*	*People's Republic of China*	16,197
5	*Busan*	*South Korea*	11,843
6	*Kaohsiung*	*Taiwan (Republic of China)*	9,471
7	*Rotterdam*	*Netherlands*	9,287
8	*Hamburg*	*Germany*	8,088
9	*Dubai*	*United Arab Emirates*	7,619
10	*Los Angeles*	*United States of America*	7,485
11	*Long Beach*	*United States of America*	6,710
12	*Antwerp*	*Belgium*	6,482
13	*Qingdao*	*People's Republic of China*	6,307
14	*Klang*	*Malaysia*	5,544
15	*Ningbo*	*People's Republic of China*	5,208
16	*Tianjin*	*People's Republic of China*	4,801
17	*New York/New Jersey*	*United States of America*	4,785
18	*Guangzhou*	*People's Republic of China*	4,685
19	*Tanjung Pelepas*	*Malaysia*	4,177
20	*Laem Chabang*	*Thailand*	3,834
21	*Bremen/Bremerhaven*	*Germany*	3,736
22	*Tokyo*	*Japan*	3,593
23	*Xiamen*	*People's Republic of China*	3,342
24	*Tanjung Priok*	*Indonesia*	3,282
25	*Algeciras*	*Spain*	3,180

https://dx.doi.org/10.22161/ijaers.6749 *ISSN: 2349-6495(P) | 2456-1908(O)*

26	*Gioia Tauro*	*Italy*	3,161
27	*Yokohama*	*Japan*	2,873
28	*Jeddah*	*Saudi Arabia*	2,836
29	*Felixstowe*	*United Kingdom*	2,700
30	*Jawaharlal Nehru*	*India*	2,667
31	*Manila*	*Philippines*	2,665
32	*Dalian*	*People's Republic of China*	2,665
33	*Salalah*	*Oman*	2,492
34	*Nagoya*	*Japan*	2,491
35	*Colombo*	*Sri Lanka*	2,455
36	*Valencia*	*Spain*	2,410
37	*Oakland*	*United States*	2,273
38	*Santos*	*Brazil*	2,268
39	*Kobe*	*Japan*	2,262
40	*Le Havre*	*France*	2,119
41	*Keelung*	*Taiwan (Republic of China)*	2,091
42	*Seattle*	*United States*	2,088
43	*Barcelona (ZAL)*	*Spain*	2,071
44	*Tacoma*	*United States*	2,066
45	*Charleston*	*United States*	1,987
46	*Hampton Roads*	*United States*	1,982
47	*Khor Fakkan*	*United Arab Emirates*	1,930
48	*Ho Chi Minh City*	*Vietnam*	1,911
49	*Savannah*	*United States*	1,902
50	*Melbourne*	*Australia*	1,863

Source: [20].

II. APPLIED METHODOLOGY

In the description of the nine PLs selected in this study, the main aspects will be considered: types of infrastructure, intermodality systems and expansion plans. These conditions may justify or subsidize a procedure for the design of a model, taking into account mainly the size and classification of the selected Platforms.

2.1 STUDY STEP 1: ROTTERDAM INTERMODAL LOGISTIC PLATFORM, IN THE NETHERLANDS

Currently, the port of Rotterdam is the most influential logistics and industrial complex in Europe. Existing since the 14th century, when it was still a small fishing port on the river Rotte, its great rise from the 19th century, when a connection with the North Sea, called the Nieuwe Waterweg, was established, establishing an important communications with the great German industry. Over the years, thousands of tons of goods transit through it daily [21].

The Port of Rotterdam and the industrial area of the port belong to the municipality of Rotterdam, whose City Hall has delegated to the Port Administration (RMPM) the responsibility for its development, management and operation. The law establishes management by private initiative, development, construction, port administration and nautical management [22].

This Administration has two operational directorates and corporate support departments to manage a wide variety of operations performed in the port. Nautical Management is the responsibility of the Navigation Board. The Commercial Development Board is responsible for the management and generation of new businesses [23].

The main movements of the port of Rotterdam are linked to the loads: chemical, mineral, liquid, dry, neo-bulk (vehicles), general, refrigerated and foodstuffs. The port operates with exceptional facilities, know-how, experience and expertise providing a better level of service and customized solutions.

The port of Rotterdam offers a variety of facilities for operating door-to-door intermodal transport through a sophisticated combination of transport modes. It offers pre-transport and post-transport services. The main types of intermodality offered are: long-distance transport through railways, pipelines, waterways, always focusing

https://dx.doi.org/10.22161/ijaers.6749 ISSN: 2349-6495(P) | 2456-1908(O)

on quality, time and low cost, taking into account environmental requirements [24].

The European Union supports the use of intermodal transport, intelligently interconnecting the most diverse modes of transport, in order to improve quality and reduce the costs of logistics operations. It ends up favoring in a positive way the reduction of road congestion, reducing bid prices to all parties interested in the logistics process.

The port of Rotterdam maintains daily connections to dozens of European terminals, responsible for the transit of the goods, and can change modes of transport with ease.

Water transport along the Rhine River has become a low-cost alternative for containers destined for countries cut by the Rhine River itself - via the Rhine-Main-Danube Canal - and the Danube River. Due to the regular services connected to numerous German domestic terminals, water transport contributes 22% of the total number of containers transported internally and externally to Rotterdam. Due to the growth in the number of home terminals, this movement tends to grow in the coming years [25].

Rail transport is ideal for transporting large quantities of cargo over long distances in all parts of the European continent. The port of Rotterdam offers excellent 24-hour rail connections to most of Europe's major industrial areas. The transit times are short and shorter than 12 hours to meet the market of Belgium and Germany. Already to meet Italy and Poland takes an average of 48 hours. The port is being set up to handle rail freight from Rotterdam to Germany in 2007 [26].

Road transport will always be a great alternative to connect the main European regions. The port is also directly connected to Europe's extensive road network, which is constantly expanding, where thousands of trucks depart daily or arrive from these destinations. The Rotterdam port pipeline system moves about 60 million tonnes of various petroleum products (naphtha, kerosene, petrol and ethylene) and chemicals.

The port of Rotterdam continues to invest in pipeline systems. Since 2003, the port authority has been carrying out its expansion works. With these investments, the port intends to increase its operations in this mode of transport. The port is approximately one hour away from Amsterdam Airport Schiphol, the main international airport in the country. Schiphol is one of Europe's most important freight airports, airfreight is moving to all locations around the globe [27].

The strategic plan for 2020 at the port of Rotterdam indicates that port operations will be highly competitive. This is what the port authority has been seeking with the new infrastructures planned for the next 20 years. One of the key projects of the 2020 strategic plan is the expansion of the Maasvlakte 2 port. With the construction of Maasvlakte 2, the port of Rotterdam will achieve a high performance and productivity position in the European market. The future of the Maasvlakte 2 port will depend not only on expansion projects, but on associated quality of life and environment projects. For this reason, the joint projects will meet the concept of sustainable development. The projects will address two major environmental issues: controlling the amount of pollution in the air and the nuisance of noise caused by companies operating in the port [28].

2.2 STUDY STEP 2: INTERMODAL LOGISTICAL PLATFORM OF BARCELONA - ZAL, IN SPAIN

The port authority is represented by administrations (local, autonomous and central), trade, industry and shipping chambers, the most representative trade unions of employers and relevant organizations and economic sectors related to port activity in the port [29].

The port authority uses the Master Plan to manage the port of Barcelona, directing its actions in the objectives of fortifying the port position throughout Europe. Through the Director Plan it is possible to modify the infrastructure of the port. Some examples are: the bridge between Adossat and Ponent, the replacement of terminal spaces, the extension of the ZAL (Zone Activities Logistic) to the south, and the new cruise terminals [24].

ZAL is a multimodal distribution and supply logistics center located in the Port of Barcelona, Spain, one of the main ports for container traffic in the Mediterranean Sea. It was specially developed for the Port of Barcelona by offering several maritime connections that connect to more than 400 ports worldwide. Due to its excellent strategic location, ZAL has benefits for distribution by sea, between Europe and the Far East; between Europe, America and West Africa, and between the Mediterranean Region and North Africa [30].

The city of Barcelona is surrounded by the largest European cities, being a strategic location for a Logistics Distribution Center by highway to all of southern Europe. ZAL has a project to improve the quality of life guaranteeing people respect, inspection, security and customs costs. With this project, it carries out its logistics flow with agility, speed and reliability, obtaining low costs [31].

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The port of Barcelona has in its terminals the specialization of handling almost all types of products, as well as multipurpose terminals that can carry different types of products.

There are four container terminals for international traffic, two terminals for domestic traffic, two car terminals, a fruit terminal, two specialized terminals (coffee, cocoa and metals), a terminal for refrigerated loads, nine terminals for other liquid cargoes and six terminals for solid loads [32].

ZAL offers several advantages to the companies installed in your area, enjoying speed and cost savings, aiming to reach the optimum point in intermodality. And for this intermodality, a single warehouse will be offered in ZAL with several types of connections. The Barcelona rail system offers an extensive and efficient rail connection to national and international destinations. This connection is achieved through the combination of public and private railway operators, ensuring the integration of rail services.

The road system offers overland connections with the European road network, connecting points between the Iberian Peninsula and the rest of Europe.

The duct system installed in the Port of Barcelona has more than 250 regular connections, simultaneously connecting more than 400 ports worldwide. It is offered international ship driver, inspection, security, customs and transitional costs included whenever necessary, speed and agility, obtaining low traffic costs [33].

While the Barcelona air system offers a total of 25 air connections in Europe and 28 intercontinental flights. It is offered by brokers, high quality services and competitive costs.

In 1997, the Port Authority of Barcelona (PAB) updated the Port Master Plan of ZAL. This plan has been guiding the development of the port in recent years. This updating was necessary due to traffic growth and modernization of the port infrastructure. The PAB is updating the Master Plan in order to seek new financing up to 2011, as well as the limitations in its execution. The plan foresees the participation of the private sector in the financing of the infrastructure necessary for the modernization of Oporto. Meanwhile, the PAB has been working with the European Union Cohesion fund to make the funding feasible in order to reduce the differences between the social and economic aspects of the territories and the citizens that are part of that region.

2.3 STUDY STEP 3: LE HAVRE INTERMODAL LOGISTICS PLATFORM, IN FRANCE

The Port of Le Havre is located on the banks of the English Channel, at the mouth of the River Seine, where it connects to the largest consumer market in the country, the Paris Metropolitan Region, the complex presents one of the continent's most intense ship traffic. Last year alone, 7,459 vessels climbed at their terminals, with an average of more than 20 freighters arriving each day [35].

The port of Le Havre handled approximately 80 million tons per year, with 2.11 million TEUs (unit equivalent to a 20-foot container) in 2005, noting that this move classifies the Port of Le Havre with the largest port in France . The port of Le Havre is also considered the fifth largest port in Northern Europe, where a quarter of the world's maritime trade passes. As far as exports are concerned, the port of Le Havre is the first port to be reached by ships when they arrive in Europe from North America or the Far East [36].

Given this scenario and container handling that has grown at an average of 8% to 10% a year, the French government and the port authority of Havre have signed a program to re-equip their ship repair facilities, replacing old cranes with new equipment . According to the port administration, with the increase in cargo volume, maritime traffic and cargo repair requests increased, business opportunities increased among the region's businessmen.

The port of Le Havre has 10 mooring points to carry out the most varied types of services, heavy reforms and "jumborizations" (the physical expansion of the vessel to increase its transport capacity), to underwater works and installations of electronic equipment . All the infrastructure is public, being used only by companies for the works [35].

The terminals of the port of Le Havre are grouped in two areas of the complex, both near the exit of the port. The Eure pier has three "dry docks", capable of receiving ships of up to 18,000 gross tons, and four repair berths for vessels up to 150 meters long.

In the dry dock, the ship enters a narrow channel with gates, until it is positioned on a base. At this point, the floodgates close and all water is pumped out, allowing jobs - such as hull or "jumborization" - to be done "in the dry". In the repair cradle, the vessel remains floating in the water [37].

The advantages of the geographical location of the port of Le Havre allow logistics operators to set up Distribution Centers for Western Europe. The port favors cabotage and transhipment operations for ports that are not on the main transoceanic regular shipping lines. The

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port also makes it easier to reach remote regions more quickly, an effective alternative to northern European ports. The port of Le Havre serves as an advantageous hub for Great Britain and the Iberian Peninsula, Central Europe (Switzerland and Hungary) and Southern Europe (Italy and the Iberian Peninsula). Thus, the port of Le Havre has as its policy the massification of traffic and is concerned with the implementation of effective solutions for intermodal connections, in order to speed up pre-shipment and post-shipment of goods [38].

The pipeline system holds about 40% of French oil-related imports through the Le Havre port terminals, accounting for a total of 37 million tonnes. This oil is carried by refinery pipelines located in the Seine valley. The port of Le Havre has two distinct locations, which can accommodate all the ships that bring in the port, as well as two giant tanks that serve as a storage area [39].

The road system connects directly the port of Le Havre with the A13 and A14 motorways to the Paris region. The road system efficiently serves cargo movements from the Port of Le Havre to various regions of France and to some of the ports considered as competitors in northern Europe that are often saturated.

In 2004, the rail system handled about 5% more of the container movement in previous years, excluding transhipment traffic, rail traffic decreased by 8%, with 127,400 TEUs, representing 8.8% of freight port. The company Le Havre Shuttles - LHS created in 1998, is the main responsible for the consolidation of rail freight, besides offering services dedicated to the agents of load and shipowners.

The airport system is serviced by Le Havre-Octeville airport which is situated 5 km northeast of the city of Havre in the community of Octeville. The airport serves Havre's commerce and industry as well as being a major hub for Lyon airport, facilitating freight flights from France to Europe [40].

France's main port, Le Havre, has entered into an agreement with the federal government to modernize its ship repair facilities. The measure is part of a public investment program in the complex that exceeds 360 million euros (the exchange used 1 Euro = R $ 2.42238, about R $ 872.05 million - 08/04/2008 - BANCO CENTRAL DO BRASIL), aims to prepare the region to meet the demands of the growing foreign trade and consolidate it as one of the main cargo handling platforms in Europe [41].

Figure 1 shows the geographical location of the three selected ports on the European continent. The port Le Havre is located on the banks of the English Channel, at the mouth of the Seine, is the first port to be reached by ships when they arrive in Europe from North America or the Far East. On the other hand, the port of Barcelona - ZAL has its privileged location, that is, it serves mainly the connections via the Mediterranean Sea. Finally, the port of Rotterdam is considered to be the most important port complex in Europe, responsible for most cargo movements in the European community.

Fig.1 - Location Map of Logistics Platforms in Europe.
Source: Google Maps, adapted by the authors, (2019).

2.4 STUDY STEP 4: IN THE UNITED STATES OF AMERICA

2.4.1 LONG BEACH INTERMODAL LOGISTICAL PLATFORM

The port of Long Beach was founded on June 24, 1911. After approximately 11 decades the port has undergone several expansions, creation of new cargo terminals, road connections among other important works carried out in the port. Today, the port of Long Beach is considered one of the most important ports in the US and the world [36].

In 1911 the State of California granted areas for expansion of the port of Long Beach to port operations. The ceded areas were lands along the coast of the Pacific Ocean lined up a distance of three miles. This type of concession ends up restricting the revenues generated through the businesses and the activities conducted by them. In 1916 the Los Angeles dock became a port project for the city of Long Beach. In 1917, the first port authority was created, aimed at supervising port operations.

In Long Beach the port infrastructure generates approximately 30,000 jobs, with the following ratio being

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one job for every eight jobs generated in the city of Long Beach. Approximately R$ 2.96 billion (the exchange used 1US $ = R$ 1.5620 - 04/08/2008 - BANCO CENTRAL DO BRASIL) is spent annually on port services.

Los Angeles County retailers spend approximately R$ 6.40 billion a year, selling durable goods and other imported products through marketing via port. In the region of the five counties (Los Angeles, Orange, Ventura, San Bernardino and Riverside counties), the port generates approximately 315,000 jobs, one job out of 29 jobs generated in the five boroughs. Some R$ 22.33 billion are spent to pay the salaries of employees involved in port operations, which accounts for approximately 4% of all salaries paid in the five counties. [33]

In California port activities generate approximately 371,000 jobs. Port operations generate approximately R$ 8.74 billion of tax payments. In the United States port operations generate approximately 1.4 million jobs. Approximately R$ 6.24 billion are spent on port-industry services. Exports of manufactured goods in the United States generate approximately R$ 28.11 billion per year. With the internal physical distribution in the United States is spent about R$ 49.98 billion per year. The retail market in the country spends approximately R$ 39.05 billion annually with sales in the American domestic market [42].

Rail accesses to the Los Angeles and Long Beach complex, responsible for most cargo transportation between the port area and the region served by the terminals, will also receive investments in the coming years. Strategic projects of more than R$ 893.49 million are planned, as well as changes in train operations.

Changes are also being negotiated in the operations of Alameda Corredor, the express rail link that connects the region of the Los Angeles terminals to the center of the city. The port authority is calling for daily departures from the wharf to Colton, a city located in the vicinity of Los Angeles that houses several warehouses and distribution centers. With the service, the agency estimates the elimination of 2 million truck trips per year [43].

Alameda Corridor was the main logistics project of the region in the last decade, representing an investment of R$ 3.74 billion. R$ 1.71 billion came from the railway operators and R$ 2.03 billion from the port authorities of the complex.

Long Beach also has projects, although much more modest, when compared to those of its port-brother Los Angeles, for the improvement of rail transport. According to its administration, the construction of a railway branch is being negotiated in the Matson Terminal, of SSA Marine, installed in the internal area of the port (the Inner Harbor) [44].

2.4.2 LOS ANGELES INTERMODAL LOGISTIC PLATFORM

The Port of Los Angeles, Southern California is situated in St. Peter's Bay just 20 miles south of Los Angeles. This port has been growing and sustaining not only its area with port operations, but also with revolutionary environmental initiatives, security measures and social programs. The port is operated and controlled by the state Tideland that encourages the marketing, navigation and fishing in the municipalities [44].

The port is not supported by taxes, but rather by revenues derived from the rates of transport services, such as: port charges, accommodation, storage, rental of properties and other port services. The port covers 7,500 acres, has about 27 cargo terminals including infrastructure for dry and liquid cargoes, containers, bulk and automobiles. The port contributes directly and indirectly to the tens of billions of dollars handled by industrial segments. Together these terminals move more than 162 million tons per year, in addition to moving annually around 7.3 million UEOs, establishing a national record of container handling.

Its port administration is composed of five members who are: President, Vice President and Directors, appointed by the Mayor and confirmed by the City Council of Los Angeles [45].

The basic concept of intermodality has been evolving much in the port of Los Angeles, the great example is the movement of marine cargo containers today that are being made by several different modes of transportation: road, rail and maritime. Today, modern trains represent an essential link in the transportation and delivery of transcontinental container freight. The railway structure includes wagons specially designed to load the containers one on top of the other (doublestack).

With capacity to operate 150 trips per day (carrying 36 million TEUs per year), the railway has three lines. It began to be built in April 1997 and went into operation five years later in April 2002. Its service was able to speed up train travel between the dock and downtown Los Angeles, which took about two hours and is now done in just 40 minutes. As there are no crossings and they do not pass through urban areas, the trains do not need to maintain speeds at 16 km/h, and can accelerate up to 65 km / h.

In 2005, the Port Authority of Los Angeles adopted a green port policy that sought to position the port as a leader in the environmental area. In June 2006, the ports of Long Beach and Los Angeles jointly

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introduced the "clean air" action plan at the San Pedro Bay port, a project aimed at reducing health risks caused by air pollution from ships, trains, trucks, among others. The port has been investing around R $ 265.86 million in the last five years.

Rail accesses to the Los Angeles and Long Beach complex, responsible for most cargo transportation between the port area and the region served by the terminals, will also receive investments in the coming years. Strategic projects of more than R$ 893.49 million are planned, as well as changes in train operations.

At the port of Los Angeles, one of the first measures to be taken will be the construction of an extension at the Transpacific Container Service Corporation (Trapac) terminal, which occupies the 135 to 139 berths in the inner harbor. The executive plan and the environmental impact studies of the enterprise, valued at R$ 39.05 million [45].

2.4.3 INTERMODAL LOGISTIC PLATFORM OF NEW YORK

The Port of New York and New Jersey (NY & NJ) has about seven cargo terminals, each terminal offering customized transportation services with a highly productive infrastructure. It is included in the New York / New Jersey Port Area: Newark / Elizabeth Port Authority Marine Terminal Complex, Port Authority Industrial Park in Elizabeth, Global Maritime Terminal and Greenville Industrial Park, both in the city of New Jersey, occupying a 23-acre site on Route 169 on Pulaski Street in Bayonne, an additional 40 acres at Newark International Airport covering the fuel storage and distribution system, and a 407-acre industrial area in Kearny South [46].

The Port Authority of New York and New Jersey is able to handle any type of cargo: bulk, liquid and dry. There are about 54 cranes in the port complex ready to move all types of cargo.

Within the New York / New Jersey region, there is a selection of logistics operators with freight expertise. The port is the ideal location for operators specializing in export, which can help with planning and other logistics needs the operations performed at the terminals. These terminals are poised to serve approximately 18 million consumers in the New York / New Jersey metropolitan area, emerging markets of the Midwest, England, eastern Canada.

The New York / New Jersey port has infrastructure to handle 20- and 40-foot containers. The Port of New York / New Jersey annually moves about 12.2% of the containers in the United States. It was in Newark in 1956 that the New York / New Jersey Port Authority built the world's first container terminal [47].

The Port of New York / New Jersey has a mobile identification program called MAR LINK that streamlines the loading process. The companies associated with this port have access to the MAR LINK mobile identification system, which works on road intermodality, the system helps to control the speed of trucks through the maritime terminals, thus allowing trucks to move thousands of containers per day to the domestic markets . With a unique ID card, the truck has access to the entire NY & NJ maritime terminal, where drivers can quickly access their cargo computerized automatically through the terminal system installed in the truck itself.

To help move cargo quickly through the terminals, the port authority is improving cargo movement through the docks through the Express Rail system. The idea is to create a fully integrated intermodal transport system that will provide important terminal operators with facilities that will facilitate and connect to a nationwide system. Three intermodal river lanes have transferred their infrastructure and the necessary support for Express Rail, aiming to save time by transferring cargo from the ship to the train, thus serving a greater variety of destinations, as well as providing reliability in loading loading times.

The first phase of the new Elizabeth Express Rail Terminal is currently operating at Elizabeth Port Authorith Terminal, adjacent to the Maher and APM terminals, these 70 acres will replace the original 32 acres of the rail network. The aerial rails were deployed, greatly improving the flow on the roads. Two more ferrous paths are programmed to contribute to the flow of loads. When all phases of this venture are complete, the port capacity will increase by almost five times the current capacity. Ultimately, the new Elizabeth Express Rail will be able to handle about one million containers annually [48].

The port authority has already invested about R$ 3.12 billion in port infrastructure to maintain competitive advantage, progress continues to accelerate with the completion of the Express Rail system. International cargo volumes at the port of New York and New Jersey in 2006 are at record levels. During a conference held at the Newark port system, New Jersey's president and secretary of commerce and the port director discussed the port's 2006 statistical results and future investments in the port system.

Container cargo volumes in the New York / New Jersey port increased by nearly 8% in 2006, coupled with continued growth in trade with the Far East, Northern Europe and Southeast Asia. It is estimated that the movement of cargo in the year 2006 in the port, exceeded the R$ 232.74 billion for the first time, giving a growth of 13% in relation to 2005. The number of containers loaded

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and empty (unit equivalent to 20 feet) exceeded the mark of 5 million [47].

Figure 2 shows the geographical location of the three ports chosen in the American continent. The Long Beach Port is considered one of the most important ports of the US West Coast and the world. Already the port of Los Angeles is located in San Pedro Bay approximately 36 km south of the city of Los Angeles, also on the west coast. In closing, the New York / Jersey port is considered to be the most important port complex on the US East Coast, this location facilitates business transactions between the United States and Europe.

Fig.2 - Location Map of Logistics Platforms in the United States.
Source: Google Maps, adapted by the authors, (2019).

2.5 STUDY STEP 5: HONG KONG INTERMODAL LOGISTICAL PLATFORM, IN CHINA

The port of Hong Kong, located in the South China Sea, serves predominantly the trade of manufactured goods, raw materials and passenger terminals. The port is considered a key factor in Hong Kong's economic development, the deep waters of Victoria harbor provide ideal infrastructure conditions for operation of any type of vessel. The port of Hong Kong is considered to be one of the world's largest cargo handling ports [49].

In 1966, the port authority decided to build a complex of container terminals at Kwai Chung in Hong Kong. Construction of the first three terminals began in 1970. In 1974, the fourth terminal, known as Hong Kong International Terminals, was built.

After the implementation of the containerization process, the arrival and departure of empty containers considerably reduced, as it was possible to develop a new system of loading and unloading the containers. This was only possible by the increase in information technology and the new container management systems adopted at Kwai Chung terminals, increasing the productivity of port operations.

With China's political and economic opening, the Hong Kong port increased the container movement, strengthening Chinese economic growth by building terminals 4, 6, 7 and 8, increasing cargo productivity at Kwai Chung terminals. In 1987, Hong Kong became the leading container handling company in the world.

The port is considered the key factor in Hong Kong's prosperity and economic growth, accounting for about 80% of China's total cargo processing. Container terminals are vital not only to Hong Kong, but also to South China, considered one of the largest industrial areas in the world. The Hong Kong port is also considered a key element in the globalization chain process, as it currently serves 80 international lines to more than 500 destinations around the world.

MTL is the oldest container operator in Hong Kong, started its services in 1972, the first ship to dock in one of the berths of terminal 1 was the ship Tokyo Bay. MTL currently operates terminals 1, 2, 5 and northern part of Terminal 9. In 1999 it reached the mark of 2.6 million TEUs, and continues to grow industrial cargoes. It

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invests heavily in infrastructure for both long-haul freight and cargo in cabotage. With a futuristic vision it is already investing in infrastructure to serve larger containers, which are already being built in order to increase cargo capacity [50].

The port of Hong Kong has long assumed the role of a gateway to southern China, as well as serving as an intermodal transportation platform providing connectivity in the Chinese mainland's distribution chain.

Container terminals in Hong Kong compete with each other for efficiency and reliability. For years, the operators of these terminals have been investing continuously in technology, dedicating significant resources, aiming at the continuous improvement of the productivity of the terminals. The performance of the container terminals becomes a differential factor along the logistics network serving South China and the Pierl River Delta, improving the flow of information to its main customers.

Adding the capacity of container terminal 9, the total container capacity at the Kwai Chung port becomes approximately 24 million UEOs, making Hong Kong port one of the largest in the world.

All container terminals were certified in July 2004 by the International Maritime Organization of Ships and Port Facility Security in terms of Port Security, (ISPS) Code. In addition to certification other safety and environmental initiatives are being implemented to maintain the position of Hong Kong Port as China's preferred port.

The Government is developing a master logistics plan for Hong Kong. The Government's intention is to transform Hong Kong into a logistics center. Recently it was established that the Hong Kong Container Terminal Operators Association (HKCTOA) the responsibility to promote the Port of Hong Kong as the most important container port in the region. The commitment of the Government and private industry to the continuous development of logistics services in the port of Hong Kong, is the main factor of the regional trade.

Container terminal operators in Hong Kong will continue to develop information technology to move forward in improving productivity, raising the level of consumer service at low costs. The use of technology via the Internet has made possible new business opportunities.

2.6 STUDY STEP 6: INTERMODAL LOGISTIC PLATFORM OF SINGAPORE, IN SINGAPORE

Singapore is a small and densely populated island city in southwest Asia, located between Malaysia and Indonesia. Singapore's economy is a market economy based on financial and industrial capitalism. As with the other Asian tigers, the main export products are state-of-the-art electronic machines and equipment. It is an extremely small country, with no natural resources and no space for agriculture, but with a growing economy, especially as it is an export platform - a model of development that has placed Singapore at the level of emerging countries [51].

Singapore has excellent port infrastructure and strategic position at the crossroads of major shipping lines, which gives it a reputation as a global hub. The port of Singapore City is one of the busiest in the world, and is also located at a strategic point in the Pacific Ocean, just off the Malacca Strait, allowing for massive entry and exit of products - this is necessary to keep the country functioning, since even food and energy need to be imported.

Singapore uses its port as a point where freighter ships unload their goods for redistribution by other ships in Southeast Asia and also carry goods from Southeast Asia to be taken to the rest of the world. In addition, the port provides a wide range of services, such as cargo handling, warehousing, distribution, shelter and ship supplies. PSA Corporation Ltd. (formerly known as the Port of Singapore Authority - PSA) is responsible for the efficiency of port services and facilities.

There are currently 4 terminals: Tanjong Pagar, Keppel, Brani and Pasir Panjang, which are home to all types of vessels. The four terminals serve 200 transport lines that provide connections to 600 ports in 123 countries. This includes daily departures to all major ports in the world.

The port of Singapore operates the largest container terminal in the world. The modern and sophisticated characteristics of the port make it possible to maintain its position of the busiest port in the world, according to its tonnage of boarding. It has specific facilities at the terminals to accommodate all types of vessels, including tank super-vessels, container ships and freighters. It is also famous for its fast connection and customs clearing facilities.

Singapore is the world's largest re-port port and is the third largest oil refining center after Rotterdam and Houston. With excellent communication facilities and geographical position, Singapore is a major center for the distribution and transfer of goods to the Asia-Pacific region.

The modern and sophisticated port facilities enable Singapore to maintain its position as the busiest port in the world, according to its tonnage of boarding. The cargo handled by sea is 179,571,000 tonnes of entry into

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Singapore and 134,592,000 tonnes of output. Container processing capacity was 23.19 million UEOs (standard 20-foot container units) in 2005.

The commercial structure is dominated by the private sector, with the state exercising regulatory and control functions. Regulatory controls exist in the form of restricted import / export licenses, as already mentioned. Guidelines and incentives are used to promote certain branches of business, such as the provision of storage space to promote Singapore as a relocation / transhipment center.

In general, there is no fixed commercial structure in Singapore, because of its size. There are about 30,000 establishments in the wholesale trade and 20,000 in the retail trade, including supermarkets, department stores and pharmacies. The average operating income of wholesalers is R$ 15.62 million and that of retailers is R$ 1.56 million.

In the port of Singapore, an average of 100 containers per hour are handled at a cost of R$ 109.34 each. In the port of Santos, for example, the handling is only forty containers per hour, with an average unit cost of R$ 390.51. And the number of employees is eleven times higher than in the port of Singapore.

There are six Free Trade Zones (FTZs) - five for maritime cargo, administered by the Maritime and Port Authority of Singapore, and one for air cargo at the Singapore Changi Airport operated by the Civil Aviation Authority of Singapore ". Such zones provide a wide range of facilities and services for the storage and re-export of taxable and controlled products. The products do not pass through the customs of the country, unless they leave the free trade zone and enter national territory.

To meet the demands demanded in the global market, Singapore's port authority constantly innovates in automating and using intelligence to enhance its operations, (CITOS), they are already building a new container terminal to serve their users.

The maritime port authority is reviewing the port's maritime plan for improvements in port security and efficiency through the four main categories, namely: transport, port operations, management and customer services.

2.7 STUDY STEP 7: TOKYO INTERMODAL LOGISTIC PLATFORM IN JAPAN

The Tokyo terminal was established by the Metropolitan Government of Tokyo in January 1972, mainly to meet the shipments of vehicles, replacing the port of Balsa (Barcaças) in Tokyo. In March 1982 the corporation assumed responsibility for the Keihin Foreign Trade Terminal Corporation. In April, 1988, he took command of all activities of the Port of Tokyo Service Corporation, which had been established in December 1980.

The port of Tokyo is responsible for the loading and unloading of all the products of the metropolitan area (industrial activities) of Tokyo, including developing programs that favor the quality of life of its inhabitants. The Tokyo terminal handles a variety of goods such as: foodstuffs, dry cargoes, liquids, bulk, among others. The main objectives of the port are: to improve the quality of life of local people, to encourage the development of the regional economy and to contribute to the growth of international trade [52].

In the Toyosu-Harumi complex there is still idle space, even considering the growth of the infrastructure facilities of the port of Tokyo. Aware of this potential, the Tokyo Metropolitan Government is planning the formation of a dynamic urban complex aimed at promoting efforts to transform the area in question for the following industrial, commercial and residential uses, improving the quality of life of its inhabitants. The main objectives of this project are:

• Creation of an urban community that brings the workplace to well-being;
• Formation of harmonizing elements of an urban complex, commercial, residential, among others;
• Creation of a favorable environment for effective cultural exchanges between the various segments of the port complex.

The OI container terminal, which is considered the number one port in Tokyo, is equipped with all the most modern port facilities, can accommodate about eight large container ships, uses in its logistics operations about 18 cranes to streamline the loading and unloading of loads. The OI terminal is one of the most important connections from Tokyo to the world, with priority being given to traffic to North America, Europe, the Mediterranean, Oceania, Southeast Asia and other parts of the world.

The port complex of AOMI is the newest container terminal in the port of Tokyo, has five cabins and eleven container operations cranes along its length of 1,570m. The container terminal of AOMI is a large-scale terminal to operate about 50,000 tons. The cargo distribution center of AOMI is situated in the southern part of the port of Tokyo, it offers handling, storage and transport services for cargoes via containers.

The ODAIBA Port Complex is a terminal that serves the international trade with a 1,800m pier capable of facilitating cargo handling activities. The terminal, basically deals with the steel trade, beneficiated wood, paper, fruit pulps, among other loads.

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Tokyo's barge complex is a terminal that operates ferries that transport vehicles linking the Tokyo metropolitan area with the locations of Hokkaido, Shikoku, Kyushu and other destinations, there are already four routes currently in use in Kushiro (through the port of Tocachi), Tomakomai (through Oarai), Kochi (through Nachi-Katsuura port) and Shinmoji (through the port of Tokushima). The terminal has an important role in the national economy, promoting energy conservation and great efficiency in the domestic logistics distribution network.

The SHINAGARA container terminal was the first to be built in Japan, unlike the OI terminal, this public container terminal is directly connected to the Tokyo Metropolitan Government.The expansion plan for the port of Tokyo provides for an enhanced study to strengthen domestic terminals, international container and cabotage terminals and other port facilities in relation to resistance to successive earthquakes in Japan, in order to ensure that operations logistic projects carried out in the Tokyo complex have the least impact on earthquakes that may still occur, hampering the continuity of supply and distribution of economic activities related to the port of Tokyo, taking into account the damages of the last earthquake that struck the Hanshin-Awaji complex .

Figure 3 shows the geographical location of the three ports chosen on the Asian continent. The port of Hong Kong is located in the South China Sea, considered one of the world's largest cargo handling ports. Singapore's port is now the largest container port in the world, as well as its strategic position at the intersection of major shipping lines. Finally, the port of Tokyo is Japan's main port complex, contributing to the development of the regional economy and contributing to the growth of international trade.

Fig.3 - Location Map of Logistics Platforms in Asia.
Source: Google Maps, adapted by the authors, (2019).

III. ANALYSIS OF RESULTS

The comparative analysis of the Intermodal Logistic Platforms (ILPs) shows that the great majority of logistics platforms in the world are born due to the existing ports, many of them with a few centuries of existence, that is, the territorial expansions facing the continent or towards the ocean, are made feasible with ports as the center of expansion. Logistics platforms have common characteristics, such as: they are administered by the port authorities; usually the physical space used by the platform was donated by the state; the main cargoes are: chemical, mineral, liquid, dry, bulk, neo-bulk, refrigerated, foodstuff, among others; platforms have more than five terminals operating; the movements of the

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containers are automated; the Hong Kong and Singapore platforms serve sixth generation ships, ie the largest ships in the world; offer administrative services, customs, life support, offer maintenance contracts for water vehicles; operate the intermodality of transport (rail, road, air and pipeline); offer door-to-door services, operate the largest refining terminals in the world; have programs of safety, environment and occupational health; have distribution centers on the platform; all platforms function as hubs, that is, as consolidation centers; facilitate cabotage operations; are poles that generate employment and income; its port operations are among the largest in the world in general cargo and container handling and finally have expansion plans.

In the research carried out, once again we did not find a systematic procedure for the implementation of logistics platforms around the world. However, it is clear that Europe presents two non-systematized procedures based on the French and Spanish experiences.

It is important to note that most of the logistics platforms deployed in the world are connected to seaports, not excluding the possibility of PL deployment in inland or inland ports.

Considering the conceptual and theoretical review carried out and the practices available in this chapter, it is observed the need for a systematized methodology the activities required to elaborate a procedure for the design of a model. Table 3 presents in Appendix A a summary of the main aspects such as: types of infrastructure, intermodality systems and expansion plans. The choice of these main aspects is based on the Regional Logistics Platform studies.

Other aspects could be considered, but are considered secondary, such as: space productivity, traffic limitation of vehicles, economic performance, size and classification. The types of infrastructure mainly characterize the main terminals of dry and liquid loads. The intermodality system reinforces the integration of transport modes, increasing the synergy required for the movement of cargo in these logistics platforms. Finally, it is observed that all logistics platforms have expansion plans, reinforced by actors involved in the implementation of short, medium and long-term planning.

IV. CONCLUSION

As answers used in Appendix A between comparisons, this article deals with the relevance of the ILPs in the world for movements in the three most important continents, represented by Le Havre (France), Rotterdam (Netherlands) and ZAL (Spain) in the United States of America. America: represented by Long Beach, Los Angeles and New York / Jersey and Asia represented by Hong Kong (China), Singapore (Singapore) and Tokyo (Japan), ie representatives of the American, European and Asian continents. The objectives were scaled up, because assessing the LPs' choice criteria in the world is linked to sea ports, because of their importance in the global commercial relations where they were the infrastructural analyzes of the ILPs: from in cargo volumes in several continents showing the approaches of the main characteristics of interest, emphasizing the types of infrastructure, the ILP systems and their LPs expansion plans located in Rotterdam (Holland), ZAL (Spain), Le Havre (France), Hong Kong (China), Singapore (Singapore) and Tokyo (Japan), Los Angeles, Long Beach and New York / Jersey (United States). The data collection and analysis allowed to realize the importance of these ILPs for the movement of cargoes to various parts of the world. The comparative results showed the importance in the economic strategies of these ILPs such as: types of infrastructure, intermodality systems and expansion plans, space productivity, traffic limitation of vehicles, economic performance, size and classification. The types of infrastructure mainly characterize the main terminals of dry and liquid loads. The system of intermodalities reinforces the integration of transport modes, increasing the synergy required to move loads in these ILPs.

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APÊNDICE A

Table 3 - Comparative aspects between Logistics Platforms in the world.

Aspects of Research Interest	**Logistics Platforms in the World**								
	Rotterdam	ZAL	Le Havre	Long Beach	Los Angeles	New York	Hong Kong	Singapore	Tokyo
Types of infrastructure	Liquid cargo terminals (chemical and petroleum), dry loads, commodities, containers, and foodstuffs. The port handled around 9.28 million TEUs in 2005.	Container terminals, domestic traffic, automobiles, fruits, coffee, cocoa and metals, refrigerated, liquid cargoes, dry cargo. The port handled about 2.07 million TEUs in 2005.	Liquid cargo terminals, dry loads, containers, Ro-Ro, general cargo, passengers and ship maintenance. The port provides an entire infrastructure for repairing ships. The port handled around 2.11 million TEUs in 2005.	Dry load terminals, liquid loads, containers and general cargo. It moved approximately 80 million tons of cargo. The port handled around 6.71 million TEUs in 2005.	Dry load terminals, liquid loads, containers and distributor warehouses. The port handled around 7.48 TEUs in 2005.	Terminals for dry loads, liquids, containers, breakbulk cars and storage systems. The port handled around 4.78 TEUs in 2005.	Terminals are: Hong Kong International Terminals (HIT), COSCO-HIT terminals (CHT), DP WORD, Modern Terminals LtdaAsia Conteineres Terminals (ACT). The port handled around 22.42 million TEUs in 2005.	Terminals for super vessels tanks, container carriers and freighters. The main terminals are: Tanjong Pagar, Keppel, Pasir Panjang and Brani. It is considered the third refining center in the world. The port handled some 23.19 million TEUs in 2005.	General cargo terminals, trade, exterior, barges, liquids. The main terminals are: OI, AOMI, ODAIBA, SHINAGARA, HARUMI, ARIAKE and TAKESHIBA. The port handled around 3.59 million TEUs in 2005.

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Intermodality Systems	The port offers a variety of intermodal transport (Door-to-door), as well as pre-transport and post-transport services. It is composed of the modalities of air, rail, road and rail.	The road and rail link connect Penisula Ibérica to the rest of Europe. The pipeline system has more than 250 regular connections. The airway system offers a total of 25 air connections in Europe and 28 intercon-tinental connections.	The port facilitates cabotage and transhipment operations for ports not on the main transoceanic lines. Works as a hub for part of Europe. It offers transport by road, rail and road.	The port offers the following transport modalities: road, railway, pipeline and air. The Alameda Corridor railroad is its main route of freight flow.	The port offers the following transport modalities: road, railway, pipeline and air. The intermodal railway traffic network was planned and designed with the concern of improving Alameda Corridor.	The port has a mobile identification program called MAR LINK that streamlines the road charging process. Regarding the rail mode, it uses the EXPRESS RAIL to move its terminal loads.	The port operates mid-stream systems to load and unload ships and barges at sea. It offers the following modalities of transport: road, railway, pipeline and air. It also offers the ferry service from Hong Kong to Macau.	The port offers the following modalities of transport: road, railway, pipeline and airport. It has six Free Zones, five for maritime cargo (MPAS) and one for air cargo (SCA).	The port offers the following modalities of transport: road, railway, pipeline and airport. The intermodality is ensured by the main expressway (highways) and rail networks connected to the port.
Expansion Plans	The strategic plan of 2020 aims to meet the future expansion of the port.	The Port Master Plan of ZAL is responsible for future expansions.	The PORT 2000 is responsible for the future expansion plan.	The main project of the expansion plan of the port is the construction of the Alameda Corredor underground canal.	The main development planned at the port is the construction of the new backyard patio of Southem California International Gateway.	The main port expansion project is the completion of EXPRESS RAIL.	The Chinese government is implementing a logistics plan for Hong Kong to consolidate the port as the largest in the world.	The main port expansion project is the automation and use of intelligence to streamline port operations.	The expansion plan for the port of Tokyo meets the following objectives: harmonizing elements and cultural exchanges between the people that circulate in the port.

Source: Authors, (2019).

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Comparative Examples of Intermodal Logistic Platforms (ILP) in the Brazil

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Abstract— *The need to show the evidences of the eight Logistics Platforms (LPs) in study and implantation in the different regions of Brazil. a summary of each platform, starting with the two logistics platform located in the Midwest (Goias and Palmas), two in the State of Bahia (Juazeiro and Feira de Santana), two in the state of Rio Grande do Sul will be presented (Guaiba and a municipality to be chosen), one in Paraná, one in São Paulo and other platforms (dry ports and Customs stations Interior) scattered in other states. It will be approached aspects of interest of the research, such as geographical location, types of infrastructure, classification of the Platform (Unimodal or Multimodal), the phases of implantation or study of the Brazilian platforms. The objective is to make a comparative between the different regions where the LPs where they are implemented. Data analyzes the relationship between transport infrastructure and regional development, notably through the implementation of a LPs network located in specific parts of the country able to spread the impact of economic growth in areas lacking adequate transportation infrastructure for your productive potential. The study methodology has as theoretical framework the recognition that the implementation of a transport infrastructure is a necessary component to promote development, but it is not enough to promote development. The results from the analysis of the theories of regional development and programs implemented in Brazil for this purpose, it was found that dropout programs to supply the lack of transport infrastructure has resulted in large gaps that constitute barriers to national development in order to reduce this gap network deployment of logistics platforms from the Integration and development Hubs is presented as a tool to induce development and reduce inter-regional inequalities in Brazil in the three regions mentioned.*

Keywords— ***Intermodal Logistics Platforms (PLIs), Multimodal Logistics, Internal Customs Stations, Integrated Logistics Center (CLI).***

I. INTRODUCTION

The importance of transportation infrastructures as one of the variables necessary to promote economic development is unquestionable, thus, Logistics Platforms (LPs) are of primary importance for Brazil [1] [2]. It can be argued whether these infrastructures are the starting point for the development of all the regions of the depressed country or if the need for their implantation derives from the endogenous development of a region that, through the natural expansion of its production, seeks to connect to other regions, creating a system in which, the greater its production, the greater the need to expand its network of economic relationships that, to be executed, depends on the transportation of goods and people, since the economic interrelations bring in his body the social interrelations [3] [4].

In Brazil, this option of structural and conceptual development is in the initial phase. It is noticeable that companies in the textile, furniture and footwear industries, for example, need to increase their flexibility as a way of facing Chinese competition in a field other than price. The idea of LPs developed in Europe since the 1990s is still stagnant in Brazil [5] [6].

As for the structural development, it is necessary to develop the concept of LP first, so as to allow the prioritization of actions, such as regional development policies and the recovery of the transport structure by the government sector, necessary for the successful implementation of LPs [5] [7].

The LPs, according to [8], are a delimited area within which all activities related to transport, logistics and distribution of goods are carried out by different operators, both for national transit and for International. These operators can be owners, tenants of buildings, equipment, facilities (warehouses, storage areas and workshops) that are built.

The operation of a Logistics Platform (LP) should be coordinated by a single entity, aiming at maintaining the harmony and the working conditions that provide the advantages described in this work. The area related to LP,

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shown in figure 01, adapted from [8] is that which must be coordinated by the Platform administration. Suppliers and markets are the agents that directly influence the functioning of a platform [6]. Figure 1 shows an operation of a PL.

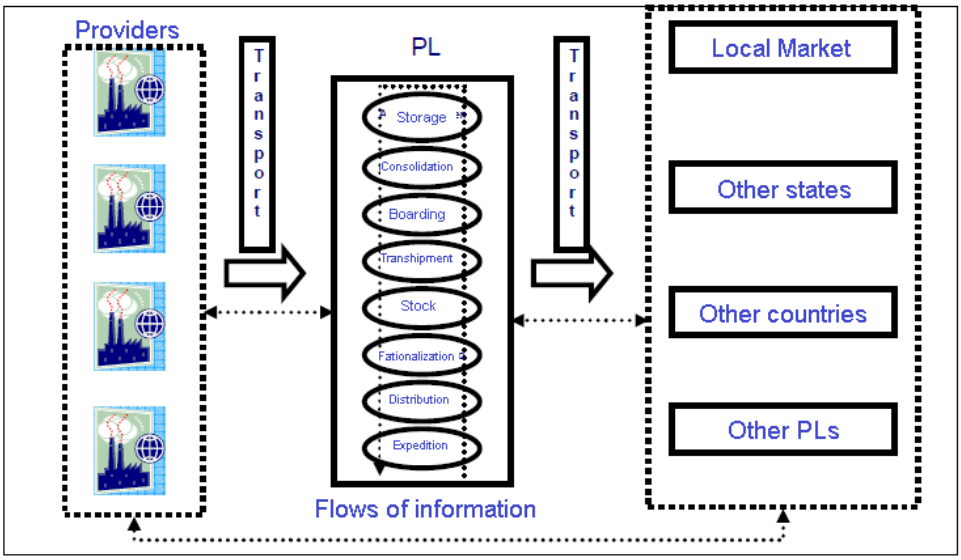

Fig.1 - Operation of a Logistics Platform.
Source: [6].

The development of a LP is not an easy task. As proposed by [10], it can be done following the 11 steps listed below: - Geographic localization, - Define supply (identify who the suppliers are, locate each category, identify the needs of the logistics network), - external and modal), Define storage, Determine the sub-zones (3 above), Define multimodal transport, Define logistics services, Define customs services, Define information system, Determine security criteria, Define distribution, Determine protection criteria environmental.

As a way to better represent the development of these platforms, it follows figure 2, developed by [9].

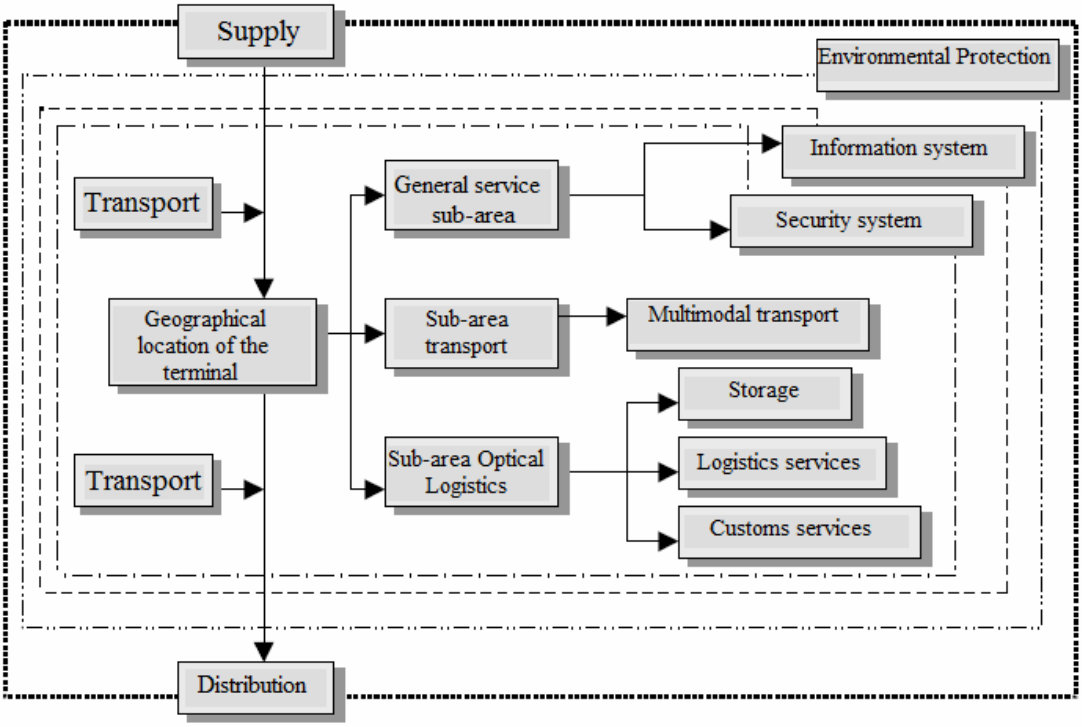

Fig.2 - Logistic Platform methodological scheme.
Source: [6].

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II. LITERATURE REVISION

2.1 GOIÁS MULTIMODAL LOGISTICAL PLATFORM

The first of these logistics intelligence centers to be implemented in Brazil is the Goiás Multimodal Logistics Platform (GMLP), an initiative of the Goian government, to be installed in Anápolis, 52 kilometers from Goiás, the geographical center of the country. It will be located at the junction of important national road and rail logistic vectors, the country's main agribusiness route and the strategic center of the South American continent (SEPLAN-Goiás, 2005).

GMLP will promote for the first time in Brazil the concept of logistics intelligence center, combining multimodality, telematics and freight optimization. By means of efficient access to the axes of road, rail and airport transportation, it will allow integration with the main logistics routes in Brazil. The platform will be implemented in an area of 6,967,790 m², between the Agribusiness District of Anápolis (DAIA), the largest in the State, with 84 companies located and located in the city of Anápolis, and important axes for logistic integration, both aerial and terrestrial (road and rail). In addition to the handling of goods, storage and reception of transit staff, the platform will cover all necessary logistics subsets to reduce handling costs. In the same space, in which the air, rail and road modalities will be integrated, the Land Transport Center, the Cargo Air Terminal, the Cargo Railway Terminal and the Services and Administration Center will be in operation. All these areas will have support infrastructure (energy, telecommunications and sanitation) and it will be possible to carry out [11]:

- Storage and distribution of the cold chain;
- Customs clearance and hiring of cargo;
- Processing, processing and packaging of goods;
- Concentration of deconcentration of loads;
- Financial and telecommunications services;
- Industrial assembly of products.

The state of Goiás is the first to implement a Logistics Platform in Brazil. Through its Secretariat of State for Planning and Development - SEPLAN, it was authorized by Law no. 14,040 of December 21, 2001, to implement the Multimodal Logistics Platform Project of Anápolis, situated 52 kilometers from Goiânia, the geographical center of the country. Figure 3 shows the Multimodal Platform of Goiás.

Fig.3 - Multimodal Platform of Goiás.
Source: [12].

2.2 LOGISTIC PLATFORM OF PALMAS (TO)

Tocantins presents itself as the state of national articulation. It is in the center of the country, being, therefore, the link between all the regions. To support this claim, the government of Tocantins has invested heavily in the intermodal transportation system formed by highways, waterways and railways that, interconnected, will lead to Tocantins' production, to other states and to the international market, at more competitive prices [13].

In order to complete the intermodal transport system, which will facilitate the production flow, the state government develops, with the Ministry of Transport, a partnership for the definitive implementation of the

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Araguaia / Tocantins waterway and the North / South railroad [14].

In Palmas, the state capital, the first Multimodal Agro-Food Logistics Platform is being structured, through a Franco-Brazilian technical cooperation agreement. The project provides for the construction of a Ceasa with separately designed areas for wholesalers of large and small sizes, environmental protection zone, storage area, manufacturing industry, port, loading and unloading platform, airport terminal, support and rail terminal.

2.3 PARANÁ LOGISTIC PLATFORM

The idea of transforming the state of Paraná into a network of logistics platforms throughout its transport system, inspired by the facilities of this type existing in France [15]. A great opportunity for Brazil, which still has a needy and outdated logistics infrastructure in relation to its competitors, show that it begins to give conditions to such logistics organizations.

The Paraná platform project is divided into four distinct phases [16]:

• The logistics master plan: it will subsidize the state's economic development plan, choosing priorities in order to achieve the best efficiency and perfect interaction between economic activities. Another dimension of the plan is the customs area, fundamental for the efficiency of the import and export process. For that, the Inner Customs Stations (EADIs) were created in Curitiba, Foz de Iguaçu, Maringá and Paranaguá.

• Paraná's seaports: another part of the "Paraná Plataforma Logística" project, is to make a strategic plan to direct the expansion and expansion projects of the Paraná port system (Portos de Paranaguá and Antonina), adapting the Port Authority and integrating with the other agents (importers, exporters, dispatchers, operators and public authorities). Another point of the project is to transform Paranaguá into a third generation port, which besides adding the industrial part that characterizes a second generation port, would have the dimension of a Logistics Platform.

• The Multimodal Pole of the West: aiming to add an East-West dimension to the "Growth Acceleration Plan - PAC" of the federal government, which provides for the transposition of the Itaipu dam, the Paraná government wants to develop the Multimodal Pole, which aims to integrate waterway projects through various modes of transportation. The idea of this Pole is to expedite the crossing of the three frontiers - Argentina, Paraguay and Brazil - with the creation of a customs port with structure for general cargoes and containers, to feed the interior of Paraná, the automobile hub and the port of Paranaguá.

• The Logistics Institute: this dimension of the project has two aspects; capitalize and centralize knowledge and information to develop the logistics of the state and train and retrain the workforce for new demands of industrialization.

2.4 INTEGRATED LOGISTICS CENTERS - CLI

An Integrated Logistics Center (ILC) is an area that encompasses a number of logistics functions, operational support, industrial processing and other related functions. This concept was conceived by the State Secretary of Transport of São Paulo within the Transport Development Master Plan (TDMP) for the period from 2000/2020. This area is designed to house an intermodal road-rail terminal and a logistics platform capable of carrying out warehousing, distribution, consolidation and deconsolidation of containers, support services and bonded areas [17].

This Center was conceived as an intermodal cargo potential within the state of São Paulo, estimated at 56 million tons in 2000, with the Metropolitan Region of São Paulo (MRSP) as the hub of origin and destination. This project has finally demonstrated that the development of the railroad and the operation of this market depend, among other factors, for the implementation of a set of facilities that have been called Integrated Logistics Centers (ILC). The TDMP indicates that the ILC is a vital element for the transportation complex to meet the public and private objectives of the state of São Paulo (RMSP, 2008).

The state of São Paulo signaled investment, along with the private initiative, in the order of R $ 1 billion in the consolidation of a new export corridor, a Logistics Platform that will allow warehousing services, merchandise transfer and other types of cargo sharing, products, intermodal terminals, container and mobile transfer equipment, as well as communication facilities, workshops, hotels and whose main attraction will be the integration of the Campinas - Vale do Paraíba - Litoral Norte route [18].

2.5 DRY PORTS

Porto seco is a customs terminal of public use, located in a secondary zone of the customs territory, for the provision by third parties of the public services of movement and storage and customs clearance of goods and baggage, coming from abroad or destined under control customs office. Dry port is the name that is given, currently the old Internal Customs Stations (EADIs), created from the legal permission contained in Decree-

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Law 1455/76 and currently governed by Decree 4.543 / 02. The services developed in dry ports may be delegated to legal entities governed by private law whose main purpose is to store, store or transport goods, cumulatively or not. The delegation is carried out by means of concession or permission of public service, after the accomplishment of competition. They are installed, preferably, adjacent to the producing or consuming regions [19].

2.6 INTERIOR CUSTOMS STATIONS - EADIS

Since 1996, a project that simplifies the creation of EADIs - Interior Customs Stations has been processed in the Brazilian National Congress. EADIs have the same bureaucratic structure necessary for foreign trade and are normally concentrated in ports, airports and border posts, such as tax inspectors of the Federal Revenue, responsible for the inspection of import taxes, health surveillance inspectors and Federal Police agents.].

The location of the first 11 EADIs was made in agreement with the state governments and meeting geoeconomic criteria translated by high concentration of import and export cargoes. Thus, EADIs were defined in Santo André and Campinas (SP), Brasília (DF), Cascavel (PR), Caxias do Sul (RS), Anápolis (GO), Manaus (AM), Salvador (BA), Juiz de Fora (MG), Recife (PE) and Resende (RJ).

The EADIs located in secondary zones (far from the ports and airports), gather the services of Customs Warehouses, allowing the warehousing of the merchandise under consignment, without import guide or exchange coverage and nationalization of the merchandise. And Customs Warehousing services, where the products imported or for export are stored under any customs regime with exchange coverage. The Customs Retrofitting Terminals (CRTs), located at a distance of not less than 5 km from the primary zones, are authorized to carry out the customs control of import cargoes shipped only in containers. After the containers have been dismantled, the goods can be stored for a maximum period of 90 days until they are cleared [15].

2.7 OTHER LOGISTICAL PLATFORMS UNDER CONSTRUCTION IN BRAZIL

In Europe, where there is a great concentration of Platforms, the existing models have been analyzed and studied by several European authors, among them. In Brazil, studies and partnerships with governments of European countries are being developed for the construction of Multimodal Logistics Platforms, which will be presented below and are illustrated in figure 4 [18].

Fig.4 - Map identifying the Brazilian states with Logistics Platforms in the study or deployment phase. Source: Adapted by the authors, (2019).

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2.7.1 TERMINAL DE GUAÍBA - TERGUA (RS)

The privileged geographical location of the Multimodal Port Terminal - Tergua, in the Municipality of Guaíba, in the state of Rio Grande do Sul, near the Mercosur Industrial Center, as well as its excellent strategic locations, which allow interconnection with the waterways, railways in the interior of the State of Rio Grande do Sul, makes it possible in the short and medium term to reduce bottlenecks in the release of cargo and services from pre- and post-port activities, encouraging the attraction of private investment to the region and to facilities to support the system, since it emphasizes the optimization of the waterway as the main means of transporting goods and cargo [20].

The Tergua Project proposes a reduction of the operational costs in the movement of goods through the use of this new location logistics option. There are several factors that cause changes in the direction of a country's exports or its imports, as well as its origins and destinations, among several, high freight costs and the precariousness of highways stand out in the case of Brazil.

The Tergua Project proposes the occupation of 350 hectares for the installation of a Port Terminal (Cais) and infrastructure in the retro-port area in the Industrial District of the municipality of Guaíba / RS with an enterprise that includes modern port facilities that will allow the installation of a new Industrial Pole in the metropolitan region of Porto Alegre, contributing significantly to the development of the southern half of the State of RS. In addition to these aspects, the Tergua Project proposes a reduction in the operational and transportation costs of goods (by up to 30%), in addition to the increase in economic activity, Research & Development, increase in income and employment [20].

2.7.2 MULTIMODAL TRANSPORTATION LOGISTIC PLATFORM - JUAZEIRO (BA)

The project for the construction of the platform is being developed by the Bahia government through the Secretariats of Planning (SEPLAN-BA) and Infrastructure (SEINFRA), in partnership with the Government of Spain, through the Ministry of Industry, Tourism and Commerce, responsible for release of the donation of 300 thousand euros destined to the realization of the Feasibility Study for the Implementation of a Multimodal Logistics Platform of Transport in Juazeiro [21].

Currently, the project is in the phase of selecting the company that will prepare the feasibility study, which will serve to define the characteristics of the Logistics Platform. Depending on what is identified, a Multimodal Platform that links railways, waterways, highway and air transport can be installed - or just the conjunction of some of these modalities. This will facilitate the flow of agricultural production in the region.

The Government of Spain donation was made through the Feasibility Studies Financing Lines (FSFL), which are an instrument of commercial policy managed by the Directorate General of International Financing of the Ministry of Economy of Spain. The LFEV is divided in three modalities: Public, Private and Multilateral.

The FSFL in the public mode is a financial instrument of cooperation to finance the feasibility studies carried out by Spanish companies for projects or programs of common interest in the beneficiary countries. This modality is implemented through the donation of the feasibility study carried out by a Spanish company by the Government of Spain to the Government of the beneficiary country.

2.7.3 INTEGRATED LOGISTICS CENTER (CLI) - SANTANA FAIR (BA)

The logistics center, which will promote intermodality between ports, highways and railways, airports and waterways in cargo transportation, established to be installed by the State Transport Logistics Program (PELTBAHIA). The Integrated Logistics Center (ILC) should be installed in the city of Feira de Santana, in the state of Bahia [21].

The state of Bahia, sought the partnership of the French in the implementation of the project, aiming to absorb the experience and high technology European. For the executive, Feira de Santana is an extremely strategic point for the arrival of the logistics center. The city is close to BR-116, BR-101 and Aratu Port, he says, citing that the platform will be made in partnership between the Luís Eduardo Magalhães Foundation (FLEM) and the State Secretariat of Planning (SEPLAN), in addition to SEINFRA and the ADÉFRANCE Foundation [21].

Besides the possibility of the international agreement with France, Spain is also interested in the implementation of more logistics platforms in the interior of the state. According to Gordilho, the Spanish have Juazeiro as an area of attention, and should invest in the financing of feasibility studies (LFEV) modality, and can donate around 300 thousand euros to carry out project studies [18].

2.7.4 LOGISTIC PLATFORM IN RIO GRANDE DO SUL

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In addition to the Tergua project in the municipality of Guaíba, the government intends to build another Logistics Platform in Rio Grande do Sul; to this end, representatives of the State Transport Secretariat and the Spanish company Advanced Logistics Group (ALG) met to begin a roadmap that aims to analyze the cities and regions with the best conditions for the implementation of a Multimodal Logistics Platform. The working group sought information to compose a study that will serve as a basis for the Strategic Transportation Plan (STP). In addition to Rio Grande, the technical team also visited the port of Pelotas. Other municipalities were visited as: Uruguaiana, São Borja, Passo Fundo, Santa Maria, Caxias do Sul, Estrela, Triunfo, Novo Hamburgo, Guaíba, Canoas and Porto Alegre [22].

Funded by the Government of Spain, the plan aims to concentrate all the necessary infrastructure for the cargo movement in Rio Grande do Sul, as well as the installation of industries that will give the final finishing to the products. The working group will also meet with business entities and unions linked to the logistics sector to discuss the implementation of the Logistics Platform and its importance for the development of the State.

With the objective of planning and implementing infrastructure programs in the road sector, the Strategic Transport Plan has the objective of incorporating to Rio Grande do Sul an investment program with a perspective of actions to be adopted for the next 20 years [23].

2.8 SYNTHESIS OF LOGISTICAL PLATFORMS IN BRAZIL

Analyzing the proposal of the Goiás complex (Goiás and Anápolis), we clearly see the intention to formalize a multimodal logistics platform, where the main objectives are: implementation of the cold chain, improvement in the customs clearance process, processing, and packaging of cargo consolidation and deconsolidation, administrative, financial and telematic services. This complex demonstrates intermodality through the following modes of transportation: Anápolis airport, Centro Atlântica and Norte-Sul railroad, BR 153, BR 060, Tietê-Paraná waterway and Porto Seco Midwest S.A.

In the Bahia complex (Juazeiro and Feira de Santana), there is also the desire to formalize a multimodal platform, through the Planning and Infrastructure Departments of Bahia, as well as the State Transport Logistics Program (PELTBAHIA). This complex will formalize intermodality through the port of Aracatu, the BR 116 and 101 highways, among other intermodal connections.

While in the Rio Grande do Sul complex (Tergua and Rio Grande do Sul), there is a clear intention to transform the complex into multimodal platforms, through the Multimodal Port Terminal - Tergua, the State Department of Transportation and other state and federal agencies, as well as Transport Strategic Plan (TSP). This complex evidences intermodality through the highways RS-124, BRs 290 and 116, besides the port of Pelotas.

At the Palmas (TO) and Paraná Platforms and at the Integrated Logistics Center in São Paulo, the same intention is observed for the implementation of multimodal platforms, through the connection of several highways, the waterway (Araguaia / Tocantins) and the railroad (North / South) connected to the state of Tocantins, while in the state of Paraná, the implementation of the platform is associated to a project of four distinct phases: logistics master plan, Paraná sea ports, west multimodal pole and logistics institute. In the state of São Paulo, the platform is characterized by the Transport Development Master Plan (TDMP) for the period from 2000/2020. This proposal meets the intermodal load potential within the state of São Paulo, estimated at around 56 million tons, with the Metropolitan Region of São Paulo (MRSP) as the hub of origin and destination.

With regard to Dry Ports or the Internal Customs Stations (EADIs) installed in our country, they can be classified as multimodal platforms in Brazil, according to denomination of the Ministry of Public Works of Spain.

It is observed that there are several studies in progress and implantations of infrastructures of logistic platforms in Brazil. However, it is not possible to show a single systematic procedure in the design of a logistical platform model. The European model (France and Spain) has prevailed in Brazilian conceptions [9]. In the bibliographic review it was not possible to show another author, besides [24], who studies and establishes a procedure for the design of Logistics Platforms under the European approach, without taking into account the unimodal and multimodal classification. Therefore, the proposal of this research becomes very interesting in terms of the possibility of merging the European, American and Asian conceptions in the proposal of the implantation of Unimodal and Multimodal Logistics Platforms for the Amazon Region, making academic research innovative, with the creation of a procedure for the design of a model of logistics platforms with intercontinental experiences, in addition to the European experiences already incorporated in the study.

It is important to note that most of the Logistics Platforms under study in Brazil are linked to sea ports,

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not excluding the possibility of PL deployment in fluvial or inland ports, or even in dry ports.

III. APPLIED METHODOLOGY

The methodology used allowed the analysis of the economic viability and the regional characteristics and the infrastructure potential and the main aspects of PLs in Brazil. The regional profiles that allowed the study for the proposal of a procedure that allows a Regional Logistics Platform (RLP) model were verified.

IV. RESULTS

Analyzing the proposal of the Goiás complex (Goiás and Anápolis), we clearly see the intention to formalize a multimodal logistics platform, where the main objectives are: implementation of the cold chain, improvement in the customs clearance process, processing, and packaging of cargo consolidation and deconsolidation, administrative, financial and telematic services. This complex demonstrates intermodality through the following modes of transportation: Anápolis airport, Centro Atlântica and Norte-Sul railroad, BR 153, BR 060, Tietê-Paraná waterway and Porto Seco Midwest S.A.

In the Bahia complex (Juazeiro and Feira de Santana), there is also the desire to formalize a multimodal platform, through the Planning and Infrastructure Departments of Bahia, as well as the State Transport Logistics Program (PELTBAHIA). This complex will formalize intermodality through the port of Aracatú, the BR 116 and 101 highways, among other intermodal connections.

While in the Rio Grande do Sul complex (Tergua and Rio Grande do Sul), there is a clear intention to transform the complex into multimodal platforms, through the Multimodal Port Terminal - Tergua, the State Department of Transportation and other state and federal agencies, as well as Transport Strategic Plan (TSP). This complex evidences intermodality through the highways RS-124, BRs 290 and 116, besides the port of Pelotas.

At the Palmas (TO) and Paraná Platforms and at the Integrated Logistics Center in São Paulo, the same intention is observed for the implementation of multimodal platforms, through the connection of several highways, the waterway (Araguaia / Tocantins) and the railroad (North / South) connected to the state of Tocantins, while in the state of Paraná, the implementation of the platform is associated to a project of four distinct phases: logistics master plan, Paraná sea ports, west multimodal pole and logistics institute.

In the state of São Paulo, the platform is characterized by the Transport Development Master Plan (PDDT) for the period from 2000/2020. This proposal addresses the intermodal load potential within the state of São Paulo, estimated at around 56 million tons, having as its source and destination the Metropolitan Region of São Paulo (RMSP, 2008).

With regard to Dry Ports or the Internal Customs Stations (EADIs) installed in our country, they can be classified as multimodal platforms in Brazil, according to denomination of the Ministry of Public Works of Spain.

It is observed that there are several studies in progress and implementations of infrastructures of logistic platforms in Brazil. However, it is not possible to show a single systematic procedure in the design of a logistical platform model. The European model (France and Spain) has prevailed in Brazilian conceptions (DUARTE, 1999). In the bibliographic review it was not possible to highlight another author, besides studying and establishing a procedure for the design of PLs under the European approach, without taking into account the unimodal and multimodal classification.

Therefore, the proposal of this research becomes very interesting in terms of the possibility of merging the European, American and Asian conceptions in the proposal of the implantation of Unimodal and Multimodal Logistics Platforms for the Amazon Region, making academic research innovative, with the creation of a procedure for the design of a model of logistics platforms with intercontinental experiences, in addition to the European experiences already incorporated in the study.

It is important to note that most of the Logistics Platforms under study in Brazil are linked to sea ports, not excluding the possibility of PL deployment in fluvial or inland ports, or even in dry ports.

Table 1 presents a summary of the aspects of interest of the research, such as: geographical location, types of infrastructure, classification of the Platform (Unimodal and Multimodal), the implementation phase or study of the Logistics Platform in the Brazilian territory, already described previously. It is observed that there is a relationship with the selected aspects (types of infrastructure, intermodality systems and expansion plans) in the nine International Logistics Platforms selected in this study, mainly with the aspects chosen in the Logistics Platforms in Brazil.

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Table 1 - Comparative aspects of Logistics Platforms in Brazil.

Aspects of Research Interest	**Logistics Platforms in Brazil**									
	Anapólis	Palmas	Paraná	São Paulo	Portos Secos	EADIs	Guaíba	Juazeiro	Feira de Santana	Rio Grande do Sul
Geographic location	State of Goias	State of Tocantins	State of Parana	State of São Paulo	Various states	Various states	State of Rio Grande do Sul	State of Bahia	State of Bahia	State of Rio Grande do Sul
Types of infrastructure	Integration of aerial, rail and road modalities. The Land Transport Center, Air Terminal, Cargo Terminal and the Services and Administration Center will be in operation.	Intermodal transport formed by highways, waterways and railways. The most important works on the platform are the completion of the Araguaia / Tocantins waterway and the North / South railroad.	Implement the Logistics Master Plan, improve the infrastructure of the Paranaguá and Antonina ports, transpose the Itaipu dam and create the Institute of Logistics.	Intermodal road-rail terminal to meet warehousing, distribution, consolidation and deconsolidation operations of containers, support services and bonded areas.	Bonded terminal of public use, located in a secondary zone of the customs territory, destined to the provision of public services and logistics of merchandise and luggage from abroad.	Bonded terminal of public use, located in a secondary zone of the customs territory, destined to the provision of public services and logistics of merchandise and luggage from abroad.	Connections to the road, railway and waterway networks in the interior of RS. Construction of a road-rail bridge over the Jacuí River and pavement of only 14 km of road to the municipality of Eldorado do Sul.	It will promote intermodality between ports, highways, railways, airways and waterways for cargo transportation.	It will promote intermodality between ports, highways, railways, airways and waterways for cargo transportation.	Connections to the road, railway and waterway networks in the interior of RS. Construction of a road-rail bridge over the Jacuí River and pavement of only 14 km of road to the municipality of Eldorado do Sul.
Platform classification (Unimodal or Multimodal)	Multimodal Logistic Platform	Logistic platform Agroalimentar Multimodal	Multimodal Logistic Platform	Integrated Logistics Center	Multimodal Logistic Platform	Multimodal Logistic Platform	Multimodal Logistic Platform	Multimodal Transport Logistics Platform	Integrated Logistics Center	Multimodal Logistic Platform
In the projct phase (deployment)	Yes	No	No	Yes	Yes	Yes	No	No	No	No
In the study phase	No	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes

Source: Authors, (2019).

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V. CONCLUSION

When meeting the established objectives of the research, it was verified that the aspects of interest were taken care of the geographic locations, the types of infrastructures and the classifications of the Platforms (Unimodal or Multimodal). The analyzes used to identify the PLs in Brazil where they were established in Table 1 where the results of each region are shown the competitive advantages of each of them, this shows that Brazil needs to develop these PLs in order to be able to dispose of all the existing production for the market internal and export.

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Logistics Platform (LP) approach in the Stakeholders view

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Abstract— *This study approaches a perspective on the perception of the stakeholders in the various fields of action, taking as a model the Regional Logistics Platform (RLP). The purpose of this article is to analyze and make feasible the main criteria for the formulation of such a model. The applied methodology was presented the existing procedures of implantation of a model of Logistic Platforms (LP): the influence of the LP in the sustainable development, showing the economic, environmental and social development and the intervening actors. The expected results were: the analyzes with qualitative economic, social and environmental impacts of the infrastructure of a RLP, becoming more relevant when the logistics service is adequate. Nevertheless, in this situation the implications of the construction of the infrastructures and the operation of the logistics equipment have ample reach and, often, almost imperceptible. Implementing and operating a RLP implies a series of positive and negative impacts on the environment of its area of influence which, when not considered, distort expectations of return to stakeholders on the implementation of a RLP. On the other hand, there is a strict relationship between the interests associated with the implementation of an PL, with the horizontal and vertical relations of the intervening actors, enabling an adequate deployment of sustainability indicators, linked to criteria that make performance evaluation of development sustainable development in the Amazon Region to identify the main positive and negative impacts associated with the implementation of a PL in the view of the Stakeholders.*

Keywords— ***Logistics platform, Stakeholders, Sustainable Development, modal transport.***

I. INTRODUCTION

With the increasing globalization process, national geographic issues are increasingly being considered and logistics plays a very important role, making organizations more competitive. In this way, the logistic locations that bring together, at the lowest cost, adequate service levels for certain goods, Logistics Platforms (LP) [1] [2] [3].

In the world, there are already some platforms, these are usually linked to seaports, because of their importance in trade relations in the world. In Brazil, although this concept is not yet widely publicized, there are some ports and airports that have the potential to become PL [4-6].

According to [7], the logistics network can be conceptualized as the physical-spatial representation of the points of origin and destinations of the goods, as well as their flows (material, information and financial) and other relevant aspects, in order to logistic system as a whole. The network includes supply, production and distribution logistics, as well as having among these branches logistics operators to maintain a good level of service offered to the customer.

This concern to satisfy the customer, the diversity of production, the pressure to reduce costs and competition between companies made intermodal transport important, for the movement of goods over great distances in the globalized logistics environment.

Green Logistics (GL) is also known as Reverse Logistics, which is the area of logistics that deals with the returns aspects of products, packaging or materials to its production center, as well as the treatment of industrial waste that will be dumped into the environment. Green Logistics is an important reference for organizations in Brazil that want to have a competitive advantage in the globalized market [8].

In Europe, this concern has played a very important role in national and regional policies. For [9], the willingness to act on the organization and movement of goods has made Europeans idealize logistics locations to improve the level of service and to boost costs. These logistic locations are defined below:

• Logistic site: place physically well delimited with the intervention of a single logistic operator;

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• Logistic zone: well defined area that groups several logistic sites, offering to several operators and facilities of intermodal branches;
• Logistical pole: a slightly delimited space that groups several sites and logistics areas and exhibits a concentration of logistical activities.

Also according to [9], logistic stowage policies address two types of distinct investments: logistical investments and kinetic investments:
• Logistical investments: they are oriented to welcome activities that value the circulation of goods and integrate the market (final production, inventory management, packaging, labeling, etc.). The logistics zones have this type of planning.
• Investments of a kinetic nature: they are oriented to study the movements, regardless of their causes, aiming to improve the circulation of goods, accelerating and regulating the transport flows, the quality of the infrastructure and the geographical location of the terminals. In these terminals, the customer finds ports, airports, multifunctional parks and shopping centers.

The concept of the Intermodal Logistics Platform (ILP) was developed in France by the Groupement Européan D'intérêt Economique (GEIE) [10], in order to replace the inefficient services provided by cargo terminals. The GEIE conceptualized the platform as being a delimited area where activities related to regional, national and international logistics are carried out by various logistics operators. Its location must be related to various modes of cargo transportation available. Its definition is made through the studies of the flows of the inputs, goods and services, associated to an evaluation of its nodes of supply and distribution, optimizing the cost versus benefit relation.

The unimodal or multimodal LPs were also conceptualized by the Spanish Ministry of Development [3] as points or connection areas of the logistics networks, including transport logistics, in which activities and technical functions of high added value are concentrated. On the other hand, the concept established by the European Platform Association - EUROPLATFORMS - in 1992 [11], describes a logistical platform as a "delimited area, within which different logistics operators handle all processes related to supply logistics and logistics of physical distribution of products, attending local, regional, national, international and global relations. " These logistic operators can be owners, tenants of the buildings, equipment, facilities (warehouses, storage areas, maintenance workshops) that are part of the logistics platform [12].

LPs were conceived, inserted and supported by an intelligent information transmission system. In addition, they were designed not to create environmental impacts in their environment and to generate employment and income for the regions that shelter them. One of the main characteristics of the LP is to be an intelligence center that combines intermodality and a pole of reduction of logistics costs. The result of its implementation promotes the increase of efficiency and effectiveness, increasing the business and the technological standard, mainly for the ease of access to new global markets, through the logistics networks.

For [3] [10] defines LP as being: "the meeting place of everything related to logistics efficiency". These LPs operate the transportation logistics infrastructures and infrastructures, important for their dynamism in the global economy, improving the competitiveness of companies, creating jobs and making logistical processes feasible, as there is a growing need for infrastructure to organize to meet its main customers (industrial, commercial and service). Storage and other facilities used in transportation logistics processes focus on the space dimension. Thus, it becomes important to enable these groupings of clients to create the necessary synergy, in order to make the logistics network efficient, effective and effective, facilitating the creation of LPs.

According to [13], LPs are facilities or areas that add commercial and technical functions in the supply chain or distribution chain, creating additional value in logistics operations.

The main advantages of using platforms defined by [10] are:
• Space productivity - should not be located in the center of the city;
• The traffic of cargo vehicles should be limited, mitigating the negative consequences they cause; and
• Economic performance (efficiency) - one should try to bring the manufacturers closer to the conveyors.

For [10] [14] it observes that a platform consists of a set of infrastructures of public and private character. The public entities, in terms of encouraging the dynamism of the economy, end up offering the appropriate infrastructure such as: preparation of urbanization of the land, implementation of transport infrastructure and provision of services offered by public authorities. While those of a private nature concern the construction of the premises within which the goods and the operation and maintenance equipment are treated.

A platform should have a regime of free competition for all interested companies, hence its public character, in addition to understanding common services

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for professionals and users' vehicles. However, in some cases, its management can be managed by private initiative through concessions. Its location should privilege some public services in order to facilitate this interaction necessary to carry out the logistics operations.

Although it is impossible to force a company to settle in a LP organized by the public authorities with predetermined rules, they end up being attracted by the concentration of activities and facilities in them. Some companies prefer to be in the vicinity, so as to escape the existing rules, while benefiting from the advantages of their existence [12].

According to [7], the logistics network can be conceptualized as the physical-spatial representation of the points of origin and destinations of the goods, as well as their flows (material, information and financial) and other relevant aspects, in order to logistic system as a whole. The network includes supply, production and distribution logistics, as well as having among these branches logistics operators to maintain a good level of service offered to the customer.

This concern to satisfy the customer, the diversity of production, the pressure to reduce costs and competition between companies made intermodal transport important, for the movement of goods over great distances in the globalized logistics environment.

Green Logistics (GL) is also known as Reverse Logistics (RL) which is the area of logistics that deals with the aspects of returns of products, packaging or materials to its production center, as well as the treatment of industrial waste that will be dumped in the environment environment. GL is an important reference for organizations in Brazil that want to have a competitive advantage in the globalized market [8].

In Europe, this concern has played a very important role in national and regional policies. According to [9], the willingness to act on the organization and movement of goods has made Europeans idealize logistics locations to improve the level of service and to boost costs. These logistic locations are defined below:

• Logistic site: place physically well delimited with the intervention of a single logistic operator;

• Logistic zone: well defined area that groups several logistic sites, offering to several operators and facilities of intermodal branches;

• Logistical pole: a slightly delimited space that groups several sites and logistics areas and exhibits a concentration of logistical activities.

Also according to [9], logistic stowage policies address two types of distinct investments: logistical investments and kinetic investments:

• Investments of a logistical character: they are oriented to welcome activities that value the circulation of goods and integrate the market (final production, inventory management, packaging, labeling etc). The logistics zones have this type of planning.

• Investments of a kinetic nature: they are oriented to study the movements, regardless of their causes, aiming to improve the circulation of goods, accelerating and regulating the transport flows, the quality of the infrastructure and the geographical location of the terminals. In these terminals, the customer finds ports, airports, multifunctional parks and shopping centers.

The concept of ILP was developed in France by the Groupement Européan D'intérêt Economique (GEIE), [10] in order to replace the inefficient services provided by cargo terminals. The GEIE conceptualized the platform as being a delimited area where activities related to regional, national and international logistics are carried out by various logistics operators. Its location must be related to various modes of cargo transportation available. Its definition is made through the studies of the flows of the inputs, goods and services, associated to an evaluation of its nodes of supply and distribution, optimizing the cost versus benefit relation.

PLs were conceived, inserted and supported by an intelligent information transmission system. In addition, they were designed not to create environmental impacts in their environment and to generate employment and income for the regions that shelter them. One of the main characteristics of the LP is to be an intelligence center that combines intermodality and a pole of reduction of logistics costs. The result of its implementation promotes the increase of efficiency and effectiveness, increasing the business and the technological standard, mainly for the ease of access to new global markets, through the logistics networks.

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A platform should have a regime of free competition for all interested companies, hence its public character, in addition to understanding common services for professionals and users' vehicles. However, in some cases, its management can be managed by private initiative through concessions. Its location should privilege some public services in order to facilitate this interaction necessary to carry out the logistics operations.

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Another definition is given by the Europlatforms - Europe Association of Freight Village [15] which describes a Logistics Platform as a delimited area within which all activities related to the logistics of supply and distribution of goods are carried out by different operators, both for regional, national and international transit. These logistics operators may be owners, lessees of the facilities, equipment (warehouses, storage areas, workshops etc.) that are available in the design of the platform.

For [16] they affirm that LP can be located in the urban perimeters. These platforms function as large distribution centers built in the subsoil of higher density routes, difficult to reach and poor mobility, especially with congestion and parking problems. This model can also offer consolidation, storage, deconsolidation and delivery services to the respective owners, guaranteeing the level of service established in the contractual instruments.

These Urban Platforms must be within a radius of up to 200 m from the stores that will be serviced. Goods are unloaded on the road, sent underground by lifting equipment, enabling each user (client) to plan to pick up their goods. This should only work where there is enough road space to load and unload the goods, as well as the availability of space for subsoil construction.

In Brazil, the intermodal transport operation is the one that ends up happening through two or more modes, from the origin to the destination of the loads, traveling with specific documents for each modality of transport. In multimodal transport, cargoes are moved through two or more modes, with only one transport document generating a competitive advantage in logistics operations. According to [7], transport in Brazil is more practiced in the intermodal modality, even because the multimodal modality is in the adaptation phase, awaiting some regulations on the following impasses:

• Definition and implementation of a single document for cargo handling;

• Approval of a Resolution of the Treasury Council (CONFAZ) on the unification of the Tax on Circulation of Goods and Services (ICMS) by the States of the Federation involved in the operation;

• Definition of cargo insurance legislation;

• Make the Multimodal Transport Operator Law (OTM) easily accessible to increase the qualifications of companies to become OTMs.

According to [17], LPs are areas where economic activities are organized logistically, with the intense use of optimization and rationality criteria.

For [14] they define the main objectives of the logistics zones:

• Spatial organization - Through which the objective is to discipline the location and arrangement of activities that consume considerable amounts of space, such as areas for product storage, parking and cargo transport maneuvers;

• Avoid the "contamination" of the urban fabric - Especially the periphery, which can be caused by negative impacts caused by facilities and infrastructures of poor aesthetic quality, which, in addition, generate negative externalities such as pollution and degradation of the environment;

• Generate specialized jobs at the local level - Logistic

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activities are considered medium and high level activities of specialization and contribute to the generation of specialized jobs, mainly in the area of management at all levels.

Table 1 presents an overview of the main characteristics, classes and aspects of an LP, emphasizing the magnitude of the load movement, observed in the concepts researched in this scientific work. In view of the alternatives presented, the concept of [15] was chosen as a reference, which approaches the concept prioritizing a well-defined and delimited area, where internally the main logistics operations of supply and distribution of raw materials and finished products are carried out in order to meet operational needs of a local, regional, national, international and global character. The choice was based on the detailing of the segments carried out by the platform, because in the presentation of the other concepts it is perceived that they are summarized, failing to privilege the real functions of a LP.

Table 1 - Summary of the main concepts of LPs.

AUTHOR	CONCEPT
Groupement Européan D' intérêt Economique (GEIE - França) (1996)	It is a delimited area where the activities related to regional, national and international logistics are carried out by several logistics operators.
Ministry of Public Works of Spain (1999)	They are points or areas of connection of logistics networks, including transport logistics in which activities and technical functions of high added value are concentrated.
EUROPLATFORMS (1992)	It is a set of facilities and equipment (infrastructure), where different activities are carried out directly related to local logistics, which can be used jointly by industries and suppliers, and which has a series of complementary services made available of the different platform users. The main function of the platform is to promote transhipment, consolidation and deconsolidation through the exchange of transport modes.
Boudouin (1996)	It is the meeting place of everything concerning logistics efficiency.
Arruda e Bastos (1997)	It is a set of infrastructure of public and private character.
Dalmau e Robusté (2002)	It is located in urban perimeters, built in the subsoil of higher density roads, difficult to reach and poor mobility, especially with congestion and parking problems.
Alavrenga e Novaes (1994)	It is a logistics network that is conceptualized with the physical-spatial representation of the points of origin and destinations of the goods, as well as their flows (material, information and financial) and other relevant aspects, so as to enable the visualization of the logistics systemas a whole.

Source Authors, (2019).

In light of the above, it is pertinent to highlight the difference between the concept of LP and Regional Logistics Platform (RLP). The major difference is in the area of physical-spatial delimitation, since on average a LP extends for approximately 105 km² [10], while the Regional Logistics Platform may extend for dimensions well above a LP. In this study, the RLP will extend for approximately 5 million km², characterizing the great conceptual difference.

II. CLASSIFICATION AND STRUCTURING

According to [11], according to the European Association of Logistics Platforms EUROPLATFORMS), there are infrastructures that are operated with one mode of transport, unimodal calls, or others that are operated with more than one mode of transport (railways, waterways, airways, pipelines and infrastructures), multimodal or intermodal calls, not implying the direct interchange between them, that is, the existence of intermodality.

According to [12], the classification of unimodal platforms are:

• Road Centers or Terminals (RC or RT): platforms consisting predominantly of a service area for trucking companies. Only in certain cases do they include a small logistics area, but always subordinate to those services.

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According to the country, these platforms assume different denominations: in Italy, autoporti, in France, centers routiers, and in Anglo-Saxon terminology, truck centers.

• Waterway Centers or Terminals (WC or WT): platforms consisting predominantly of a service area for waterway transportation companies. Only in certain cases do they include a small logistics area, but always subordinate to those services.

• Airline Centers or Terminals (AC or AT): platforms consisting predominantly of a service area for cargo transportation companies. Only in certain cases do they include a small logistics area, but always subordinate to those services.

• Railway Centers or Terminals (RC or RT): platforms consisting predominantly of a service area for rail freight companies. Only in certain cases do they include a small logistics area, but always subordinate to those services.

• Urban Distribution Centers (UDC): platform for grouping, consolidation, deconsolidation of cargo for later urban distribution. These city logistics are usually located in the outskirts of cities and often integrate within a logistics platform as one of their areas.

• Distribution Parks (DP): platforms, usually of a regional nature, equipped with all the necessary requirements to carry out the activities of storage and distribution. This is where the logistics departments of all production companies, distribution companies, logistic operators, storage companies, etc. are established. The dominant functional areas are storage and distribution, with logistics centers for companies and logistics distribution platforms being present. Examples of this type of infrastructure are the Coslada logistics park, or the Botlec distripark at the port of Rotterdam.

• Transport Centers (TC): logistics platforms focused on road transport. They may be metropolitan or inland. They generally have the logistics area and the service support area to service people and vehicles.

Regarding Multimodal Logistics Platforms, still in accordance with the definition given by Europlatforms, addressed by [11], the following are:

• Port Logistic Activity Zones (LAZ): logistical platforms aggregated to ports and located adjacent to maritime terminal terminals. The development of these platforms allows an extension of the port hinterland, as an area of influence and attractiveness. As an example of port LAZ are: Rotterdam, Barcelona, Valencia, Algeciras and Sines.

• Air Cargo Centers (ACCs) - These are specialized areas for the exchange of air transportation and road or rail transportation with regard to cargo movement. The provision of logistics services in this type of platform occurs in a sequential manner: first the general cargo is treated and then the service rendering activities are processed in addition to the cargo dispatch. As an example, in Europe, they are: Paris-Orly, Frankfurt, Amsterdam-Shinpholl and Madrid-Barajas.

• Dry Ports - They are located in a secondary zone and that allows the connection between a port or airport and the respective origin and / or destination. They have a multimodal or intermodal zone and include other functional areas such as customs services. In Brazil there are already several dry ports, also known as the Customs Customs Station (EADI).

• Intermodal or Multimodal Logistics Platform (ILP or MLP): it is a "delimited area, within which different logistics operators handle all processes related to supply logistics and the logistics of physical distribution of products, taking into account relationships local, regional, national, international and global ".

Table 2 summarizes the main types of Logistics Platforms detailed earlier.

Table 2 - Types of Logistics Platforms.

TIPOS DE PLATAFORMAS LOGÍSTICAS	
UNIMODAL	MULTIMODAL OR INTERMODAL
• Centers or Bus Terminals - CT or CBT; • Waterway Centers or Terminals - WC or WT; • Railway Centers or Terminals - RC or RT; • Airport Centers or Terminals - AC or AT; • Urban Distribution Centers or City-Logistics - UDC or CL; • Distribution Parks or Distriparks - DP or DD; • Transport Centers - TC.	• Logistic Activity Zones - LAZ; • Air Cargo Centrals - ACC; • Dry Ports - DP; • Multimodal or Intermodal Logistics Platforms - MLP or ILP.

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III. MATERIALS AND METHODS

3.1 EXISTING PROCEDURES FOR THE IMPLEMENTATION OF A MODEL OF LOGISTICAL PLATFORMS

During the bibliographic review two implantation procedures of LP, the French and Spanish models were found. It is observed that there is no explicit systematization of the models studied, but there are three important segments in both: infrastructure services (administrative, customs, life support, maintenance and telematics), structuring axes (modal transport) and the services offered by logistics operators. Table 3 summarizes the main aspects of the French and Spanish models.

Table 3 - Summary of the main aspects of the French and Spanish Models.

MAIN ASPECTS OF THE MODEL	FRENCH MODEL	SPANISH MODEL	COMMENTS
Infrastructure services (administrative, customs, life support, maintenance and telematics)	It is divided into three segments (professional, equipment and organization). The segments serve: reception, information, accommodation, food, banking, travel agency, basic and specific equipment, customs clearing, basic maintenance in vehicles and computer and telecommunications system.	They present segments similar to the French model, such as: administrative centers (information, room rent, registry services, translation, banking system, etc.), as well as hotel services, small maintenance in transport vehicles, customs clearing services and telematic system.	There is a certain similarity in the infrastructure services offered by the two models. There are some basic differences, but in general, it is not enough to de-characterize the segment as a whole.
Structuring axes (transport modes)	Group infrastructure of major transport hubs. It presents in its great majority models of Intermodal Platforms with its respective intermodal terminals integrating the transport by road, rail, waterway, air and pipeline.	It acts as a multimodal distribution supply logistics center. They have several multimodal terminals, that allow to integrate the intermodality between the diverse modes of transport.	It is observed that the two models are characterized by the intensive use of intermodality, that is, integrating the main transport modes through specific terminals.
Logistic Operators (services offered)	It provides supply and distribution logistics services, such as: chartering, brokerage, commercial and customs advice, equipment rental, warehousing and transportation.	Provides supply and distribution logistics services, such as: deconsolidation, consolidation, storage and sorting, finishing operation, quality control, repackaging and labeling.	It is observed that the Logistic Operators offer similar basic services, with some differences, that do not characterize the presented models.

Fonte: Autores, (2019).

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It is important to note that the comments made earlier emphasize the main aspects of the procedures surveyed in the literature that define the French and Spanish models. However, such procedures present restrictions that can be explained by the following examples: difficulty of physical space for expansion, lack of compliance with environmental legislation, depth of draft at the terminals, among others. If these models were applied in the Amazon Region, we would have at least two major constraints: the first would be to attend to Brazilian environmental legislation and international pressures, mainly from NGOs, and the second would be to study the best scenario to implement the most appropriate model.

The model to be implemented in the Amazon Region would only be feasible if it met the criteria of Sustainable Development (SD). The other constraint would be to choose the best scenarios for applying the model, this choice should be compatible with the most appropriate scenario. Given these constraints, it would be pertinent to develop a new model for the Amazon Region that would meet the potential of the French and Spanish models, along with the environmental and alternative scenarios suggested for the Amazon Region.

3.2 THE INFLUENCE OF LOGISTICAL PLATFORM IN SUSTAINABLE DEVELOPMENT

The term "sustainability" has become known since the publication of the Brundtland Commission report, Our Common Future (CMMAD, 1991) [18], but today the term has become common and banal. Sustainability in a simplified way means "the ability of a system to reproduce itself over a period of time [19].

Sustainable development is based on the interaction of three development criteria: economic (growth, market expansion, profit maximization and externalization of costs), social (satisfaction of basic human needs, increased equity, community participation in policy decisions and use of appropriate technologies) and ecological (respect to environmental capacity, conservation and recycling of resources and reduction of effluents), forming a triad with sustainability in the center [19].

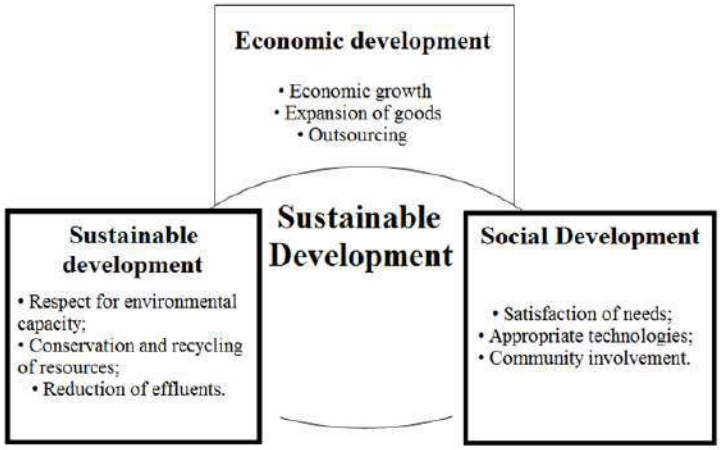

Fig.1 - Sustainable Development.
Source: Adapted by the authors [19].

For [20] he argues that development to be sustainable must be related to ethics and politics, based on the arguments of Amartya Sen and Aristotle, which addresses two basic questions: human motivation and the evaluation of social achievements. The basic questions support that "growth is a necessary condition, but not at all sufficient to achieve a better life." It highlights the need for economic growth without negative environmental and social externalities. In addition to indicating the mobilization of internal resources as a way to generate sustainable activities and taxes on luxury goods to subsidize low wages.

For [21], he argues that the concept of sustainability must be applied locally, based on the planning of the community itself, such as the need for basic inputs and protection of primary resources. The actors [22] reinforce the need to prioritize geographic and cultural dimensions and place, as a prerequisite of any attempt in this direction, the possibility of access to goods and services as raw material and energy.

For [22], it conceptualizes sustainability as "conscious control of the process of social metabolic reproduction by freely associated producers (with self-control), in contrast to the unsustainable and structurally

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established characteristic of adversaries." That is, the opposition between cooperation and dispute.

Already [24] shows the need for changes and questions the current development pattern (linear - input of raw material versus output of products and waste), which is maintained not only by the depredation of natural resources but, above all, at the expense of the concentration of capital, immediate return and a contingent of marginalized individuals of the system.

In Brazil, the logistics segment can be considered of fundamental importance to the consolidation of sustainable development projects for any region, especially for our Amazon Region, but it is pertinent to point out that the region does not yet have a well defined sustainability policy.

The Ministry of Transport has as a reference for guidance and evolution of its environmental policy the precepts of sustainable development, contributing for future generations to enjoy the natural resource base available in our country.

Based on the basic concepts of sustainability presented in the Brazilian Agenda 21 - Bases for Discussion, and the results of studies carried out within the framework of the Organization for Economic Cooperation and Development (OECD), which concluded by a conceptualization of environmentally friendly transportation logistics sustainability, will be characterized the sustainability of transport logistics in the Brazilian case. This characterization will constitute a reference for a harmonized sectoral action, aiming at the integration of the public transport policies with those of other sectors and with the planning and planning of the territory based on the paradigm of sustainable development.

The discussion on environmentally sustainable logistics involved links between environmental protection objectives at the local, regional and global levels that could be expressed in numerous environmental quality parameters. The OECD project has two benchmarks: (a) that strategies for environmentally sustainable transport logistics to be successful require a qualitative concept and a set of targets that can be quantified; and (b) quantified targets are small in number and reflect critical values and trends of environmental quality [25].

The OECD project has adopted the following definition for environmentally sustainable transport logistics: "it is transport logistics that do not endanger public health or ecosystems and meet mobility needs consistently with (a) the use of resources renewable levels below their regeneration rates and (b) the use of non-renewable resources at levels below the development of renewable substitutes".

Within this project, the types of transport logistics impact on the environment were classified into three categories: local and regional impacts of atmospheric emissions, global impacts of atmospheric emissions and local and regional impacts not resulting from atmospheric emissions. Next, six environmental sustainability criteria were established to meet transport logistics: reduction das emissões de óxidos de nitrogênio de fontes de transporte, de forma a permitir o alcance de padrões de qualidade do ar para dióxido de nitrogênio, ozônio e deposição de nitrogênio:

• Reduction of emissions of volatile organic compounds (VOCs) at such a level in order to avoid excessive levels of ozone; reduction of emissions of carcinogenic volatile organic compounds to an acceptable level of risk;
• Reducing emissions of particulate matter to levels that prevent air contamination;
• Control of carbon dioxide emissions, in order to meet per capita values consistent with internationally established targets;
• Control of vehicular noise and traffic so that the levels resulting from exposure pose no health risk or cause serious discomfort;
• Adequate land use, so that the area of influence of transportation systems meets the objectives and constraints of ecosystem protection.

In the continuity of these studies on transportation logistics, consensus was reached on the issue that sustainability will only be achieved through a set of measures that includes both technological development contributions and significant changes in transportation activity, in order to environmental variables necessary for the sustainable development model for the Amazon Region.

The implementation of a Logistics Platform is important for the sustainable development of a region, but one must consider the economic, social and environmental influence when designing transport infrastructure projects. In this sense, the environmental variable added a new component to the infrastructure management process, which aims to complete the circle of interfaces of the transport logistics segment, which already worked on social, technical, and economic conditions associated with sectoral enterprises. Environmental feasibility becomes the criterion for decision-making on transport systems, together with the criteria of economic, technical and social feasibility.

Environmental variables will be considered in all phases of development of the transportation logistics

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system: planning, design, implementation and operation. The importance of the environmental feasibility of transport logistics infrastructure lies precisely in the fact that it is considered in the planning phase, when different alternatives are used to meet the demand for transport. Thus, the viable alternatives from the environmental point of view are defined, as well as the conditioning factors of this feasibility. Decisions taken on the basis of this criterion and in association with the other criteria mentioned above will trigger a process of environmental analysis in the subsequent stages of design, implementation and operation of transport systems [25].

This principle is directly related to the principle presented below, since the environmental feasibility of a transport logistics undertaking implies the adoption of environmental considerations and respect for the needs of the environment.

In accordance with Law No. 10233 of June 5, 2001, infrastructure management and the operation of land and water transport will be governed, inter alia, by the principle of compatibility of transport logistics with the preservation of the environment environment, reducing the levels of noise pollution and atmospheric contamination, soil and water resources. The preservation of environmental quality becomes an objective of transport logistics actions, determining the development of transport solutions that promote the said compatibility with the preservation of the environment.

The relationship between transport logistics and the environment is multiple and involves transport infrastructure, vehicles and associated factors of accessibility and mobility; the users of the transport system and the populations affected positively and negatively, by the implantation and operation of the infrastructure and the transport logistics services; the characteristics and conditions of the environment under direct and indirect influence of transport. The achievement of the balance of this relationship starts with the commitment of all parties to the need to preserve the environment, as well as the recognition that transport demands deserve a response from the transport segment.

Currently, Brazilian environmental legislation basically contemplates all possibilities for preserving environmental quality, providing for preventive, corrective and compensatory instruments related to the consequences of interventions in the natural and environmental resources of the country.

Programs to control the emission of vehicles and to rationalize the use of oil and natural gas derivatives are examples of successful initiatives to reconcile transport logistics with the preservation of air quality.

The environmental licensing system has evolved and presented positive results, not only in the implementation of measures of environmental control of transport logistics projects, but also in the change of culture within the transportation sector, in order to introduce greater awareness of the need to internalize variables in studies and transport activities.

The practices and norms regarding each modality of transport logistics will be adapted and improved, in order to incorporate the environmental consideration in detail. Consequently, analyzes of transport logistics investments are also reviewed, with the objective of quantifying and accounting for the environmental costs associated with the projects.

Thus, a network of new relationships and new opportunities, as well as constraints and constraints, is perceived for sectoral development compatible with the preservation of environmental quality. This intricate network leads to the need to structure these relationships and their treatment, through an environmental management system that works in a coordinated and continuous way, taking into account the intervening actors and an evaluation system that can measure the level of sustainable development required for each physical space chosen to be the object of PLs implementation [26].

3. 3 INTERVENING ACTORS

According to [27], in the new contemporary world business environment, the interests of shareholders, customers, suppliers share space with the demands of society, government, private initiative and logistics operator. And for this group, the so-called stakeholders, who are responsible for generating value from new ventures. Meeting the needs of stakeholders is no longer an option and becomes a strategic differential.

There are different definitions in the literature for the term stackholders. The authors [3] [10] [28] [29] adopt more comprehensive classifications, considering stackholders all persons or "stakeholders." Regardless of the existing classifications, it can not be denied that there are more stakeholders related to the company (the so-called primary) and those that are not directly influenced or affected by the business actions (the secondary ones) [29]. The first group includes shareholders, employees, customers, suppliers, the community and the environment, among others. Among the secondary stackholders, one can cite as an example the media and pressure groups.

According to [28], when studying this subject, it is necessary to understand that there is an interdependent

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network of relationship between organisms and the stackholders. This interdependent relationship network will define the interaction of its various components and will be responsible for business gains or losses, according to the performance of the company.

In the studies conducted by [3] [10] [12] [16], some stakeholders were identified, directly or indirectly, with the implementation of LPs, such as: government, society, investors, unions, private sector, NGOs, logistics, employees, competitors, financial agents and partners etc.

IV. RESULTS

The choice of the stakeholder to be adopted depends on the criteria considered and the relative importance assigned to each of them, which requires a significant research effort to reach the most characteristic group of the area investigated. For the purposes of exemplification and with the studies cited above, table 2.4 was elaborated containing four criteria for the choice of the stakeholders that will be approached in the present work. The criteria chosen were: importance, impact, level of power and level of interest, in accordance with the studies of [10]. The score was elaborated taking into account three levels of intensity: high (3), medium (2) and low (1) [30]. The result of the evaluation can be seen in the last column of table 4.

Table 4 - Criteria for choosing Stakeholders.

SELECTION	CRITERION 1	CRITERION 2	CRITERION 3	CRITERION 4	RESULT
Stakeholders	The importance of stakeholders in the success of the project.	The impact on the project if the stakeholders are not included in the project.	The level of power that stakeholders have to block or prevent project progress.	The level of interest that stakeholders have to help project progress.	Evaluation
Clients	2	1	1	1	5
Providers	2	3	3	2	10
Investors	3	3	2	3	11
Syndicate	1	1	3	1	6
Private initiative	3	3	3	3	12
ONGs	1	1	2	2	6
Government	3	3	3	3	12
Society	3	3	3	3	12
Shareholder	3	3	3	2	11
Logistic operator	3	3	3	3	12
Employees	1	1	1	2	5
Financial Agent	2	2	2	2	8
Competitors	1	1	1	1	4
About us	2	1	1	1	5

Source: Authors, (2019).

It is observed that the stakeholders that had the best evaluation were the following: society, government, private initiative and logistic operator, confirming the main bibliographies consulted [15].

It is important to highlight the representativeness of the community members in the public hearings during the presentation process of the LP implementation model, as well as to charge the government with a strong enforcement action through regulatory agencies, creating policies, guidelines and regulations.

The implementation of a LP imposes a series of associated interests on the actors involved, as well as allowing a series of sustainability indicators to be deployed. The following will be presented in a very brief way as if they give these associated interests.

Society should play an important role in discussions at public hearings, in order to resolve the social, environmental and economic issues arising from the implementation of a LP.

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The government acts in the formulation of policies, guidelines and regulations, mainly in the operational, social, environmental and economic issues arising from the implementation of a Logistics Platform.

The private initiative must meet the requirements of the government regulatory agencies, in order to guarantee the needs discussed with society, so that the social, environmental and economic decisions arising from public hearings can be monitored by stakeholders.

It is known that the logistics operator (concessionaire) is part of the private initiative, but they have an important role, because it will operate the logistic complex taking into account the requirements of the government regulatory agencies. The gains of these interests associated with the intervening actors can be translated in the strengthening of the organizational image, in the fidelity to the brand of the offered services, in the access to new markets and capitals, in the greater commitment and motivation of the employees in producing, in the reduction of conflicts and in the financial return to shareholders and investors.

The following is a brief summary of the definition and importance of the actors involved [27].

4.1 SOCIETY

In Sociology, a society is the set of people who share goals, tastes, concerns and customs, and that interact among themselves constituting a community. Society is the object of study of the social sciences, especially Sociology.

It is also called a partnership or association the grouping of people for the performance of private activities, being reserved for the first expression to the meeting for business purposes and the second for the set that aims at social outcomes regardless of financial benefits, according to articles 53 and 981 of the Code Civil.

A society is a group of individuals that form a semi-open system, in which most of the interactions are made with other individuals belonging to the same group. A society is a network of relationships between people. A society is an interdependent community. The general meaning of society refers simply to a group of people living together in an organized community.

The origin of the word society comes from the Latin societas, a "friendly association with others". Societas is derived from socius, which means "companion," and thus the meaning of society is closely related to that which is social. It is implicit in the meaning of society that its members share mutual interest or concern about a common goal. As such, society is often used as a synonym for the collective of citizens of a country governed by national institutions that deal with civic welfare. check out

Finally, people from various nations united by traditions, beliefs or common political and cultural values, are sometimes called societies (eg, Judeo-Christian, Eastern, Western, etc.). When used in this context, the term acts as a means of comparing two or more "societies" whose representative members represent alternative, competing, and conflicting worldviews.

4.2 GOVERNMENT

Government is the highest instance of executive management, generally recognized as the leadership of a state or a nation. Usually the government or cabinet is called to all the executive directors of the State, or ministers (hence also called the Council of Ministers).

The form or regime of government can be Republic or Monarchy, and the system of government can be Parliamentary, Presidentialism, Constitutionalism or Absolutism. A nation without a Government is classified as anarchic.

It can be said that form of government is a concept that refers to the way in which the institution of power is given in society and how the relation between the conclusion of the system of government, on the other hand, is not confused with the form of government , since this term refers to the way in which powers are related.

4.3 PRIVATE INITIATIVE

The definition of the concept and scope of the "entrepreneur", especially in relation to its condition of "organized" activity (article 966), which, consequently, allows to frame societies as simple or entrepreneurs has been one of the topics on which raised the greatest controversy.

Much has been discussed about art. 966 in the new Civil Code, which defines the "entrepreneur", that is, "It is considered an entrepreneur who carries out professionally organized economic activity for the production or circulation of goods or services." Still, in its single paragraph, we have the following hypotheses of exclusion "It is not considered an entrepreneur who exercises an intellectual profession, scientific, literary or artistic, even with the help of auxiliaries or employees, unless the exercise of the profession constitutes element of business ". This definition is the complete reproduction of the provisions on the same subject in the Italian Civil Code, which, as we know, was the paradigm for the new Brazilian Business Law.

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The term "entrepreneur" leaves the field of status or personal qualification and has a legal definition. With that, the word becomes precarious to define those who are part of a society or are owners of a business of their own. Nevertheless, we know how difficult it will be, and even impossible, to make such a change in such deeply rooted customs.

In conclusion, economic activities are no longer classified as commercial or civil, and the term "individual firm" ceases to exist. The definition becomes, for those who carry out the activity individually, as an entrepreneur or autonomous. For those who join, the definition becomes simple society or business society. In both cases the lucrative purpose is indispensable.

4.4 LOGISTIC OPERATOR

The origin of the term logistic operator, as it is called in Brazil, comes from the concept of outsourcing logistics services (outsorcing), which emerged in the United States in the 80's and nowadays heavily disseminated in European countries as Third-party Logistic Provider - 3PL or Logistic Provider. According to [31], the term 3PL began to be used as a synonym for "subcontracting elements of the logistics process".

In the literature, several definitions of logistic operators have emerged in the last years, among them, that of [32], which states that logistic operator is the logistics service provider that has recognized competence in logistics activities, performing functions that can encompass the entire logistics process of a client company or only part of them.

Finally, it is observed that other authors use different criteria to characterize the 3LPs. According to the authors [33], some are stricter, requiring that, to be classified as 3PL, a logistics service provider must carry out a wide range of activities in an integrated manner, having the capacity to carry out projects, operation and management, as well as own long-term contracts with its customers. Other authors are less strict and consider that any company that performs some logistic activity, under contract, for third parties, with capacity for planning, operation and management, should be considered a logistics operator or a 3PL.

4.5 SUSTAINABILITY INDICATORS AS PERFORMANCE MEASURES

In the 1980s, it was realized that economic growth should be more socially fair and more compatible with the preservation of the natural resource base. To this global objective, it was called "sustainable development". Sustainability may mean concluding different program objectives at the same time. Social and environmental economic concerns should be analyzed and dealt with jointly [34].

At the end of the 1980s, there were proposals for the development of indicators that could meet environmental needs. Such proposals for the creation of indicators have the central objective of providing a basis for formulating national policies and global agreements, as well as strengthening decision-making, taking into account the interests of public and private sector stakeholders. The proposal of the indicators still seeks the interaction between the anthropic activity and the environment and give the concept of sustainability more grounding and applicability [35].

The development of environmental and sustainability indicators have three types of approach. The first part deals with biocentric issues, consisting of the identification of indicators that deal with the biological, physical-chemical or energy aspects of the ecological balance of ecosystems. The second part deals with economic aspects, prioritizing monetary assessments of natural capital and the use of natural resources. The third part seeks to balance the aspects of the economic system and the quality of human life, and in some cases can contemplate aspects of the political, cultural and institutional system. It is important to note that this research will focus on the third strand [36].

The indicators constructed from the perspective of the third strand are, as a rule, interaction models of anthropic activity / environment that can be classified into three main types: state, pressure and response.

State indicators seek to describe the present physical or biological situation of natural systems, pressure indicators attempt to measure / evaluate the pressures exerted by anthropic activities on natural systems, and finally the so-called response indicators seek to assess the quality of policies and agreements formulated to respond to and minimize human impacts [37].

The great difficulty found in the indicators is the lack of systematized information and the difficulty of comparing data produced based on different sources / methodologies, creating difficulties in the measurement of sustainability indicators.

It is important to highlight that the emergence of the indicators considered in the third strand can only be understood as an integral part of a process of refinement of sustainability indicators.

Since the late 1950s, the world has been measuring economic development through GDP. However, in the 1990s, Pakistani economist Mahbub ul Haq developed an

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indicator that could measure wealth, literacy, education, life expectancy, birth rates and other factors for the various countries of the world. This index came to be called the Human Development Index (HDI). The UN has been using this index annually since 1993 by the United Nations Development Program.

It should be noted that both the HDI and its improved versions, the so-called third-generation indexes, are not the most adequate to measure sustainable development, since it does not address environmental issues.

Among the recent attempts to develop synthetic indexes of sustainability and sustainable development, we highlight the Environmental Sustainability Index (ESI), developed by the Universities of Yale and Columbia with the support of the World Economic Forum. The premise of the ESI is to analyze and evaluate environmental sustainability over time and identify the determinants of "environmental success" and long-term sustainability.

The main problems encountered in sustainability indices and indicators are: absence or fragility of the conceptual design, fragility of the criteria for choosing the representative variables and lack of clear criteria for integrating the data used.

The formation of the municipal sustainability indexes is composed of four groups of indexes, namely: quality of the environmental system; quality of human life; anthropogenic pressure; and political and institutional capacity.

The indicators and variables used in the municipal sustainability index were selected based on the work of [37-43], in addition to the matrixes of the project Biodiversity, Population and Economy [44] and critical review by some specialists.

The main criteria adopted in the choice of sustainability indicators were [44]:

(1) Relevance

• The variable's ability to translate the phenomenon. This criterion directly measures the phenomenon;

(2) Local grip

• Capacity of the variable (or indicator) to capture phenomena produced that can be transformed at the local level;

(3) Availability

• Coverage and timeliness of data;

(4) Variable capacity

• Allow time comparisons.

Taking into account that the main objective of the previously mentioned criteria is to create compatible indicators for the region studied, an additional criterion used in the choice of variables and indicators was the possibility of calculating them to other locations, such as continents, states, mesoregions, microregions, municipalities and districts.

Table 5a and 5b describe the composition of the indicators used in the thematic indexes of human life quality, anthropogenic pressure and political-institutional capacity.

Table 5a - Thematic indices and indicators.

THEMATIC INDEXES	INDICATORS	COMPOSITION OF INDICATORS
QUALITY OF HUMAN LIFE	Quality of housing	Percentage of subnormal dwellings
	Life conditions	Longevity Index - HDI
		Education index - HDI
	Income	Income index - HDI
	Environmental health and safety	Index of deaths in traffic accidents
		Index of deaths from respiratory diseases
		Index of deaths from parasitic diseases
		Homicide death rate
	Health services	Index of water supply
		Sanitary installation index
		Garbage collection service index
ANTHROPIC PRESSURE	Urban pressure	Population pressure rate
		Housing density per room
		Number of vehicles per capita
		Urban energy consumption
	Industrial pressure	Industrial Energy Intensity
	Agricultural pressure	Density of crop and passage in the municipality
		Average growth rate of crops and passages in the last 10
		Rural energy intensity

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Table 5a - Thematic indices and indicators.

THEMATIC INDEXES	INDICATORS	COMPOSITION OF INDICATORS
	Vegetal cover	Proportion of area occupied by forests and planted forests and area occupied by forests and natural forests in establishments Vegetal cover

Source: Authors, (2019).

Table 5b - Thematic indices and indicators.

THEMATIC INDEXES	INDICATORS	COMPOSITION OF INDICATORS
INSTITUTIONAL CAPACITY	Political-administrative autonomy	Fiscal autonomy Public indebtedness Election weight Higher level employees
	Municipal public management	Informatization Urban policy councils and decentralization Urban management tools Environment Council Number of municipal conservation units
	Environmental management	Environmental NGOs Political-electoral participation
	Information and participation	Written press Press release

Source: [45], adapted by the authors, (2019).

It is observed a relationship between the indicators presented previously with the intervening actors chosen for the purpose of this study. The thematic indexes addressed in the definition of the indicators previously proposed (human quality of life, anthropic pressure and institutional capacity) are directly or indirectly related to stakeholders, society, government, private initiative and logistic operator. Some examples can be cited: the Living Conditions (HDI) indicator relates to the intervening government and society actors, the indicator Industrial Pressure (Industrial Energy Intensity) relates to actors intervening government, private initiative and logistic operator among others. Table 6 presents a matrix with the main relationships between stakeholder actors and related indicators.

Table 6 - Main relationships between the stackholders and the indicators.

Atore stakeholders	Indicators
Society	• Living conditions (HDI); Health service; Income; Urban pressure.
Government	• Living conditions (HDI); Health services; Quality of housing; • Industrial pressure; Public administration.
Private initiative	• Industrial pressure; Information and articulation; Income; Environmental health and safety.
Logistic operator	• Industrial pressure; Environmental health and safety; Income; Environmental management.

Source: Authors, (2019).

The calculation methodology was tested four times, by different methods of standardization, by assigning weights to the variables, using the techniques of multivariate analysis. This methodology can be tested in the Amazon Region or in the capitals of the six states of the region, contemplated in the proposal of this research.

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Finally, there is a close relationship between the interests associated with the implementation of a Logistics Platform, with the horizontal and vertical relations of the intervening actors, allowing an adequate deployment of sustainability indicators, linked to criteria that make the performance evaluation of sustainable development possible to identify the main positive and negative impacts associated with the implementation of a Logistics Platform.

4. 6 POSSIBLE IMPACTS (POSITIVE AND NEGATIVE) ASSOCIATED WITH A DEPLOYMENT OF REGIONAL LOGISTIC PLATFORM

Some positive impacts can be evidenced with the implementation of the Regional Logistics Platforms, according to [3]:

• Rationalize logistics activity, ordering the continent, region, state, mesoregion, microregion, municipality and district, contributing to the formalization of new businesses;

• Encourage intermodality, valuing existing structures and networks, boosting intermodal transport;

• Promote environmental gains by reducing pollutant emissions (CO2) and concentrating activities that are dispersed and poorly located;

• Contribute to the sustainable development of the region and some specific territorial areas, generating jobs and new forms of wealth creation;

• Increase competitiveness by promoting infrastructure that enhances sustainable development, turning the geographical situation into a competitive advantage;

• Improve the flow of accessibility and mobility of cargoes and people among the geographical areas served by the Regional Logistics Platform;

• Provide all the necessary infrastructure to streamline the flow of imports and exports;

• To create new jobs, specialized, demanding the increase in technical qualification, in the upper secondary courses, in the upper and post-graduate courses (specializations, MBAs, masters and doctorates) in order to improve the training of this specialized workforce;

• Develop ecotourism potential and related activities, such as commerce, restaurants, hotels, etc.

However, there are negative impacts that can be observed in the implementation of the Regional Logistics Platforms, as [3]:

• Locating the Logistics Platform in an appropriate place, in case this does not occur there will be a loss of space productivity - it is aberrant to carry them out in the city center;

• Preferably limit the traffic of cargo vehicles and the negative externalities they cause; and

• To demonstrate the operational (efficiency, effectiveness and effectiveness) performance of the Regional Logistics Platform - if this does not happen, companies will distance themselves from the logistics complex.

It is observed that the main impacts (positive and negative) are directly related to the correct performance of the intervening actors (society, government, private initiative and logistic operator). The correct implementation of the objectives of a Regional Logistics Platform presupposes the direct participation of the intervening actors, in the incessant search for the positive impacts arising from the implementation.

In the implementation of a Regional Logistics Platform, it is extremely important to supervise the regulatory agents of the government in order to ensure that policies and guidelines are duly complied with.

Performance indicators, in turn, are appropriate instruments to measure phenomena, including allowing time comparisons, which facilitates decision-making by taking into account the interests of public and private sector stakeholders, minimizing the appearance of negative impacts, to the detriment of strengthening of positive impacts, resulting from the implementation of a Regional Logistics Platform (RLP).

The infrastructure of a RLP facilitates the realization of the productive and social activity of individuals and organizations. By providing conditions for economic growth, it becomes essential to development, even if it is not in itself sufficient to guarantee it.

Among the challenges of investing in public infrastructure of a RLP are the identification and measurement of qualitative impacts of an economic, social and environmental nature. The greater the number and intensity of the expected positive and negative impacts, the more significant the need for evaluation, through performance indicators, becomes. It is worth mentioning that the logistic operations of a RLP take place in a specific space, within a specific geographic area and that its use is related to the movement of goods and services between two distinct points. In this context, it is fundamental to know both the vision of the idealizers and the opinion of the possible beneficiaries / users of the projects (intervening actors). This counterpoint aims to improve the harmony between both designers and users, providing a favorable environment for choosing the best projects from the point of view of society and government as a whole. Such procedures should aim to complement

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the traditional cost-benefit analysis, seeking results that reflect the different natures of the positive and negative impacts caused by the projects of a RLP.

V. CONCLUSIONS

Finally, the concern with qualitative economic, social and environmental impacts of the infrastructure of a RLP becomes more relevant when the logistics service is adequate. In this situation the implications of the construction of the infrastructures and the operation of the logistics equipment have ample reach and, often, almost imperceptible. Implementing and operating a RLP implies a series of positive and negative impacts on the environment of its area of influence which, when not considered, distort expectations of return to stakeholders on the implementation of a RLP.

On the other hand, there is a strict relationship between the interests associated with the implementation of a Logistics Platform, with the horizontal and vertical relations of the intervening actors, enabling an adequate unfolding of sustainability indicators, linked to criteria that make the performance evaluation of the possible to identify the main positive and negative impacts associated with the implementation of a Logistics Platform, in the view of the Stakeholders.

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Networks of Collaboration and Management in of Phytocosmetrics Companies in the Amazon

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Abstract *— Competitive increasingly markets require organizations to be competitive which is not always possible because of financial and technical constraints. These limitations can be overcome through partnerships between organizations in a network format. Networks can be considered instruments favorable to the development and success of organizations. Networks can be understood as a set of different organizations with distinct knowledge and skills that have common interests. Together they constitute a set of skills and employ varied resources, for a certain period of time, for the common goal to be achieved. Knowing the organizational profile of the companies representing the phytocosmetics segment installed in the state and knowing who their partners are and the types of knowledge they use and create can be the first step towards the creation of networks that stimulate the sector in the State, promoting local development And the competitiveness of these companies.*

Keywords *— Amazonas, Companies, Cosmetics, Networks, Partnerships, Phytocosmetics.*

I. INTRODUCTION

The concept of sustainable development has been the subject of studies and discussions on several continents. It began in the 1960s, being intensified and better delineated in 1987 in the Brundtland Report of the World Commission on Environment and Development, created in 1983 by the United Nations [1].

It is clear that concern for the environment has become indispensable for the social and economic development of nations, especially developing nations, which leads us to new paradigms of utilization of resources available for the generation of foreign exchange for cities, states and countries.

The proper use of the natural resources of the Amazon forest has been the subject of numerous discussions and public policies. Finding alternatives for the promotion of economic and social growth, linked to environmental sustainability has been intensified by studies in several knowledge segments such as energy, medicine, agriculture, business and management, among others [2] [3] [4] [5] [6] [7] [8].

The production of phytocosmetics or cosmetics containing ingredients from the forest, which is one of the activities of the bio-industries, whose relevant legislation does not impede its development, as in the case of herbal medicines, has grown significantly in Brazil and the world. However, even with the country's good performance in personal hygiene, perfumes and cosmetics, the segment in the Amazon still represents a small percentage of the national scenario [6] with only 3.6% of the companies installed in the country [9].

Between 2004 and 2015, 1113 companies were legally installed in Brazil, linked to the cosmetics industry, of which only 6 in the State of Amazonas [9]. The country's Gross Domestic Product between 1997 and 2014 grew around 64.8%, while the cosmetics market grew 389.4%; On average 9.2% in the last 18 years [9].

Competitive markets are increasingly demanding that organizations be competitive. Organizational competitiveness has been studied by authors [10] who attribute the success of many organizations to the capacity to generate knowledge and innovate, which is not always possible due to financial and technical limitations.

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These limitations can be overcome through partnerships, which can be performed between organizations acting in a network format. Networks can be considered instruments favorable to the development and success of organizations. The links between the members represent a channel for transferring knowledge and technologies, stimulating innovation and competitiveness.

Despite being a field of knowledge in development, collaborative networks are already recognized as a way for companies from different segments to survive in dynamic environments in which technologies, society and markets are constantly changing. These networks have also been seen as a way to create value, since they allow the development of new capacities to deal with the uncertainties, needs of innovations, mass customization and competition [11] [12] [13] [14].

In view of the significant growth in the segment of cosmetics, perfumery and personal hygiene products in the last 18 years, and the potential that the Amazon has for the production of cosmetics with ingredients derived from local biodiversity, this chapter intends to present the organizational profile of the companies representing the Segment of phytocosmetics installed in the State, to know who their partners are and the types of knowledge they use and develop, so that it is possible later to seek mechanisms to stimulate the sector in the State, through partnerships in the form of networks, promoting development Competitiveness of these companies.

II. NETWORKS OF COLLABORATION

The current scenario is characterized by numerous changes in markets, technologies and organizational structures. Stopping knowledge of technology, promoting technological learning and innovation are essential elements for the survival and development of organizations, reflecting on society and the economy.

The ability to generate and absorb innovations is being considered, more than ever, crucial for an economic agent to become competitive. However, in order to keep pace with the rapid changes taking place, it is extremely important to acquire new skills and knowledge, which means increasing the capacity of individuals, companies, countries and regions to learn and transform this learning into a factor of competitiveness. This dynamic process of obtaining and developing knowledge for technological advancement and innovation is fundamental to the knowledge-based or, more specifically, learning-based economy [15] [16].

Faced with the speed of changes and pressures suffered by the market, the process of creation and transformation becomes increasingly complex: in any area, there is more available knowledge than time to process and transform them, as well as these processes , Usually involve multidisciplinary knowledge, which may make it more difficult to manage knowledge, increase the cost and time for processing, internalization, analysis and transformation of knowledge [11] [17] [13] [18].

Although many consider today that the process of globalization and the spread of information and communication technologies allow the easy transfer of knowledge, it is observed that, contrary to this thesis, only information and some knowledge can be easily transferable. Crucial elements of knowledge, implicit in research, development, and production practices, are not easily transferable because they are rooted in specific people, organizations, and locations. Only those with such knowledge may be able to adapt to the rapid changes imposed by the market [19], which will only be possible if companies have flexible, dynamic and adaptable organizational structures favorable to the process of communication and creation of knowledge [20].

This complex dynamics of the innovation process requires efficient and effective actions that articulate the diverse inputs, which is not always possible to a single organization with limited technical and financial resources, thus requiring the need to establish partnerships with several entities and organizations, seeking to Such as the possibility of working in cooperation networks [21].

Collaborative networks help businesses survive in dynamic environments. These networks have also been seen as a way of creating value by enabling them to develop new capabilities to deal with uncertainties, needs for innovations, mass customization and competition

Numerous benefits have been associated with the emergence and development of innovation networks such as the ability to access external resources and a broad knowledge base, analysis of new opportunities, and the development of core competencies of the company. Therefore, it is not surprising that so many disciplines have noticed the importance of the issue. Even if they have different approaches, these search currents share a common starting point: innovation networks emerge through the collaboration of multiple stakeholder groups. Companies, universities, private research centers, public institutions, investors, government agencies, and many others.

With regard to studies on collaborative networks for the phytocosmetics segment in the State of Amazonas, we find the work of [3], which deals with knowledge networks for the areas of drugs and cosmetics in the State. Based on the methodological basis, the principles of knowledge networks sought to identify and analyze the

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relations of exchange established between actors belonging to government, private companies and institutions that promote knowledge. For the formation of knowledge networks, the mobilizing programs (governmental and non-governmental actions aimed at promoting the activity of pharmaceuticals and cosmetics in the state) were used as a basis.

In the work it was verified that the knowledge is produced by public and federal teaching and research institutions; That the learning process in the network of knowledge of pharmaceuticals and cosmetics is used for the training of human resources (postgraduate, courses, lectures seminars). The knowledge transmitted is of the technical and management type [3].

In the State of Amazonas, the biotechnology division / multidisciplinary support center and pharmacy course of UFAM, coordinations of research of natural products, botany and physiology of the Instituto Nacional de Pesquisas da Amazônia – INPA, Fundação Oswaldo Cruz, EMBRAPA, Fundação de Medicina tropical e Hemocentro do Amazonas would have the capacity to develop knowledge in the segment of drugs and cosmetics [3].

2.1 Concept and Formation of Networks

Collaboration can be conceptualized as the process where an objective is achieved with the help of something or someone. Assist, participate. It is a process in which institutions share information, resources, and responsibilities to plan, execute and evaluate activities together. Collaboration implies trust, effort, and dedication. In addition, it is important to maintain a close and comprehensive interaction to facilitate the exchange of tacit knowledge information, to create technological skills and to solve problems of resources and capacities not always available in the company [22].

The collaborative network is a link between several organizations that are independent, geographically distributed and heterogeneous in terms of their operational environment, culture, goals and social capital, but which share information, resources and responsibilities to plan, implement and evaluate activities together To achieve common and compatible objectives [23] [22].

The main benefit of networks is that they bring together participants (in this case individuals and organizations) who could not normally have access to each other. Although there is a tendency for participants to be attracted to others as themselves, studies on networks have demonstrated the importance of heterogeneous agents [23] [13] [18].

[23] list as benefits and reasons for the collaborative work: to increase performance in the market; Increase the use of resources (assets and liabilities); Improve customer service; Reduce the cost and time of product development; Share costs to increase product quality; Increase and improve technical and managerial skills and knowledge; Obtain technology with participating companies to achieve economies of scale in production; Reduce risk; Reduce inventory to gain rapid market access and increase flexibility to reach an international presence for micro and small enterprises; To deal with change.

Similarly, other authors have identified that the effectiveness of collaboration in networks, especially those of innovation, can be determined by elements related to the participants, such as the company's overall strategy, the intensity of innovation [24], technological capabilities of [25]. [26] pointed out that power, trust, coordination, communication, efficiency and research and development harmony are the key elements for effective management of innovation networks.

The concept or notion of innovation networks is shaded by the evolution of concepts of innovation systems. This is especially true when one presents the broader notion that innovation networks involve processes of interaction between heterogeneous actors producing innovations at any level of aggregation (regional, national, global). In principle, processes of interaction between heterogeneous actors occur in innovation systems, although in the approach of innovation systems, the most relevant concern is the capacity or elements necessary for companies to innovate. Viewed from the perspective of public policies, innovation systems refer to innovation processes in a generic way and to how they affect the economic development of a country, region or sector [27].

Harmony is defined as the development of mutual interests among the actors in a network. Actors involved in partnerships, at any stage of an innovation process, should seek to understand one another's perspectives, to resolve their conflicts on the smallest possible issues, at the level of debate rather than simply to accept them. A degree of conflict may be necessary for innovation, while at the same time cooperation may be necessary for efficiency [26].

In order to be competitive in a cooperative network, organizations must adopt a mutually beneficial position with the other participants of the network, where each one has its specific competence, and it is essential to develop a compatible organizational infrastructure, allowing members of the cooperation network to share their Resources, supporting at the same time the operations to be carried out in order to achieve the proposed objectives, and to build adequate management methodologies,

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guaranteeing high performance of the business activities [23].

The networks have a cycle composed of the identification of an opportunity, the identification of an opportunity, the identification of an opportunity, the identification of an opportunity, Creation, operation and dissolution. After identifying the business opportunities, the organizations belonging to the networks need to be structured in order to achieve certain objectives. Once you reach your goals, the network disappears and you are either looking for new business opportunities.

Network actors are often heterogeneous, needing tools that match language and procedures. Thus, protocols or planning are developed, identifying the responsibilities of each one, cultural aspects and ethical values, as well as the common way of doing the actions. There is a division of the tasks, so that those who have a certain competence suppress the actors who do not have them. In most cases, it has been found that there is an attempt to equalize knowledge so that the transfer process is well assimilated, impacting on the result to be achieved (for example, a training program) [11] [23] [13] [28] [25] [29] [30].

Facing the challenges, [25] stresses that an appropriate reference model, support infrastructures, management and technological alignment of relationships are necessary for the success of networks. Inhibitors and challenges can be mitigated through clear organization, adequate workforce, finance, communication, skills and partnership development. It is necessary to develop the capacity for interoperability, that is, solutions that ensure the minimum exchange of data and information between autonomous and heterogeneous actors belonging to the network, all without losing focus on their commercial activities. In such contexts, companies must continue their routine activities of distribution and marketing of products. At the same time, they are developing new network innovation activities.

2.2 Structure and Dynamics of Collaboration Networks

The structure of a network is defined as the web of links that are established between the elements that constitute a set of organizations. In this sense, the structure can provide elements for the integration and coordination between companies, it allows to verify the interfaces and to seek the optimization of resources and competences. Its dynamics is related to the exchange of information, the necessary relations for the achievement of the objectives to which the networks propose [31].

The structure and dynamics of a network can demonstrate how interorganizational relationships occur, the flow of knowledge between the institutions that comprise it, the form of information exchange, the services used, the use of infrastructure, technological development and technology transfer. Interorganizational relationships refer to any type of contacts between two or more organizations, and may occur between similar or unlike organizations, involving transactions, flows and resource links.

[13] detected that the relations between the actors existed even before the formation of the network. The proposal to create a network that solved a certain situation was presented by the participants who saw the possibility of reducing their institutional deficiencies. Such relationships can facilitate the dissemination of information and knowledge to centers and work groups that were not initially connected.

These informal relationships (networks) tend to be based on personal contacts or "communities of practitioners," or simply arise in the normal course of business. It is important to note that formal or coordinated networks can be targeted, facilitate the achievement of objectives and can be coordinated by business organizations such as chambers of commerce, research associations, technology services companies, consultants, universities, public Research or sponsored by local, regional or central government resources [32].

Partnerships between organizations allow existing constraints in organizations to be overcome. Networks can be considered instruments favorable to the development and success of organizations. The links between the members can be a channel for transferring knowledge and technologies, stimulating innovation and competitiveness [32].

According to the [32], the number of different partners for each category is relevant because it makes it possible to distinguish between the largest and the smallest agents in the networks. The number and duration of relationships are also important. Ideally, this could contribute to the identification of the importance of the different relationships that constitute the networks around the companies.

[3] presented the structure and dynamics of three sub-networks of knowledge originated from the production of cosmetics set up in 2002, from the signing of a contract, established under the Technological Export Support Program (PROGEX) Between Renata Baraúna Silva, SA Pharmakos, Pronatus do Amazônas Industry and trade in pharmaceuticals and cosmetics Ltda., Companies in the cosmetics and pharmaceutical manufacturing sector, located at Centro de Incubação e Desenvolvimento Empresarial - CIDE and FUCAPI, for survey and study To overcome technical barriers (various analyzes) aimed at the export and adaptation of the products to the standards of ANVISA and the European community.

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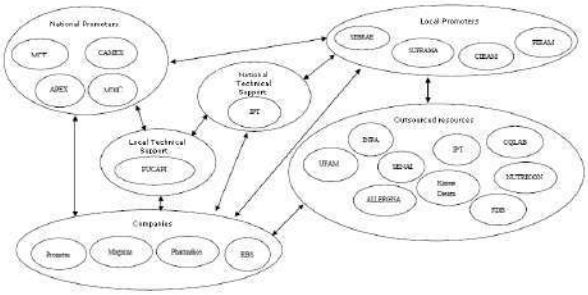

Fig. 1. Network and flow of knowledge established by the PROGEX mobilizing agent, where three cosmetics manufacturers were presented in the State of Amazonas. Source: [3].

According with Pimenta's (2005) research (Figure 1), The national promoters (MCT, MDIC, CAMEX and APEX) and local (SUFRAMA, FIEAM, CIEAM and SEBRAE) promoters of PROGEX responsible for local technical support (FUCAPI), CIDE and the company Renata Baraúna Silva [3]. The knowledge required for the improvement of product quality and the implementation of the studied production process flow through the network; Compliance with international technical standards; The conduct of laboratory tests and safety and efficacy tests of the product; The adequacy of product design and the development of packaging.

According to [8], currently this segment of cosmetics, personal hygiene products and perfumes count with 15 companies installed and operating in the State. Despite the importance of phytoindustry for the development of the State, few have been the big companies that have settled for the production of phytocosmetics in the Amazon.

Many reasons may be inhibiting or constraining the development and installation of these companies in the region such as technical standards, market-relevant legislation, lack of partners, funding, research and development. In order for the phytocosmetics industry to become a sustainable alternative to the economic model applied to the Northern Region, more efforts will be needed to optimize relations in research, teaching, technological development, production chain and relevant legislation among the actors involved in the Chain reaction [8].

III. METHODOLOGY

For this research, a multiple case study approach was used to understand the nature and complexity of a given phenomenon, occurring simultaneously in several institutions. Multiple case studies were chosen, since they allow a more dense research, increasing the external validity and contributing to obtain more realistic results [33].

The case studies were carried out in companies producing phytocosmetics (cosmetics, personal hygiene products and perfumes, which have some ingredient derived from the Amazonian biodiversity) installed in Amazonas, except handling pharmacies.

Through research carried out on a scientific basis, studies were identified that mentioned 15 different companies that would act in the manufacture of cosmetics, perfumery and hygiene products in the State. The survey on the web allowed the identification of another 12 companies in the segment. From a total of 27 companies identified, it can be confirmed that 15 of them are producing cosmetics, perfumes or personal hygiene products with inputs of the Amazonian biodiversity, presented in Table 1 [8].

According to the start date of operations of the identified companies, it was observed that 73% of them started operations after the year 2000, when there is an effort by the State of Amazonas to promote the local bio-industry. Still, according to cadastral data, it was possible to verify that, of the companies headquartered in the capital, 57% have some physical support from the State or from local Incubators [8].

Table 1: List of identified companies.

Seq	Companies
1	Amazon Ervas
2	Amazon Green
3	Anna Morena Fitocosmeticos da Amazônia
4	Aroma Ativo
5	Beleza da Floresta
6	Bella Cabocla Produtos Naturais Da Amazônia
7	Bio essência - Anauá
8	Cheiro Amazônico
9	Empório & Aromas da Amazônia
10	Gotas da Amazônia
11	Harmonia Nativa
12	N. L. Mayer – Amazon Biocare
13	Natus - Esponjas Vegetais da Amazônia
14	Pharmakos d´Amazonia
15	Pronatus do Amazonas

3.1 Methods of Data Collection

Contact was made with fifteen (15) companies, of which 13 (thirteen) of them were interviewed and the other two (two) did not return on the possibility of scheduling an interview.

The data collection instruments were composed of three (3) thematic sections to guide the research, the first one referring to the characterization of the organization, the second about the partnerships and the third identifies

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the types of knowledge generated and those received from the partners. For the thematic section 1 a questionnaire form was elaborated and in the sections two and three interview scripts were applied. The applications of the two instruments had an average duration of 50 minutes.

E-mail and telephone conversations were also used as a means to clarify doubts and supplement data. Data collection was performed between March and December 2014.

Personal interviews, considered as a vital source of information in case studies, were structured with key informants (managers) within the organizations and recorded in order not to lose any information that might be relevant to the work. Thematic sections were structured with the purpose of obtaining information about the organizational structure, taking into account that the partnership process and the creation of networks initially require a basic support of planning and management of the companies. Information was sought on who the partners would be and the nature of the partnership, as well as what types of knowledge were exchanged with these partners.

3.2 Tabulation and Data Analysis

The questionnaires were tabulated with the aid of electronic spreadsheets and analyzed by means of descriptive statistics. The results were presented by means of graphs.

The recorded interviews were transcribed and analyzed with the help of text editors and their analysis was carried out through the content. Attention was paid to aspects related to the thematic sections (characterization of the organization, partnerships, types of knowledge generated and those received from partners), established in this work, in order to obtain knowledge about the inherent aspects.

IV. RESULTS AND DISCUSSIONS

Of the fifteen companies currently operating in the cosmetics market in the State of Amazonas, it was possible to apply the research instruments to 13 (thirteen) of them. It was found that 31% of the companies interviewed produced and commercialized products from other segments as functional foods. All, however, produce and commercialize at least one cosmetic product.

In agreement to [34], cosmetics are hygiene products and perfumes consisting of natural or synthetic substances, used externally in various parts of the human body, skin, capillary system, nails, lips, external genitals, teeth and mucous membranes of the Oral cavity, have the sole and primary purpose of cleaning, perfuming, altering their appearance and / or correcting bodily odors and either protecting or keeping them in good condition. Among the cosmetic products produced by the companies interviewed we have soaps, intimate soaps, vegetable sponges, shampoos, hair conditioners, bath oils, environmental scents and others.

4.1 Characterization of the Organizations Producing Phytocosmetics in the State of Amazonas.

It was verified that 84% of the companies interviewed are small and medium-sized enterprises, which, according to studies cited by [22], "have scarce human and financial resources, limited managerial competence, making it difficult to anticipate market needs." Small and medium-sized enterprises are considered to be important economic pillars [35], and are more likely to establish collaboration agreements with other organizations to meet their undeveloped or insufficient skills [22].

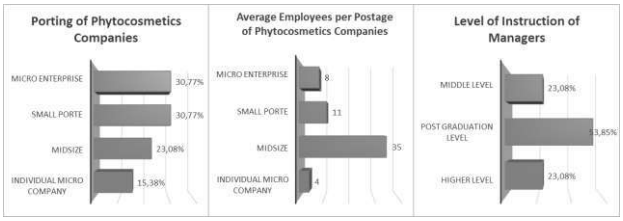

Fig. 2. Portion of the Phytocosmetics Companies of the State of Amazonas and Average Employees.

The average number of employees per company size is in line with the SEBRAE classification (2014), of which: companies with up to 19 employees are considered micro enterprises; From 20 to 99 employees are small companies; 100 to 499 employees are medium-sized companies; And above 500. According to [36] all companies surveyed are included in the Small Business Classification, are made up of micro and small enterprises and individual microentrepreneurs.

It was also verified that the level of education of the managers of these phytocosmetics companies is that 77% have undergraduate or postgraduate studies and have family management.

These micro, small and medium-sized enterprises have, in their almost total majority (92.31%), a clear division of activities and responsibilities within the organization, even though sometimes the same person has different responsibilities [37].

About 92% of companies have planned to develop new products or processes, however, only 23.08% of companies interviewed have stated formalized strategic planning. According to the interviewees, their plans are not coded, but they do forecast costs and investments. The lack of well-defined planning can imply in the company's internal capacity to implement competitive strategies with a focus on innovation [38] [39].

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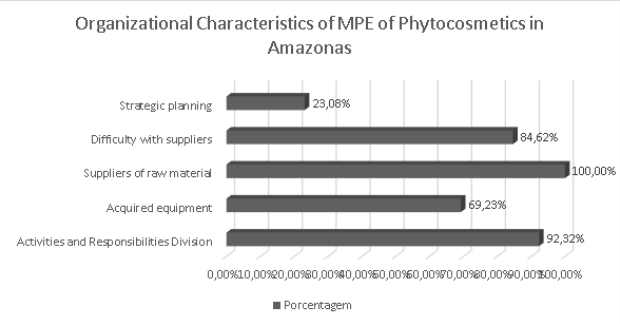

Fig. 3. Characteristics of Phytocosmetics companies in the State of Amazonas.

The equipment used for the production process was in 69.23% of the companies interviewed, acquired. The remaining 30.77% reported having purchased non-specific equipment from the production area, adapting them to production requirements. This can be considered the initial step in an innovation process, which results from adaptation / improvement of existing machines and equipment or product-related processes, adaptations and improvements [40].

All the interviewees stated that the raw materials used in their phytocosmetics production processes come from local suppliers and 84.62% of the interviewees have some difficulty in cooperation / negotiation with suppliers due to technical and / or geographical issues, Difficulty in maintaining the quality and continuity of inputs. [41] suggest as an alternative to this type of situation, the use of raw material from cultivated areas, thus improving supply chain control, chemical variation and quality of inputs, which in the State practically Has not been done, with the exception of two interviewees who mentioned having cultivated areas for the partial supply of their production lines.

All phytocosmetics firms interviewed stated that training is fundamentally important and encouraged by company managers. However, only 30.77% of them declared that they can apply the knowledge obtained in their productive processes. This fact is, according to interviewees, because many training programs have impractical content for their current technological and financial levels.

Information and communication technologies are considered relevant by all companies interviewing and all have stated that they use some degree of technology investment to improve their products or production processes (through market surveys and technical information).

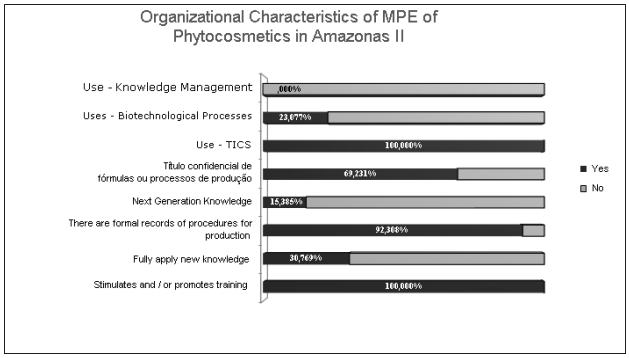

Fig. 4. Characteristics of Phytocosmetics companies in the State of Amazonas.

Only 15.38% of the phytocosmetics companies interviewed stated that they use state-of-the-art knowledge in the development of their products, which means that, according to managers, their production processes are relatively simple, with low aggregate inputs and Their equipment does not require high technologies. Despite the low technology added to the production process, 69.23% declared to make the greatest possible secrecy about their production processes.

In the perception of the managers interviewed, only 23.08% use biotechnological processes in the development and production of their products. However, they emphasized the importance of processes for the development and use of new components of biodiversity in the cosmetics segment. No organization interviewed has any knowledge management system implemented in their companies. They recognize the importance of "knowledge", especially those related to plant properties. However, knowledge in companies is at an unspoken level.

In the matter of the networks presented by [3] they were not mentioned by the managers. This may have occurred because of the end of the network life cycle. After the objectives have been reached, they will be dissolved [11] [23] [13] [28] [25] [29] [30]. Several actors mentioned by the managers in this research are the same ones described in the work of [3], which reflects their continuous performance.

4.2 Partnerships and Recognized Competencies

Contemporary organizations are embedded in a dynamic system, subject to abrupt changes, with emerging technological complexities in the goods and services segments, and in order to remain in the market, they must achieve ever higher levels of efficiency and effectiveness. Innovation, whether product, process, marketing or management, must be constant to meet the demands of an increasingly dynamic market. Small and medium-sized phytocosmetics companies in the state of Amazonas do not escape the general rule and, in order to

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obtain competitive advantages, they need to win partners to develop competences that, alone, could not achieve their limitations. "In the new scenario, there is a need for partnerships so that new products and processes achieve their true usefulness, which is to improve the quality of life of humanity" [21].

It was found that 92,31% of the phytocosmetics companies interviewed stated that they were part of or have already done some kind of partnership with government / non-profit institutions / bodies. Suppliers are seen as partners by 76.92% of respondents and 53.85% of respondents said they have or have already partnered with competitors.

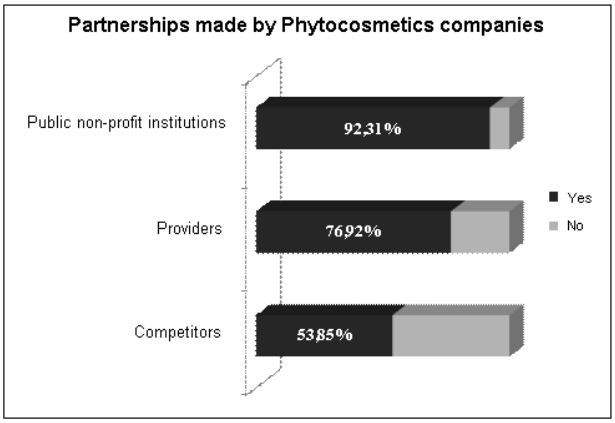

Fig. 5. Partnerships

Partnerships between organizations allow existing constraints in organizations to be overcome. Networks can be considered instruments favorable to the development and success of organizations. The links between the members can be a channel for transferring knowledge and technologies, stimulating innovation and competitiveness [32].

Six different companies were mentioned as partners. However, it was observed that the perception of partnership was not always reciprocal. [25] emphasizes that many small and medium-sized enterprises may lack experience and techniques for building relationships beyond the immediate contractual status and lose to the efficiency of approaches.

The lack of reciprocity leads one to consider the existence of unresolved conflicts in the partnerships. There was an absence of harmony. As for the suppliers mentioned, these are outsourced laboratories responsible for testing on cosmetics or on prototypes. Also mentioned were cooperatives, responsible for material for packaging and raw materials.

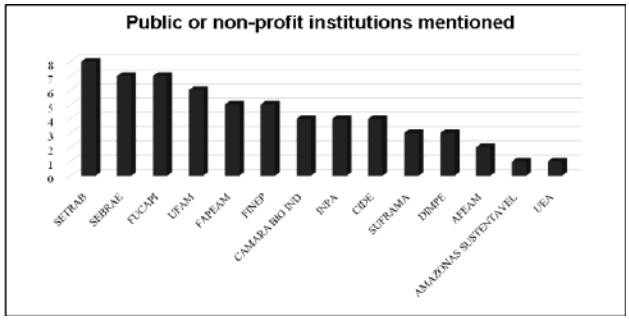

Fig. 6. Public or non-profit institutions mentioned as partners

Figure 6, shows the public and/or non-profit institutions mentioned as partners

1. SETRAB - Secretaria de Estado do Trabalho do Amazonas is responsible for implementing government policy. It was mentioned for having organized and invited companies to participate in fairs. She was also mentioned as responsible for the Handicraft Fair of the Avenida Eduardo Ribeiro. It was noticed, however, that currently the fair is under the responsibility of the Association of Handicrafts Fairs of Amazonas, non-profit entity. This mistake can also be explained by the fact that SETRAB is responsible for the registration of Artisans in the State. Thus, for owners of small and medium businesses in the area of cosmetics in the state to trade in the fair, held on Sundays, must own a portfolio of craftsman obtained at this Secretariat.

2. SEBRAE - Serviço Brasileiro de Apoio às Micro e Pequenas Empresas is a private not-for-profit entity. IT was mentioned as a partner because of the numerous courses offered, mainly in the area of management.

3. FUCAPI - Fundação Centro de Análise, Pesquisa e Inovação Tecnológica is recognized by managers of phytocosmetics companies as a partner in educational and technological activities and was also mentioned by virtue of the business incubator.

4. UFAM – Universidade Federal do Amazonas. The Institution was mentioned as a partner in staff training and also in the development of research.

5. FAPEAM (Fundação de Amparo à Pesquisa do Estado do Amazonas) and FINEP (Financiadora de Estudos e Projetos), were mentioned for making available to the segment the promotion to the research and development of its products / processes. It was also mentioned, in the development segment, the AFEAM - Agencia de Fomento do Estado do Amazonas.

As partners that provided physical support were mentioned:

- DIMPE - Distrito Industrial de Microempresas e Empresas de Pequeno Porte do Amazonas, connected to Secretaria de Estado de Planejamento, Desenvolvimento, Ciência, Tecnologia e Inovação – (SEPLAN-CTI).

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- SUFRAMA - Superintendência da Zona Franca de Manaus, autarquia vinculada ao Ministério do Desenvolvimento, Indústria e Comércio Exterior which manages the Zona Franca de Manaus, and CIDE - Centro de Incubação e Desenvolvimento Empresarial which in addition to the physical support also provides technical and management support through the partnerships).

Researchers from Instituto Nacional de Pesquisas da Amazônia – INPA and Universidade Federal do Amazonas – UFAM were mentioned as partners in the development of research and professional training.

When questioned about participating in a network or group that dealt with the development of the segment or that had this function, four managers mentioned the possible participation in meetings of the Câmara Setorial da Bioindústria, collegiate, consultative, support and intermediary organizations in the representations, promotions and Defense of the interests of the State's economic development, together with other chambers, makes up the organizational structure of the Secretaria de Estado de Planejamento, Desenvolvimento, Ciência, Tecnologia e Inovação – SEPLAN-CTI. They also expressed some dissatisfaction with the content of the discussions and did not have an interest in maintaining participation in the meetings of the chamber.

They also expressed some dissatisfaction with the content of the discussions and did not have an interest in maintaining participation in the meetings of the chamber.

Credibility and trust in coordinating a network are extremely important to ensure that multiple actors can work with cohesion. Coordination is defined as the concatenation of different actors, so that each part of the relationship can perform some tasks to achieve collective goals [26].

4.3 Knowledge used by Phytocosmetics Companies

At this time, organizations face a new competitive and unstable scenario, which requires a rapid response to the market and the consumer. To do this, you need to have the knowledge to respond effectively to change. It was verified that the companies of the segment of phytocosmetics demand knowledge of management, marketing, technical and scientific knowledge. What differs between the companies studied is the level of knowledge that each one holds until the moment.

The main knowledge they develop is related to the areas of formulation of their products, improvements in the production process, equipment adaptation, raw material quality, testing and product quality control.

According to [34], personal hygiene products, cosmetics and perfumes are classified in Group 1 and Group 2, according to the "probability of occurrence of unwanted effects due to improper use of the product, its formulation, purpose of use, areas of Body to which they are intended and care to be observed when in use ". The products of Group 2 require larger manufacturers require, safety and / or efficacy proof as well as information and care, mode and usage restrictions, which requires companies to higher level of knowledge.

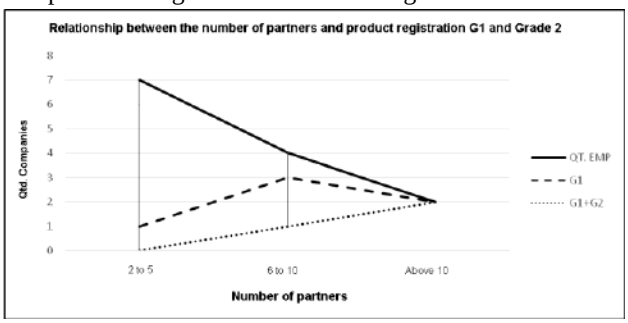

Fig. 7. Relationship between number of partnerships and registration of Products G1 and G2.

It was found that companies with fewer partners have more lack of knowledge related to business management, bureaucracies with sanitary surveillance agencies, need technical support for stability and quality of production.

As shown in Figure 7, seven companies surveyed have up to five partners and among them only one has notification on the ANVISA website. The company that has the notification of products of Group 1 has few partnerships because its management is made by a Mexican group that bought the company from the former owners.

Among four companies with 6 to 10 partners, it was found that 3 of them have records of Group 1 products and one of these three also has a Group 2 record. A company in this group does not have any type of product registration. This fact may have occurred because this company was newly incubated and still in the process of regularization with the agency. The two companies with more than ten partners have records of Group 1 and Group 2 products.

Thus, it was found that only 46% of phytocosmetics companies have their production procedures duly coded and authorized or notified by ANVISA.

It is understood that these procedures duly registered or notified to the agency were constituted by the technical and management knowledge of the companies in the segment.

The managers of the companies have stated that they do not use their knowledge of traditional communities in the development of their products, they use popular knowledge, usually derived from the knowledge of families about the use of plants and are transferred from generation to generation through stories and recipes "curators ".

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According to the managers, the great challenge is to prove the effectiveness of these revenues and register them. Codification of production knowledge is essential for companies in the phytocosmetics industry. In addition to regularization, such knowledge can be valuable in an innovation process at various stages of the process [12].

V. CONCLUSION

The phytocosmetics companies of the state of Amazonas are micro, small and medium-sized enterprises and individual microentrepreneurs, and are therefore small businesses;

- Most managers of micro, small and medium-sized companies have a complete upper level;
- Organizations have a clear view of activities and responsibilities within the organization, even when sometimes the same person has different responsibilities.
- Most companies do not have formal strategic planning; Make cost forecasts and investments empirically. Even so, they are always planning new products or new ways of producing, concerned with meeting market demand and reducing costs;
- Often the equipment available in the market to be used in the productive processes of these micro, small and medium enterprises do not meet the production capacity of the companies. They are generally developed for large companies, in some cases;
- The raw materials used in the great majority of companies come from suppliers located in the State itself and the managers experience difficulties in negotiating or technical issues of the quality of the inputs with these suppliers;
- Although all companies stimulate training and training, no company can put into practice all the knowledge gained. Generally the reality of the company is different from the theoretical model of the training and its physical and financial availability are incompatible with the instructions passed on in the training.
- They recognize the importance of biotechnology and knowledge management for their enterprises, but declare that they do not use or use very little of these processes. Relying on R & D expenditures and lack of patent registration, one can characterize applied technologies in the productive processes of companies as low technology.
- Despite the small amount of technology added to the production process and the product, companies seek to maintain the confidentiality of their production processes, avoiding to share them with third parties, which demonstrates a high degree of mistrust.
- They have not mentioned any network participation currently. Some have stated the existence of the industry chamber of the bioindustry and have not shown much interest in participating. According to some interviewees, the sectoral chamber was not very objective in the resolution of demands of the segment, the discussions were at the institutional political level and the businessmen of the segment demand concrete results. They also declare that they do not attend meetings because of the few observable results;
- Most of the declared partners are public and non-profit institutions, which demonstrates the importance of public policies for such support to be possible;
- There is a mistrust in partnering with competitors. Trust is greater when partnerships are sought with suppliers;
- The main partner mentioned was SETRAB - Secretaria de Estado do Trabalho do Amazonas for organizing companies to participate in fairs. They also mentioned the Eduardo Riberio Avenue Fair, which is currently coordinated by the Association of Craft Fairs of Amazonas. SEBRAE - Serviço Brasileiro de Apoio às Micro e Pequenas Empresas recognized by courses in the area of management. FUCAPI - Fundação Centro de Análise, Pesquisa e Inovação Tecnológica that is recognized by managers of phytocosmetics companies as a partner in educational and technological activities and was also mentioned by virtue of the business incubator. UFAM - Universidade Federal do Amazonas. was mentioned as a partner in staff training and also in the development of research.
- Also mentioned, Fundação de Amparo à Pesquisa do Amazonas – FAPEAM and Financiadora de Estudos e Projetos - FINEP were involved in the promotion of research and innovations as well as actors that provide physical and technical support such as the Distrito Industrial das Micro e Pequenas Empresas - DIMPE, and the Centro de Incubação e Desenvolvimento Empresarial – CIDE;
- State phytocosmetics companies have production, management, marketing and differentiated techniques. Of the interviewees, five more experienced companies demand knowledge related to science and technology, related to the development of new products and packaging while others need management knowledge and bureaucratic aspects related to sanitary surveillance agency authorizations;
- Knowledge in most companies is tacit. The codified knowledge was acquired mainly by the acquisition of machines and equipment;
- The main knowledge they develop is related to the areas of formulation of their products, improvements in the production process, equipment adaptation, raw material quality, testing and quality control of the product;
- There is a lack of cooperation strategies among most of the companies interviewed. Joint actions need to be

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designed to meet the real needs of micro, small and medium-sized companies in the segment;
- Local management companies that have more connections have more products notified at ANVISA.

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On the Effectiveness of Interactive Detection of Code Anomalies: An Empirical Assessment

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***Abstract*—*Background: Detection of code anomalies should be performed as early as possible in order to effectively reveal refactoring opportunities in due time. Refactoring aims at improving software maintainability, but their late application is counter-productive or even prohibitive. Detection of code anomalies is traditionally supported by non-interactive detection (NID) techniques, which encourage developers to reveal anomalies in later revisions or versions of a program. The reason is that this technique does not support progressive interaction of developers with anomalous code. In addition, it reveals anomalies in the entire source code upon an eventual developer request. More recently, the notion of interactive detection (ID) has emerged to address NID's limitations. This technique reveals anomalies when code fragments are still being edited and without an explicit developer request, thereby encouraging early anomaly detection. Problem Statement: Recent studies suggest the use of NID might lead to: (i) a low number of correctly identified anomalies, and (ii) ineffective refactoring actions. Although ID seems promising, there is no knowledge about its impact on anomaly detection and refactoring actions. Goal: Evaluate the effectiveness of an ID technique on early anomaly detection. In addition, we analyze the aid of an ID technique in performing effective refactoring actions. Method: We conducted a controlled experiment with 14 subjects that underwent tasks related to anomaly detection and judgments of required refactoring actions. Results: Our study reveals the use of ID improves anomaly detection as developers tend to early identify more anomalies when compared to the use of NID. Conclusions: Although ID contributes to detect more anomalies than NID, the former may induce to ineffective refactoring actions.*

Keywords*—*Code Anomalies, Interactive Detection, Software Refactoring.

I. INTRODUCTION

Code anomalies are structures in a program that often indicate the presence of deeper maintainability problems [1]. Code anomalies should be early detected, during the ongoing implementation of a program rather than in later maintenance tasks. Early detection of anomalies is likely to lead to effective refactoring actions [2]. Refactoring is a behavior-preserving change in the program structure intended to remove code anomalies and improve software maintainability [1]. However, the early detection of code anomalies is not a trivial task and many factors can hinder the realization of this task. Among those factors, we highlight that developers may not be able to early identify code anomalies due to their lack of experience on this task [3]. In addition, conventional techniques may offer limited support or discourage early detection of code anomalies [3].

Several techniques for (semi-) automated detection of code anomalies have been proposed in the literature (e.g. [3][5][6][7]). Most of these existing techniques are characterized as supporting non-interactive detection (NID) [3][6]. NID techniques reveal a global list of code anomalies once the source code is completed and compiled. Moreover, the use of NID demands an explicit and eventual request of the developer so that the full source code analysis is triggered. More importantly, NID techniques do not offer means for developers interact with the anomalous code elements while they are producing, editing or inspecting their program statements. All these characteristics of NID techniques encourage late detection of code anomalies.

On the other hand, the notion of interactive detection (ID) has been recently proposed [6]. An ID technique is intended to reveal code anomalies in program fragments

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without an explicit developer request, thereby encouraging early detection of code anomalies. In contrast to NID, ID provides support for developers interacting with anomalous code as they edit or browse program statements. Unfortunately, there is little empirical knowledge about the effectiveness of interactive detection of code anomalies [6].

Most of the empirical studies on anomaly detection strictly focuses on the evaluation of NID [9][10][11][12]. These studies pointed out NID techniques induce to a low number of correctly identified code anomalies. Other studies also suggested NID techniques induce to the realization of ineffective refactoring actions [21][22].Therefore, the expectation is that ID techniques can better promote early identification of code anomalies and, as a consequence, effective refactoring actions. Even though organizations and developers might want to consider the adoption of ID techniques, there is no evidence in the literature about its effectiveness on anomaly detection. In other words, there is still a lack of empirical knowledge about the use of ID.

Therefore, our goal is to address the following research question: "Can the use of ID improve the effectiveness on anomaly detection and refactoring actions?". For doing so, we conducted a controlled experiment involving 14 subjects with different working experience and technical knowledge. Subjects performed tasks related to anomaly detection and judgments of refactoring with support of both ID and NID techniques. In order to evaluate the effectiveness of both techniques, we used two measures: precision and recall. We select these two measures because they have been widely adopted in other effectiveness studies involving code anomaly detection [13][14][15]. Our comparative analysis allowed us to evaluate whether some ID characteristics could bring benefits or drawbacks for effective anomaly detection.

The experimental results revealed the use of ID has achieved better effectiveness on code anomaly detection when compared to NID techniques. Developers identified a much higher number of code anomalies when using the ID. On the other hand, we have observed the use of ID might lead to a high number of false positives and, consequently, developers can be induced to perform ineffective refactoring actions.

The remainder of this paper is organized as follows. Section 2 introduces basic concepts required to understand the analysis performed in our study. Study settings are described in Section 3 while the results associated with interactive detection of code anomalies are discussed in Section 4. In Section 5, we present the threats to validity observed in our study. Related work is discussed in Section 6. Finally, we present our conclusions and point out directions for future work in Section 7.

II. BACKGROUND

This section presents essential concepts related to code anomalies, code refactoring and support for anomaly detection.

2.1 Code Anomalies and Refactoring

Code anomalies are symptoms on the program structure that may indicate the presence of deeper maintainability design problems [1]. They suggest where perfective maintenance is required in the source code [1]. Several code anomalies have been proposed and cataloged by several researchers, including Fowler [1], van Emden and Moonen [13], and Arevalo [16]. Typical examples of code anomalies are Feature Envy and Long Method [1].

Early detection of code anomalies is the only possibility of promoting the longevity of a software system. Early detection is the ability of identifying opportunities for refactoring [1][19][20] as soon as anomalies are introduced in the source code by programmers. Longer the code anomalies remain in the source, harder it becomes to refactor out these anomalies from a program. Refactoring [1][17] is defined as behavior-preserving change made in structure of a program with the aim of improving software maintainability. Fowler [1] has identified more than 70 different types of refactoring, which range from local changes in a specific code element (as the Extract Local Variable refactoring) to a global change (as the Extract Class refactoring).

The effectiveness of refactoring actions is largely dependent on the effectiveness of detecting the code anomalies. Preliminary studies [21][22] have exposed negative consequences on code quality whenever ineffective and late refactoring actions are performed. Thus, developers need to identify anomaly instances more effectively and opportunely so that refactoring actions can be performed. In contrast, if developers miss the occurrences of anomaly instances, developers can perform ineffective refactoring actions in the source code.

2.2 Support to Detection of Code Anomalies

Usually, developers use (semi)automated techniques to guide their effort on anomaly detection [18][23]. These techniques are basically comprised of two components [3][7]: (i) a mechanism for anomaly detection; and (ii) a user interface responsible for displaying detected anomaly instances, i.e. occurrences of code anomalies identified by

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the detection mechanism. The detection mechanism may allow developers to choose or define algorithms for anomaly detection. Developers can choose some metrics and thresholds to compose their own detection algorithms [5]. Based on developer's interaction with the aforementioned components and the anomalous code elements, anomaly detection can be classified according to two different techniques, as shown in Figure 1.

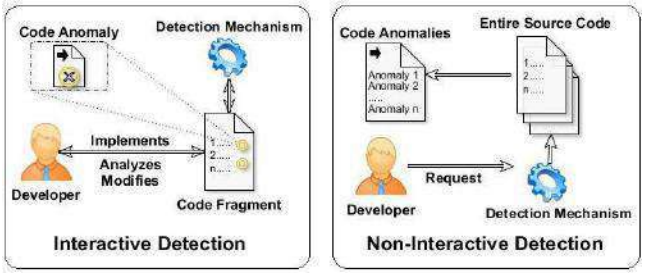

Fig.1: Comparison between techniques for anomaly detection.

Interactive detection (ID) is a technique that supports developer's interaction with anomalous code elements (Figure 1). The ID techniques reveal anomaly instances in code fragments without an explicit request from the developer. Thus, the ID techniques constantly work on detecting anomaly instances in code fragments being manipulated by the developer. Thereby, a developer using ID techniques can early identify instances of code anomalies. Once developers do not directly interact with the mechanism for anomaly detection, they are able to perform other programming activities. In summary, developers are able to analyze, modify and implement the source code while they interact with the anomalous code elements [6].

Non-interactive detection (NID) is a technique that does not support developer's interaction with anomalous code elements (Figure 1). The NID techniques reveal anomaly instances in the entire source code upon an explicit request from the developer. The mechanism for anomaly detection receives the request, and then, it detects anomaly instances in the entire source code. Thereby, developers using NID techniques identify anomaly instances only later (e.g., when code is already implemented). Once developers directly interact with the mechanism of anomaly detection, they are not able to concurrently perform other programming activities in the source code [6].

We analyze the ID technique through Stench Blossom [3]. This tool provides the programmer with three different views, which progressively offer information about the anomaly instances in the code fragment being visualized or edited. Initially, the developer interacts with the Ambient View (Figure 2A). This view relies on the metaphor of a "flower", where each "petal" represents the possible occurrence of a specific anomaly in the code fragment. Higher the radius of a "petal", the higher is the probability of occurrence of the anomaly. The mechanism for anomaly detection of Stench Blossom calculates this probability. For more information about a specific anomaly instance, the developer must click on the "petal" displayed in the Ambient View. When the developer selects an anomaly, the name of code anomaly is presented in a dialog box and then, the Active View is displayed to the developer (Figure 2B).

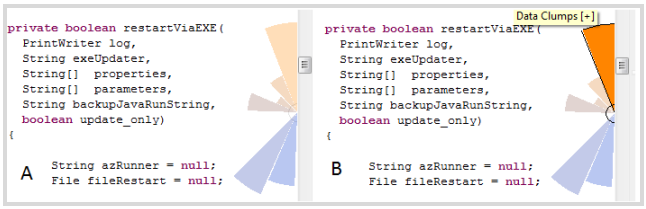

Fig.2. Ambient View (A) and Active View (B).

Finally, if the developer requires detailed information about a specific instance of a code anomaly, the Explanation View (Figure 3) can be displayed from a new click on the name of the anomaly under analysis. The developer can use the color gradation to verify which code fragments are related to a specific instance of code anomaly. Therefore, the interaction with anomalous code elements provided by Stench Blossom, allows developers better understanding the origins of different instances of a given code anomaly.

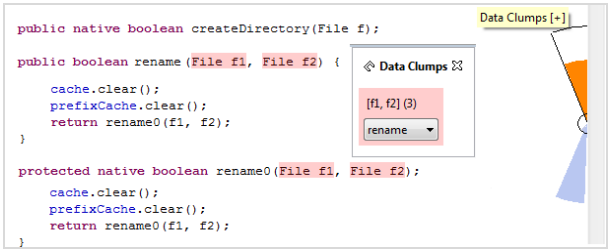

Fig.3. Explanation View.

III. STUDY SETTINGS

This section presents the main concepts related to execution of this research. The details related to the experiment, the choice of subjects and procedures for data analysis are described below.

3.1 Effectiveness evaluation

Effectiveness on detection of code anomalies is one of most important criteria for choosing a technique to perform this activity [8][9]. When a technique for detection of code anomalies is considered effective, it means the technique is able to detect a high number of anomaly instances in a program. In addition, effective techniques should ideally detect only anomaly instances

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are indeed a maintainability problem. If developers use effective techniques, they can identify anomaly instances and consequently refactoring opportunities in order to improve the software maintainability [8][9].

We used precision and recall to evaluate the effectiveness of anomaly detection. In the following, we define the concepts required to understand these two measures. Existing code anomalies (ECA) are actual anomaly instances identified by the technique for anomaly detection, where these instances are indeed confirmed by the experts as a maintainability problem. Experts are developers with deep knowledge about the system and its maintainability problems. Detected code anomalies (DCA) are anomaly instances identified through the use of an anomaly detection technique. Not all the detected code anomalies are confirmed as existing (actual) code anomalies by the experts. True positives (TP) are those anomaly instances present in both DCA and ECA sets – i.e. anomaly instances identified by experts that actually represent a maintainability problem. False positives (FP) are anomaly instances identified by the programmers using a detection technique, but they are not in the ECA set. Finally, False negatives (FN) are anomaly instances not identified by the developers, which are in ECA.

The precision and recall measures defined in above equations (Eq) were adapted from Rijsbergen [26] and have been widely used in other studies [13][14][15]. These previous studies were also focused on comparing techniques for anomaly detection. Precision quantifies the rate of true positives by the number of detected code anomalies. Recall quantifies the rate of true positives by the number of existing code anomalies.

3.2 Research Questions

In order to address our general research question (Section 1), we defined two specific goals: (i) assess whether developers using the interactive detection (ID) technique identify code anomalies more effectively compared to the non-interactive detection (NID) technique; and (ii) assess whether using ID technique lead developers to perform ineffective refactoring compared to NID technique. Thus, we defined three research questions (Table 1) to achieve the aforementioned goals.

Table 1. Specific Research Questions

RQ	Description
RQ1	Does the ID technique improve the *recall* in detection of code anomalies?
RQ2	Does the ID technique improve the *precision* in the detection of code anomalies?
RQ3	Does the ID technique contribute to perform ineffective refactoring actions?

The first research Question (RQ1) compares both techniques using precision measure. This analysis is important because it shows the effectiveness of the ID technique regarding the number of true positives and false positives. Similarly, in our second research question (RQ2), we compared the recall measure of ID and NID techniques. The recall is as important as the precision. For example, it allows us to find which technique induced developers to miss more anomaly instances.

Finally, our third research question (RQ3) is focused on evaluate how the techniques interfere in the refactoring actions. As we discussed, code anomalies are considered indicators for refactoring actions. Thus, our work consider as effective refactoring actions, those modifications applied over anomalous code elements in order to improve the system maintainability. Although, techniques for anomaly detection might indicate false positives, and hence, developers will apply refactoring actions over code elements that do not represent a true threaten the system maintainability (i.e. ineffective refactoring actions).

For each research question, we defined hypotheses (H) which are summarized in Table 2. Thereby, we defined H1 and H2 due to empirical evidence found in the work of Murphy-Hill and Black [3]. This work pointed out the use of interactive detection (ID) technique can increase the number of anomaly instances found in the source code. Therefore, our expectation is that the use of ID technique may improve the effectiveness on detection of code anomalies in terms of precision and recall measures. We defined H3 as consequence of H1 and H2. Since ID technique constantly provides (i.e. regardless developers' request) information about anomaly instances, this amount and availability of information may improve the developers' reliability on anomaly detection. Consequently, our expectation is that developers may reduce the amount of false positives and hence, a smaller amount of ineffective refactoring actions would be performed.

Table 2. Hypotheses

H	Description
H1	The ID technique has a better recall than the NID technique.
H2	The ID technique has a better precision than the NID technique.
H3	The ID technique leads to performing less ineffective refactoring actions than the NID technique.

3.3 Method and Subjects

We use the recommendations outlined in the work of Kitchenham et al. [24] as a guide for establishing and implementing a controlled experiment. The subjects

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accomplished tasks related to detection of code anomalies and identification of refactoring opportunities (Section 3.4). They performed these tasks with support of ID and NID techniques. We choose the ID technique provided by Stench Blossom [3] for two main reasons: (i) it provides support to all ID features [6], as previously discussed (Section 2.2); and (ii) to the extent of our knowledge, it is the only robust solution that provides automated support for ID.

We choose the NID technique provided by manual inspection due to it has been widely used in other comparative studies [10][3][4] of techniques for anomaly detection. In addition, this technique does not require automated detection, thereby providing no specific influence of a particular detection mechanism. Similarly, we have also not found any other automated detection technique that supports the same set of anomalies addressed by Stench Blossom. For instance, the automated detection proposed by van Emden and Moonen [13] provides support to only two code anomalies (Instanceof and Typecast). Conducting a comparative experiment against just these two code anomalies would produce quite limited results. Finally, it also provides us with a reference to analyze the impact of an automated ID technique.

The comparison between ID and NID techniques allowed the analysis of whether particular characteristics of ID (e.g. early detection) bring apparent (dis)advantages. It is not the intent of this experiment to compare various ID techniques, such as the one realized by Stench Blossom. This choice is because, to the extent of our knowledge, there is no other robust automated solution that offers an interactive technique for supporting anomaly detection. Finally, many would consider ID and NID complementary rather than competitive techniques as they are naturally targeted at different development stages (Section 2.2). Although ID and NID can be used in a complementary way, they can also be used with the same purpose during a programming activity (e.g. analysis of code fragments). In the context of our experiment, the techniques for anomaly detection were evaluated with the same purpose: detection of code anomalies while browsing code elements.

Regarding to the subjects of this study, we recruited two main groups: (i) postgraduate students and (ii) professionals developers. These subjects were selected based on the criteria of interest in participating of the experiment. We expected from subjects, at least, intermediate knowledge in Java and refactoring. However, we did not expect from subjects knowledge about code anomalies or the interactive detection technique used in the experiment. Due to space constraints, detailed description of subjects profile may be found online in our paper supplementary material [25].

3.4 Experiment Description

The subjects performed tasks related to identification of code anomalies and refactoring opportunities. In these tasks, the subjects manipulated Java code files extracted from Java Core Library [25]. We have chosen this project because is an open source industrial system, making it easier to replicate this study by independent researchers. Four code files were selected according to the similar size and amount of the code anomalies. The experimental phase required two code files – one file for the ID task (e.g. file A) and the other to NID task (e.g. file B). This criterion was adopted because both files could be used in the tasks, regardless of the order, reducing their influence on the results of the experiment. Each experimental task was individually conducted with the first author as an observer of the experiment. It is also important to mention we already provided the environment with all the files and tooling support required to execute the experimental tasks. The maximum time each subject had available for executing the experimental tasks was 60 minutes. A detailed description of experimental tasks may be found online in our paper supplementary material [25]. Finally, we organized the experiment into three different phases, namely:

Phase 1 – Pre-Experiment: Initially, the subjects answered a questionnaire to collect the necessary data for definition of subjects' profile (Section 4). Then, the subjects received a material with the definition of eight (8) code anomalies supported by Stench Blossom, as well as an example of the occurrence of each one. A detailed description of code anomalies used may be found online in our paper supplementary material [25]. A deadline of 15 minutes (maximum) was given for the subject to understand these definitions. This step was intended at leveling the knowledge of the subjects. Finally, the subjects underwent a training session about Stench Blossom and the Eclipse IDE version used in the experiment.

Phase 2 – Identification of Code Anomalies: Subjects identified the occurrences of eight (8) different types of code anomalies supported by Stench Blossom. The data related to identification of code anomalies were transcribed into a form. During the use of ID technique, the subjects could agree or disagree with the detections proposed by this technique. Thus, false positives arising from the ID technique could be omitted when subjects used their knowledge in making decisions about the existing anomaly instances. Two tasks were performed in

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this experiment phase: one with the ID and another one with the NID. We computed for each task: the total (T) number of detected code anomalies (DCA), the number of true positives (TP) and the number of false positives (FP). The data obtained from these tasks will be used to evaluate the first and second hypothesis (H1 and H2) and the Section 4.1 provides its detailed description.

Phase 3 – Judgments of Refactoring: Subjects performed judgments of refactoring using ID and NID techniques. This phase consisted in identifying of Feature Envy anomaly. We decided to focus on Feature Envy for this experimental phase, as this is the only code anomaly currently supported by the implementation of the Explanation View (Section 2.2). After the identification of Feature Envy, the subject should infer about the usefulness of applying a refactoring action. In positive case, the subject should answer the following questions: (i) how scattered is the anomaly in the analyzed code, (ii) how likely removing this anomaly and (iii) which refactoring actions are required. The aforementioned questions are directly related to judgments of refactoring [1][2]. The following concepts are required to understand this task: Ineffective Refactoring (IR) occurs when the developer positively infers about refactoring from an instance of Feature Envy anomaly, which has been considered a false positive. Effective Refactoring (ER) occurs when the developer positively infers about refactoring necessity from an instance of Feature Envy anomaly, which has been considered a true positive. The data obtained from these tasks will be used to evaluate the third hypothesis (H3) and its description can be seen in Section 4.2.

3.5 Analysis Method

We applied statistical analysis on the data obtained from experimental tasks. Such statistical analyzes were carried out with support of the R tool [27]. This tool provides means for calculating statistical tests considered in this study: (i) Wilcoxon signed-rank test [28], and (ii) paired T-Test [28]. The first one is applied to the values associated with the correctly identified anomaly instances. This test was selected since the data were not following a normalized distribution. The second one is applied to the values of recall and precision since the obtained measures were following a normalized distribution. The execution of the experimental tasks derived data for two samples: the sample with the aid of ID and the sample with the aid of NID technique. The aforementioned statistical tests can be applied since each observation in the first sample can be paired with one observation of the second sample.

IV. RESULTS AND DISCUSSION

In this section, we present the results of the experimental tasks described in Section 3.4. Each subject spent on average 45 minutes to execute the experiment. Therefore, the upper limit of one hour was enough for the subjects conclude the tasks. Whenever it is appropriate, statistical analyzes are presented. The first phase (Section 3.4) of the experiment involved the application of a questionnaire aiming to determine the subjects' profile. Table 3 summarizes the main characteristics of the subjects' profile. Their profile meets our study assumptions since all subjects have at least intermediate knowledge about Java, detection of code anomalies and program refactoring. The following subsections present the key results and findings revealed by our study.

Table 3. Results of the pre-experiment questionnaire

Question	Results
Professional practice	7 Subjects were postgraduate students and 7 subjects were professional developers
Experience time	Half of the sample had between 5 and 8 years of experience in software development
Using IDE	All subjects have used some IDE
Java proficiency	On a scale from 0 to 4 **(*)**, 36% of subjects answered 2 and 57% of subjects answered 3
Anomaly detection proficiency	On a scale from 0 to 4 **(*)**, approx. 80% of the subjects answered 1 or 2.
Refactoring proficiency	On a scale from 0 to 4 **(*)**, approx. 60% of the subjects answered 3 or 4.
(*) 0 means "not proficient" and 4 "very proficient"	

4.1 Identification of Code Anomalies

The second phase involved the execution of the tasks related to identification of code anomalies using non-interactive detection (NID) and interactive detection (ID) techniques. The tasks focused on analyzing the effectiveness of using ID on the detection of code anomalies. Table 4 describes the results per subject or full sample (FS) with respect to the detected code anomalies (DCA), true positives (TP), and false positives (FP).

Table 4. Results of identification of code anomalies

Subject	NID			Subject	ID		
	DCA	TP	FP		DCA	TP	FP
Developer 1	4	4	0	Developer 1	6	5	1
Developer 2	7	6	1	Developer 2	15	13	2
Developer 3	9	8	1	Developer 3	16	14	2
Developer 4	6	5	1	Developer 4	9	7	2

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Developer 5	10	8	2	Developer 5	11	9	2
Developer 6	12	9	3	Developer 6	14	11	3
Developer 7	6	5	1	Developer 7	5	5	0
Total	**54**	**45**	**9**	**Total**	**76**	**64**	**12**
Student 1	4	3	1	Student 1	10	8	2
Student 2	4	4	0	Student 2	5	4	1
Student 3	8	6	2	Student 3	12	9	3
Student 4	5	4	1	Student 4	3	3	0
Student 5	7	5	2	Student 5	10	7	3
Student 6	5	4	1	Student 6	6	5	1
Student 7	2	2	0	Student 7	8	6	2
Total	**35**	**28**	**7**	**Total**	**54**	**42**	**12**
FS Total	**89**	**73**	**16**	**FS Total**	**130**	**106**	**22**
FS Average	**6,1**	**5,2**	**1,1**	**FS Average**	**9,3**	**7,6**	**1,6**

ID technique increases both true and false positives: We observed the subjects identified 22 false positives when using the ID technique. That is, the number of false positives is approximately 38% higher than the number of false positives (16) produced when subjects used the NID technique. Similarly, the subjects identified 106 true positives (i.e. anomalies correctly identified) based on the use of ID technique, while subjects identified 73 true positive based on the use of NID technique. Therefore, the use of ID increased in 45% the total of true positives by the subjects when identifying code anomalies. Finally, the data related to true positives generated with ID and NID techniques were statistically significant ($p = 0.002$, $df = 12$, $z = 3.05$, using a Wilcoxon signed-ranks test [28]).

Aiming to provide an additional perspective on the effectiveness of the interactive detection of code anomalies, we also analyzed precision and recall measures. Therefore, we applied those collected measures in the equations defined in Section 3.1. The Table 5 illustrates the results of these metrics for both ID and NID techniques. The precision and recall measures were calculated in order to address the research questions RQ1 and RQ2. In addition, these results were used in order to test the hypotheses H1 and H2, respectively.

ID increases recall: When analyzing recall measures, we observed that, in average, the subjects using the ID technique achieved a score of 0.30, while the use of the NID achieved 0.21. Thus, the results represent a difference of approximately 30% in favor of the ID technique. Similar results could be observed when analyzing different samples (e.g. students or developers). For instance, the developers' sample improves recall values in 40%, while the students' sample improves recall values in 50%. Likewise, the data related to recall in this task through ID and NID was statistically significant ($p = 0.0013$, $df = 13$, $t = 4.06$, using a Paired T-Test [28]) in the task of identification of code anomalies.

We also found that recall suffers direct influence regarding the subjects' working experience. The results allowed us to conclude the use of ID can directly affect the recall values. The use of ID implies the interaction of subjects with the anomalous code elements as they progressively analyze code fragments. Therefore, developers are able to achieve more coverage with ID regarding the correctly identified instances of code anomalies. Finally, we can confirm the first hypothesis (H1), since the use of ID led to better recall values compared to the use of NID.

Table.5. Precision and recall

Subject	**ID**		**Subject**	**NID**	
	P	**R**		**P**	**R**
Developer 1	0,83	0,20	Developer 1	1,00	0,16
Developer 2	0,87	0,52	Developer 2	0,86	0,24
Developer 3	0,88	0,56	Developer 3	0,89	0,32
Developer 4	0,78	0,28	Developer 4	0,83	0,20
Developer 5	0,82	0,36	Developer 5	0,80	0,32
Developer 6	0,79	0,44	Developer 6	0,75	0,36
Developer 7	1,00	0,20	Developer 7	0,83	0,20
Average	**0,85**	**0,37**	**Average**	**0,86**	**0,26**
Student 1	0,80	0,32	Student 1	0,75	0,12
Student 2	0,80	0,16	Student 2	1,00	0,16
Student 3	0,75	0,36	Student 3	0,75	0,24
Student 4	1,00	0,12	Student 4	1,00	0,08
Student 5	0,70	0,28	Student 5	0,71	0,20
Student 6	0,83	0,20	Student 6	0,80	0,16
Student 7	0,75	0,24	Student 7	0,80	0,16
Average	**0,80**	**0,24**	**Average**	**0,83**	**0,16**
Total Average	**0,82**	**0,30**	**Total Average**	**0,84**	**0,21**

ID and NID techniques have similar precision: We observed the average of precision measures with ID was 0.82, while the use of NID achieved 0.84. As opposed to recall values, the difference of precision measures with NID and ID was not significant. This finding is revealed when analyzing percentage values. We also realized the subjects' working experience directly affected the results. The professionals' sample achieved better precision values compared to the students' sample. As previously discussed, although the use of the ID technique increases the number of false positive, it also tends to increase the number of true positive - which directly affect precision values. According to results illustrated in Table 5, there is no evidence to support that the subjects using ID have worse (or better) precision than subjects using NID technique. Therefore, we cannot confirm or refute the second hypothesis (H2).

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The results indicated there is no negative impact when the interactive detection of code anomalies is performed progressively - i.e. while the developer is browsing or editing the code. Software developers are likely to benefit from detecting anomalies earlier, when they constantly receive feedback provided by ID. Moreover, the constant availability and higher amount of information through ID led developers to accept a higher number of anomaly instances. However, if the subject holds a higher level of working experience, he can be more confident to infer (i.e. accept or reject) about the suggestions of anomaly instances from ID. The data described in Table 4 allow us confirm this assumption. More experienced developers using ID obtained a lower number of false positives compared to the students (fewer working experience) using the same technique. In a similar way, developers identified a higher number of true positives compared to students. Finally, these results are similar to those presented in the work of Murphy-Hill and Black [3], as developers identify more true positives using ID compared to developers using NID technique.

4.2 Judgments of Refactoring

In the third phase (Section 3.4), subjects performed judgments of refactoring using non-interactive detection (NID) and interactive detection (ID) techniques. These tasks were performed in order to address the research question RQ3, which is validated by testing the hypothesis H3. In summary, we analyzed whether the subjects performed ineffective refactoring (IR) or effective refactoring (ER) related to occurrence of Feature Envy anomaly. Section 3.4 shown a detailed description of the judgments of refactoring. Finally, the Table 6 illustrates results from the accomplishment of aforementioned tasks.

Table 6. Results on judgments of refactoring

Subject	NID		Subject	ID	
	IR	ER		IR	ER
Developer 1	-	X	Developer 1	X	-
Developer 2	-	X	Developer 2	-	X
Developer 3	-	X	Developer 3	-	X
Developer 4	-	X	Developer 4	-	X
Developer 5	-	X	Developer 5	-	X
Developer 6	-	X	Developer 6	-	X
Developer 7	X	-	Developer 7	X	-
Total	**1**	**6**	**Total**	**2**	**5**
Student 1	X	-	Student 1	X	-
Student 2	-	X	Student 2	-	X
Student 3	-	X	Student 3	X	-
Student 4	-	X	Student 4	-	X
Student 5	-	X	Student 5	X	-
Student 6	-	X	Student 6	-	X
Student 7	X	-	Student 7	X	-
Total	**2**	**5**	**Total**	**4**	**3**
FS Total	**3**	**11**	**FS Total**	**6**	**8**

ID technique may increase IR: We verified the subjects performed 3 ineffective refactoring when using the NID, while the subjects using the ID performed 6. That is, the use of ID occasioned a growth of 50% in the ineffective refactoring performed by subjects. Moreover, when analyzing the results achieved by the developers' sample, subjects performed only 1 ineffective refactoring when using NID, while 2 ineffective refactoring were performed when ID was employed. The same proportion of growth (i.e. 50%) occurs in the results obtained from students' sample. We noticed 2 ineffective refactoring were performed when the NID was used, while subjects using the ID performed 4.

In summary, we observed the subjects using ID are likely to perform more ineffective refactoring compared to subjects using NID technique. Moreover, we could observe that working' experience also influences the results of this task, since the developers performed 50% fewer ineffective refactoring than the students. During the second experimental phase, we observed most of the false positives were related to occurrences of the Feature Envy anomaly. Furthermore, the students using ID pointed out the majority of false positives. This fact led us to conclude occurrences of false positives might be directly associated with developers' working experience. Moreover, the use of the ID technique for the anomaly detection also directly affects the refactoring actions.

Concluding, we can refute the third hypothesis (H3) by analyzing the collected data associated with judgments of refactoring (Table 6). The use of ID might induce developers to perform ineffective refactoring actions because the existence of the anomaly instance that could indicate the refactoring action may be untruthful. In short, if the developer performs refactoring on a false positive related to some anomaly, the effort to accomplishment this task might not contribute to improving the system maintainability.

V. THREATS TO VALIDITY

Sample size and diversity: Fourteen subjects performed the controlled experiment. The results may have direct influence from size of the sample and the subjects' working experience on anomaly detection and refactoring. To mitigate this threat, we choose a sample comprising by students and developers. Furthermore, we conducted training sessions in order to leveling the knowledge of subjects with respect to these topics.

Experiment Complexity: Other threats to validity are related to: (i) the difficulty in understanding code files

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chosen for the experiment, and (ii) the nature of the selected experimental tasks. With the aim of minimizing the first threat, the code files were selected according to the size and time available for each task. Furthermore, we performed a pilot experiment in order to adjust the time required to perform these tasks. Aiming at mitigate the second threat, one of the paper's authors monitored all the experimental tasks. In addition, subjects received instructions for completing the questionnaires and demonstrations prior to the completion of the experiment tasks.

Integrated Development Environment: We used the version 3.3 (Europe) of the eclipse IDE due to compatibility problems of Stench Blossom. Thus, the subjects' experience in using this IDE version may have been harmed because it was a version older than the one being used by developers nowadays. However, observations of the subjects did not lead us this phenomenon had any influence on their performance. In addition, aiming to minimize this threat, we provided specific training on the use of the Eclipse IDE 3.3.

Sample of Code Anomalies: Finally, we restricted subjects to discussing only eight types of code anomalies. In contrast, Fowler has cataloged a list with more than twenty code anomalies [1]. Therefore, the eight code anomalies supported by Stench Blossom may not necessarily be a representative sample of anomalies found in certain programs. Likewise, we only focused on one code anomaly in the Explanation View - Feature Envy anomaly. Therefore, subjects' judgments of refactoring may be different for other kinds of code anomalies.

VI. RELATED WORK

This study represents a first independent assessment of interactive detection (ID) of code anomalies. We have chosen the ID technique supported by the Stench Blossom (Section 2.2). This technique was proposed and implemented by Murphy-Hill and Black [3]. We have chosen this particular technique for three main reasons: (i) it provides support to all main features of an ID technique [6]; (ii) it offers automated robust support for ID; and (iii) to the extent of our knowledge, it is the only robust solution that provides automated support for ID.

In our evaluation, we compared the effectiveness on detection of code anomalies with ID and NID techniques. Mäntylä et al. [10] also conducted an empirical evaluation comparing two different techniques. However, they did not evaluate the ID technique for anomaly detection. Instead, they compared manual inspection in contrast to semi-automatic technique (i.e. both techniques were non-interactive). Since ID technique provided by Stench Blossom presents a visualization environment, we seek in the literature related works that also present use of these environments in detection of code anomalies. Parnin et al. [11] evaluated the impact of visualization techniques in the anomaly detection. However, they did not evaluate the use of ID-sensitive visualization of code anomalies.

None of the aforementioned studies presented information about false positives found from the use of different detection techniques. Moreover, none of them analyzed the impact of ID on the identification of refactoring opportunities and their consequences. Although Macia et al. [12] evaluated the number of false positives on anomaly detection, the technique used by them does not support ID. Finally, only Murphy-Hill and Black [3] evaluated the use of their ID technique. However, they prioritized aspects related to usability guidelines such as availability, lucidity and context sensitiveness. Consequently, they did not observe if the ID technique improved the effectiveness on anomaly detection and, consequently, on judgments of refactoring.

VII. CONCLUSION AND FUTURE WORKS

The use of interactive detection (ID) technique can lead developers to early identify opportunities for refactoring actions and hence, bring significant benefits to system maintainability. Using ID: (i) developers can perform other programming activities in source code concomitantly to anomaly detection; (ii) developers are constantly aware about the anomaly instances when analyzing different code fragments; and (iii) developers tend to find early a higher number of anomaly instances due to the amount and availability of information related to code anomalies.

Although developers using ID may identify more anomaly instances found in their code, its use may also increase the number of false positives in early anomaly detection activities. Findings of our study point out that these differences of ID and NID occur for different reasons. First, the amount and availability of information may confuse the developer in the task of interactive identification of code anomalies. Second, the lack of developers' working experience directly contributes to a higher acceptance of suggestions of anomaly instances yielded by an ID technique.

The effectiveness measurements also revealed that ID do not considerably improve the precision of early anomaly identification. However, we realized the subjects' working experience could directly affect the results associated with this measure. The higher the subjects' working experience, the higher is the values observed for precision. Analogously, the subjects'

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working experience also directly affected the recall measures. Actually, the subjects' working experience improved recall values in a greater proportion compared to values associated with precision.

Finally, new experiments about ID effectiveness can be performed using a different set of code anomalies with different levels of granularity (i.e. anomalies that affect different code elements, such as packages, classes and methods). This recommendation is even more relevant for the second phase of the experiment (Section 3.4), which focused on the occurrence of the Feature Envy anomaly.

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Effects of Transcranial Direct Current Stimulation of the Cerebellum (ctDCS) Associated with Cognitive Training in the Working Memory on Healthy Elderly

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***Abstract*—** *The present research presents a study with the intention of advancing the knowledge of the repercussions of the cerebellum stimulations. The study investigated the acute and cumulative effects of transcranial cerebellum current (ctDCS) stimulation associated with cognitive training for working memory in healthy elderly. A total of 30 volunteers, aged 60 to 72 years, underwent five sessions consisting of the application of the following protocols on the entire cerebellum hemisphere: the Experimental Group (15 participants) received an anodic electric current (anodic ctDCS) and the Control Group (15 participants) received a sham current (simulated ctDCS), both of whom underwent cognitive training while receiving transcranial anodyne cerebellar current or sham (online) stimulation. Participants' performances were measured through specific neuropsychological tests to assess working memory (Digit Span test in direct and indirect order and Letter-Number Sequencing test). After a week and three months of the last stimulation session, the participants performed the neuropsychological tests again to check for possible remnants of the intervention (follow-up). The results suggest that there was no difference between the performance of Experimental Group (anodic ctDCS) and Control Group (sham ctDCS) in different neuropsychological tests, regardless of the time of application ($p>0,05$). While the anodic ctDCS improved the performance of the Experimental Group in the intra-group analysis Digit Span test in direct order when compared to baseline and the follow-up three-month ($p<0,05$).*

***Keywords*— aging, cerebellum, cognitive training, transcranial direct current stimulation.**

I. INTRODUCTION

In recent years, with the increase in research on the cerebellum, its circuits and functions (ITO, 2012), evidenced that its functions were not only related in the acquisition of motor skills, but also related in the execution of cognitive functions, emotional processing and behavior (BALDAÇARA et al., 2011).

The cerebro-cerebellum is involved with various regions of the cerebral cortex, in which its main entry involves the contralateral cerebral cortex. Their efferences are transmitted through the dentate nucleus that protrude into the cortex of prefrontal association, for example, involved in working memory (MARTIN, 2013).

In the process of aging, there are some changes in the cerebellum, such as a reduction in the volume, in the

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white matter (HOOGENDAMA et al., 2012; KOPPELMANS et al., 2015) and in the quantity of cells called Purkinje (ANDERSEN et al., 2003; WOODRUFF -PAK et al., 2010; ZHANG; ZHU; HUA, 2010).

Non-invasive brain stimulation techniques applied to the cerebellum have been used to understand the cerebellum during cognitive behaviors as well as to modulate cerebellum functions (GRIMALDI et al., 2016). Among the techniques, one of the most used is transcranial direct current stimulation (ctDCS) (GRIMALDI et al., 2014).

The ctDCS is a technique that uses continuous and low intensity electric current, capable of altering the excitability in the stimulated region and may induce the increase or decrease of excitability, depending on the polarity used. It is a non-invasive method, safe, painless, easy to apply and with few adverse effects (CRETAZ, 2017; MONTE-SILVA; BAPTISTA; BALTAR, 2017).

The ctDCS is also an interesting adjuvant tool in the treatment of several diseases of neurological, psychiatric and motor conditions (STAGG; NITSCHE, 2011), and can be used in conjunction with other cognitive techniques in the treatment of degenerative processes of dementia, cognitive training (SILVIA et al., 2017).

Cognitive training through specific cognitive activities aims at preserving or enhancing an individual's intellectual abilities in order to produce improvements in the performance of everyday tasks (NUNES, 2017).

Thus, this research aimed to investigate the effects of transcranial cerebellum current stimulation, associated with cognitive training of working memory in healthy elderly. Understanding these effects in healthy individuals helps to understand the physiology of the cerebellum in its typical state and thus to be able to develop prevention strategies and alternative therapeutic techniques for the rehabilitation of individuals with cognitive impairments.

II. MATERIALS AND METHODS

The study consisted of 30 right-handed elderly volunteers aged 60 to 72 years (mean ≅ 66.3), 25 female and 5 male, recruited from the research group in Exercise, Nutrition and Central Nervous System (ENCNS) of the Department of Physical Education of the Federal University of Pernambuco (UFPE).

Design Research:

The TCT Stimulator (TCT Research Limited) was connected to a pair of silicon-carbon electrodes (35cm²) embedded in saline solution (NaCl 0.9%), the active electrode was centered especially the cerebellum in the midline 2 cm below the inion and 1 cm posterior to the mastoid process, while the reference electrode was positioned in the right deltoid muscle (FERRUCCI et al., 2013).

The participants received anodic stimulation with current intensity of 2mA and duration of 20 minutes (POPE; MIAL, 2012). To ensure safety, a current density of 0.028 mA / cm² was applied, since this value is below the threshold for damage (NITSCHE et al., 2003).

For the sham stimulation, the same protocol was used for the anodic stimulation, however, the electric current was applied with duration of 30 seconds which is not enough to cause a modulation (NITSCHE et al., 2008).

The realization of the cognitive training occurred individually and simultaneously to the transcranial stimulation by direct current. The training consisted of unimodal intervention focusing on the ability of working memory to verify its relation with the cerebellum.

The cognitive training was composed of five sessions (CARVALHO; NERI; YASSUDA, 2010; LIMA-SILVA et al., 2010; ARAMAKI; YASSUDA, 2011) with duration of one week. It should be noted that for each session a cognitive task was carried out that diversified between the "computer" model and "pencil and paper", in order to stimulate the intervention.

For the construction of the tasks, a gradual gradation of difficulty levels (easy, medium and difficult) was developed in order to increase motivation for adherence to training. (GOLINO, FLORES-MENDOZA, 2016). The materials used in the activities, including the records and instruction sheets were developed by the researchers, based on the literature.

Cognitive Tasks:

Cognitive task Visual N-Back: during the *Visual N-back Task*, images of animals were presented to participants at a distance of 60 centimeters from the computer screen. The volunteer's task was to judge whether the image that appeared at the time was similar to or different from the previous (1-back) image. To record the responses, two buttons were placed below the image shown, where the red corresponded that the current image was different from the previous one and the green image was the same as before. Participants were instructed to press one of the buttons on the computer screen with the mouse and a response time was not established.

Task Word List: This task was to present 4 word lists (50 words each list) of different categories (food, object, professions, hobbies / games) through slides. Each word was displayed on the computer screen for 2.4 seconds, totaling a time of 2 minutes for each list. The task of the elderly person was to read aloud the words in the list and,

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at the end of each one, to write on the answer sheet all the words that could be remembered in the time of 3 minutes.

Face Recognition Task: the task was to present a set of black and white frontal face images of men and women, taken from the Pictures of Facial Affect (POFA), Picture Bank developed by psychologist Paul Ekman (1997). The pictures presented facial expressions related to the six basic emotions (joy, sadness, disgust, fear, surprise and anger). Participants were instructed that the image of a face (target image) would be projected onto the computer screen. Then the image disappeared and a set of faces (image-option) was presented, in which the participant should identify which of these was the previously presented image (target image).

Genius Task: At the beginning of the activity, participants were given four red, blue, green and yellow circular tokens and a white, portable holder.

They were then instructed that a sequence of these colors would be displayed on the computer screen for 5 seconds, in which they should watch carefully so that after completion of the projection he tried to reproduce the sequence on the white medium, as he could remember.

Figure Arrangement Task: participants received the disordered WAIS-III Figure Arrangement test cards with pictures representing snippets of a story. The volunteer was instructed to order them by following a correct order of events. In all, there were 11 stories (items), in which they were counted and organized within pre-determined test times.

Experimental Procedure:

The volunteers initially answered a Sociodemographic Questionnaire, MoCa Cognitive Screening Test and the Geriatric Depression Scale (GDS-15), which served as eligibility criteria. After the screening, a randomization was performed, in which the participants were randomly divided into two groups, 15 for the Experimental Group, and 15 for the Control Group.

Participants were submitted to five sessions followed by cerebellar tDCS. In these sessions, the volunteers were individually submitted, for 20 minutes, to anodic stimulation for the Experimental Group and sham (fictive) for the Control Group. The two groups performed cognitive training during anodic tDCS or sham (online) stimulation depending on the group to which they were inserted.

The cognitive training was composed of five cognitive tasks, in which they were aimed at stimulating working memory. The experimental procedure will be detailed below.

• First session, the volunteers performed the tests of the digits and sequence of numbers and letters of the WAIS-III Scale Serving Baseline-T1 for the search (offline). Then the cerebellar ETCC intervention was performed with the N-back Task. After five minutes of the end of the stimulation, the Digit Tests and Sequence of Numbers and Letters of the WAIS-III Scale (T2) were reapplied. The objective was to ascertain the immediate effect of the stimulation compared to the performance of the participants in the initial tests (baseline).

• Second session, the volunteer performed the task of "word list" during the cerebellar anodic tDCS or sham.

• Third session, the task of "face recognition" was performed during cerebellar anodic tDCS or sham.

• Fourth session, the "Genius" Task was performed during the cerebellar anodic tDCS or sham.

• Fifth session, the cognitive task of "storytelling" was performed during the cerebellar anodic tDCS or sham.

After five minutes of the end of the stimulation, the tests of the digits and sequence of number and letters were applied again in order to verify cumulative effects (T3). After a week and three months of the last stimulation session, the follow-up was performed by reapplying the tests of the digits and sequence of number and letters (T4 and T5) in order to ascertain the remaining effects of the stimulation in the participants

Data Analysis:

There were 30 participants, but there was a loss of participants in the follow-up of one week and 1 in the follow-up of 3 months in the Experimental Group and in the Control Group. Thus, due to the losses during these moments of the study, the principle of intention-to-treat analysis was used.

The GLM test was used for repeated measurements to detect differences between Time and the effect between Time x Group on the dependent variables (direct-order digits, inverse order and sequence test of letters and numbers), we observed the criteria of normality from the Shapiro-Wilk and sphericity from the Mauchly Test, for the variables that did not present normality was used as a criterion of correction the standardization in Z score, when the sphericity was not detected, it was used the Greenhouse-Geisser Correction Criterion. The level of significance was set at 0.05.

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III. RESULTS AND DISCUSSION

Thirty healthy elderly people participated in the research.

Data analysis is presented in the order of application of the neuropsychological instruments in the time function- T1 (baseline), T2 (second evaluation), T3 (third evaluation), T4 (follow-up one week) and T5 of three months) - for the two groups - Experimental (anodic ETCCc) and Control (ETCCc sham).

Based on the GLM test of repeated measures, it was observed that there is an interaction effect between Time and Group for the test of the digits in the direct order (F (3.04, 85.13) = 2.57, p = 0.04, eta square = 0.084).

The posthoc analysis (Bonferroni) of the interaction between time and group, showed that there is difference in the values of the tests in the direct order within the experimental group between time 1 and time 5 (p <0.05), however the interaction between Time and Group showed that there was no difference in the test values in the direct order within the Control Group (p> 0.05) between the five times

Regarding the results of the test of digits in the reverse order, GLM analysis showed that there is no effect on the interaction between Time and Group in both the intra-group analysis of the Experimental Group and that of the Control Group.

GLM revealed that there was no interaction effect between Time and Group for the sequence number and letters test in the intra-group analysis in both groups (p> 0.05).

In the comparison of the means of each subtest (direct order, inverse order and sequence of numbers and letters) between the Experimental and Control groups for all application times (T1, T2, T3, T4 and T5) there was no significant difference between the means of the groups (p> 0.05).

Table 1 Mean performance among Experimental and Control groups in neuropsychological tests.

	TEST GROUP	MEAN	p
DDO	EXPERIMENTAL	9,704	0,934
	CONTROL	9,762	
ROD	EXPERIMENTAL	4,007	0,395
	CONTROL	4,54	
SNL	EXPERIMENTAL	6,633	0,532
	CONTROL	6,167	

Subtitles: DDO: Digits of direct order; ROD: Reverse order digits; SNL: Sequence of numbers and letters. P * <0.05.

Concerning adverse effects, the participants reported sensations of pruritus, tingling, burning (mild), difficulty concentrating, drowsiness, redness. In addition to two participants who obtained a small first degree burn below the electrode in the right arm and metallic taste in the mouth in the anodic stimulation.

IV. CONCLUSION

The results of this research showed that there was no significant difference between the group receiving anodic CTCC and the group receiving CTCC sham in the working memory tests. These findings confirm the idea that the concept of polarity-dependent is not well diffused for transcranial DC stimulation in the cerebellum, since in the literature there is no consensus on the types of stimulation responses (anodic, cathodic and sham) work memory.

There is evidence that cathodal stimulation may have a facilitating effect on the performance of participants in arithmetic tasks when compared to anodic and sham stimuli that do not show significant differences (POPE; MIAL, 2012).

On the other hand, studies have observed that anodic and cathodic stimulation on the cerebellum can impair the performance of participants in a task of remembering numbers (FERRUCCI et al., 2008), as well as differences between the three types of stimulation (anodic, cathodic and sham) in the results of the N-Back task (VAN WESSEL et al., 2016), suggesting that the effects of cerebellar CTEF may vary according to the tasks applied.

There was a difference in the results of the volunteers in the three tests for working memory, which may be related to the complexity of the task. The direct-order digit test requires a more direct relationship with the phonological loop, while reverse order and sequence of numbers and letters also requires the participation of the central executive system.

It is seen that the effects of cathodic and anodic stimulation on the cerebellum are not fully elucidated, a fact that may be linked by technical and experimental questions and the complexity of the cerebellum structure and its various connections with motor and / or cognitive activities during the protocol may to influence the effects of CTEF (Horvath and Carter, Forte, 2014). In addition, physiological and functional changes in the cerebellum relative to the aging process itself may influence the effects of cerebellar anodic ECCT.

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Regarding the specific training for working memory considering each group, the results of the means between the Experimental and Control group and the intra-group analysis of the Control Group did not present significant differences, suggesting that there were no transfer effects.

In relation to the adverse effects, it is seen that some studies even presenting protocols considered safe have reported burns after CTEC (WANG et al., 2015; WOODS et al., 2016; MELO, 2016). Other symptoms, such as metallic taste in the mouth, although not common, have also been reported in studies using transcranial direct current stimulation (FERRUCCI; CORTESE; PRIORI, 2015; MELO, 2016).

In conclusion, the limited number of studies that approach this methodology and the elderly population makes this project present an innovative character and thus contributes to the construction of new evidences and protocols for the investigation of cerebellar stimulation and cognitive training in order to improve the quality of life of the elderly population.

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Bootstrap Method in Price Analysis in Reverse Logistics of Solid Waste from Commercial Restaurants

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***Abstract*—** *Reverse logistics is defined as the practices and processes established to organize the returns of products from point of sales to the manufacturer in order to repair, recycle or dispose of these items in the most economical way possible. There's a close connection between reverse logistics and environmental protection because it focuses on the management of products, components and materials that have been used and disposed of, and of which the manufacturer has some kind of responsibility. Its purpose is to reuse these products and, where possible, reduce the final amount of waste. To demonstrate the economic viability of reverse logistics, robust statistical procedures are required. Among these procedures, we can highlight the bootstrap method, which is a resampling procedure used to estimate statistics of a population by sampling a set of data with repetition. Therefore, the objective of this study was to use the bootstrap method to estimate the ideal selling price of solid waste in a network of commercial restaurants in the metropolitan region of Recife, in order to obtain information on the profit from the operation. The results showed that the bootstrap method was an efficient statistical tool in the analysis of data from reverse logistics operations and can be used in decision making on the variation of solid waste sales prices in the chain of restaurants studied. Therefore, the network of restaurants studied can certainly profit from the reverse logistics operation, in addition to sustainable business marketing that attracts a larger group of customers.*

Keywords*— *Computational Statistics, Mathematical Modeling, Operational Analysis, Statistical Analysis, Sustainable Economy.

I. INTRODUCTION

Reverse logistics (RL) has the power to create tangible and intangible value to the used and/or returned goods, extracting the maximum value from them. This method avoids wastage with labor, time and with the raw material itself, whose purchase is minimized. In addition, it adds value by increasing product lifecycles, which takes into account after sales, thus generating customer satisfaction and loyalty. Based on this, buyer feedback is needed so that one can think of continuous improvement and analyze the reasons for product returns, which should lead to future improvements or new product designs [1].

Scholars from around the world have defined four reverse logistics network standards: established by the companies themselves, outsourcing to third parties, integration of direct and reverse logistics and joint construction by related companies. All of these standards have their own advantages and disadvantages, but for companies that build the reverse logistics network alone, which can directly contact customers and obtain more accurate information, have the cost of high deployment [2].

The food industry can benefit from one of the reverse logistics models, so it's necessary to assess the financial viability of selling, donating or disposing of the waste produced locally. There's a need for rapid movement of food products along the supply chain, which requires not only management, but also the development of a backward product flow management system. For this reason, RL is a good choice for dealing with this kind of problem as it deals with the return and management of waste products along its reflux supply chain. In addition, the company receives tax benefits and advantage over the competition.

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The obstacles posed to LR are the questions about the level of adoption of reverse logistics by restaurant owners, the rate of consumer return of food products to restaurants, the way in which the waste is managed, the role of the firm at the level of reverse logistics adoption and which determinants influence the level of adoption of reverse logistics by retailers in the context of Brazil. In fact, many managers question the advantages of implementing reverse logistics. Erroneously, they believe that this is just a cost-generating factor for the company. In fact, the adoption of reverse logistics is not a matter of choice. With the emergence of the National Solid Waste Policy, companies must adapt and implement waste management systems and reverse logistics, under penalty of being penalized with fines, forced to paralyze their operations, have financial losses and damages the image of the company.

On August 2, 2010, Law 12.305 was introduced, which defined reverse logistics as the "Instrument of economic and social development characterized by a set of actions, procedures and means to enable the collection and restitution of solid waste to the sector recycling, in its cycle or in other productive cycles, or other environmentally adequate final destination" [3].

Sustainable and green initiatives can aid in the planning of operations and the traceability of products, which favors the adoption of reverse logistics by the industries. Their adoption not only supports the triage of operations, but also the greening of the supply chain, in line with global government sustainability regulations, in addition to generating profit.

It's appropriate to know the cost and price of all the products or services involved in the RL, and to balance these two factors in order to make a profit, it's necessary for the service to go through a pricing process, which is considered one of the problems of the organizations. However, when done correctly, pricing becomes a powerful lever to foster growth with profitability and to achieve strategic business goals [4].

It's known that the bootstrap method shows a great practicality and accuracy in relation to other classical statistical methods in relation to the continuous variables that a study can contain, so it was chosen as the method of analysis in this study [5]. Therefore, the bootstrap method is a robust statistical tool capable of assisting in decision making on the ideal sale price of solid waste formed in the researched restaurants.

II. METHODOLOGY

2.1. Sampling

The research involved 32 commercial restaurants in the à la carte fast food chain, all located in the Metropolitan Region of Recife, which used reverse logistics in their favor during the year 2018. The survey was conducted during the month of May to November 2018. The prices of each recyclable product were surveyed through quotations with cooperatives, selective collection programs, old iron, industries and estimates provided by market professionals, whose information is periodically updated on the CEMPRE website (www. cempre.org.br). In the period of the survey the price of the pound of cardboard was in R$ 0.26, plastic R$ 0.60 and paper at R$ 0.30. However, in the present study, only the prices of plastic and paper were considered, since they were the most important recyclables in the reverse logistics of the studied restaurants. For the analysis, it was necessary to quantify the weight of the discarded recyclables monthly. To do it so, a place was separated in each of these restaurants to accomplish this task. All teams involved received training on how to properly dispose of and how to perform the weighing.

2.2. Statistical analysis of data by the bootstrap method

Efron and Tibshirani (1993) presented the basic underlying ideas in the bootstrap method, in the classic scope of inference of statistics, as the following. A bootstrap sample is a sample composed by $x^* = (x_1^*, x_2^*, \ldots, x_n^*)$ that is obtained in a random form with repositioning from the experimental sample $x = (x_1, x_2, \ldots, x_n)$, also designated bootstrap population. Here, the asterisks denote that x^* it is a randomized version, or resampling of x, rather than a new group of real data, the bootstrap sample consists of corresponding members of x. In each bootstrap resampling procedure of size n, we obtained the arithmetic mean $\bar{x}_i^*$ which was calculated by Equation 1.

$$\bar{x}_i^* = \sum_{i=1}^{n} \frac{\bar{x}_{in}^*}{n} \quad (1)$$

For a number m resampling, the bootstrap arithmetic mean was calculated by Equation 2. The standard deviation was determined by Equation 3.

$$\bar{x}_m^* = \sum_{i=1}^{m} \frac{\bar{x}_i^*}{m} \quad (2)$$

$$\sigma_m = \sqrt{\frac{1}{m-1} \sum_{i=1}^{m} (\bar{x}_i^* - \bar{x}_m^*)^2} \quad (3)$$

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The bootstrap probability distribution is obtained by the following sequence:

$$x^*_1 = [x^*_{11},\ x^*_{12},\ L\ ,\ x^*_{1n}]$$
$$x^*_2 = [x^*_{21},\ x^*_{22},\ L\ ,\ x^*_{2n}]$$
$$M$$
$$x^*_m = [x^*_{m1},\ x^*_{m2},\ L\ ,\ x^*_{mn}]$$

In practice, the bootstrap distribution is constructed by the Monte-Carlo method with a number of repetitions, m, that are sufficiently large. In this case, bootstrap arithmetic means converge to the normal probability distribution (Manly, 1997). Its convergence is guaranteed by the great numbers law, because, $(x^*_1,\ x^*_2,\ L\ ,\ x^*_n)$ are nothing more than a sample of independent random variables and are identically distributed. Operationally, the bootstrap procedure consists of a resampling of the same size and with repositioning of the experimental sample data, and calculus of statistic interest for each resampling, called pseudo-values.

The following algorithm was built by the Monte Carlo method to optimize the average price in reverse logistics:(**1**) the experimental sample was selected by using a generator of random numbers. The n values with repositioning to form bootstrap samples of the same size as the original; (**2**) the arithmetic average was computed in each procedure of resampling; (**3**) step (**2**) was repeated a m number of times, this way obtaining m values of the statistic in question and(**4**) the mean $\bar{x}^*_m$ was obtained. The mean $\bar{x}^*_m$ was used to estimate the average price. The confidence interval ($CI_{Boot\text{-}z}$) for the estimator $\bar{x}^*_m$ is calculated by Equation 4. The simulation process was carried out using a programme developed in the C++ language, with a generator of random numbers. In the present work 2,000 bootstrap interactions were carried out.

$$CI_{Boot-z}\left(\bar{x}^*_m, 100(1-\alpha)\%\right) = \left[\bar{x}^*_m - z_{\alpha/2}\sigma_{m_{boot}};\ \bar{x}^*_m + z_{\alpha/2}\sigma_{m_{boot}}\right] \qquad 4$$

III. RESULTS AND DISCUSSION

To test the feasibility of applying the bootstrap method on the ideal sale price of solid waste formed in the researched restaurants, was used data from one restaurant that served as a model for the others. In this case, the prices of plastic and paper were used, since they are the recyclables of greater weight in the reverse logistics of said restaurant. Due to anonymity, the commercial establishment was classified as restaurant 1. In this case, the number of recyclables produced during the year 2018 are presented in Table 1. The average selling price of waste (R$/kg) for the paper and plastic was R$ 0.30 and R$ 0.60, respectively. Table 2 shows the prices of recyclables in the year 2018. These values were obtained by multiplying the quantity produced by the respective values in R$/kg.

Table 1. Production of recyclables per month (kg) in restaurant 1.

Month	Recyclables	
	Plastic	Paper
01	43.4	21.7
02	35.9	18.2
03	32.4	14.4
04	42.0	23.4
05	36.7	18.5
06	44.2	22.3
07	41.5	21.5
08	36.2	17.9
09	36.7	16.7
10	41.9	23.9
11	39.2	21.7
12	44.1	25.4

Table 2 shows a significant variability in the values of recyclable prices. These variations may cause fluctuations in the estimates of profit figures from sales of recyclables. This makes it difficult to find the true profit margin, since in this case the average price varies within a certain confidence interval. Figures 1 and 2 show the histograms of plastics and paper prices, respectively.

Table 2. Price of recyclables(R$) per month in restaurant 1.

Month	Recyclables	
	Plastic	Paper
01	26.0	6.5
02	21.5	5.5
03	19.4	4.3
04	25.2	7.0
05	22.0	5.6
06	26.5	6.7
07	24.9	6.5
08	21.7	5.4
09	22.0	5.0
10	25.1	7.2
11	23.5	6.5
12	26.4	7.6

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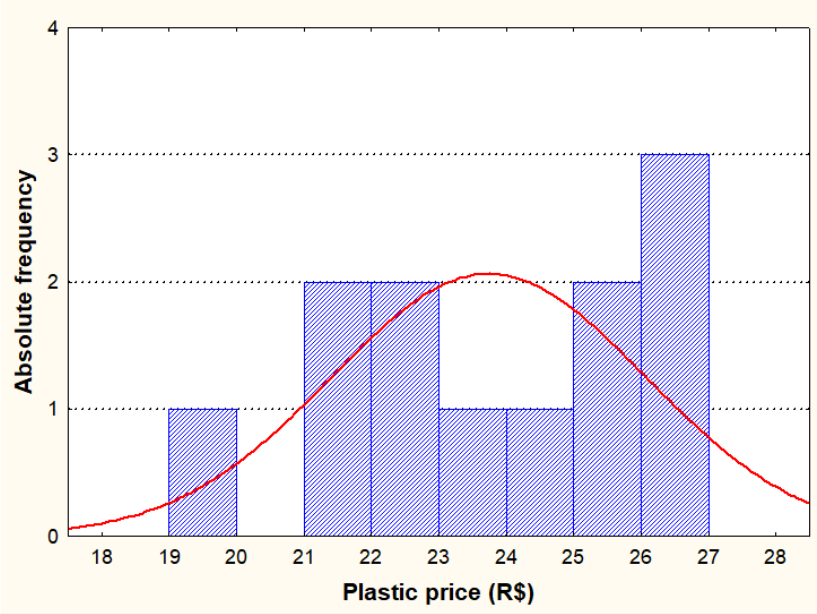

Fig. 1. Histogram of plastic prices

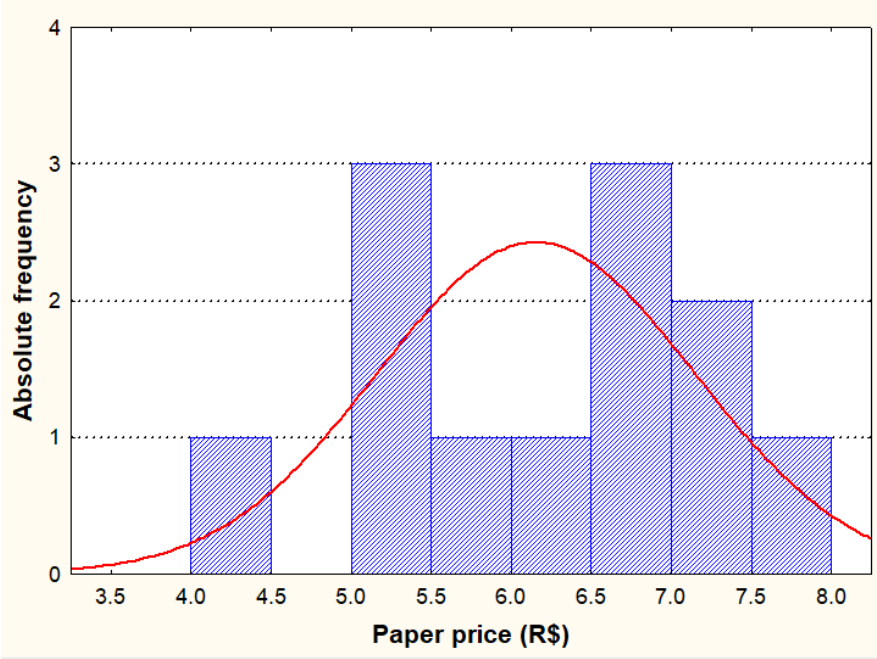

Fig. 2: Histogram of paper prices

However, many evaluations in sampling theory has limited use when the data set is small (Figures 1 and 2). For example, the estimate of the standard deviation for n, normally distributed values, is very sensitive to fluctuations when n is small (Table 2) than when it's large [8]. However, to solve this problem, it's necessary to collect a large number of samples, in order to reduce statistical fluctuations in the data set. On the other hand, often due to financial issues and limitations of the collection conditions, it's not always possible to make collections of a large number of samples. The Big Numbers law guarantees that, when n = 30, there's a probability that the data will have a normal distribution [9]. However, Silva et al., 2007 [10] found that even for n> 30, the normality condition isn't guaranteed when there are anomalous values, and the arithmetic mean is inadequate to represent the data set. In case of the data presented in Table 2, it's observed that the sample amount was less than 30. It makes a very difficult statistical analysis adequate, often limited only to the discussion of range of values, or in the very one estimate using the median.

https://dx.doi.org/10.22161/ijaers.6755 ISSN: 2349-6495(P) | 2456-1908(O)

On the other hand, there's a big statistical problem that needs to be solved. The median doesn't adequately represent a set of data since it's a measure of central tendency lower than the arithmetic mean [11]. This would cause an underestimate, as the extreme values are discriminated by the median. In this case, the median doesn't adequately represent the values in the data set. The bootstrap method is a fairly viable alternative to solve this problem, since the Central Limit Theorem guarantees that when n is sufficiently large, the mean and standard deviation estimators are normally distributed and converge to their true values [8]. However, using the bootstrap method, it's possible to obtain an arithmetic mean that's resistant to fluctuations in sales prices of recyclables (Table 2), and consequently a more robust confidence interval. Figures 3 and 4 show the bootstrap histograms of plastics and paper price values for 2000 interactions.

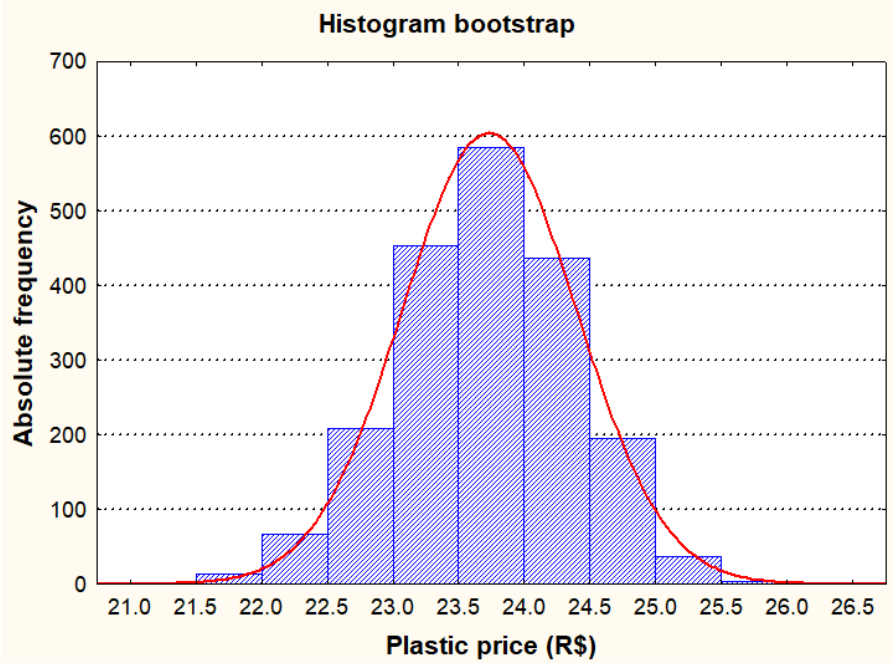

Fig. 3: Histogram bootstrap of plastics prices

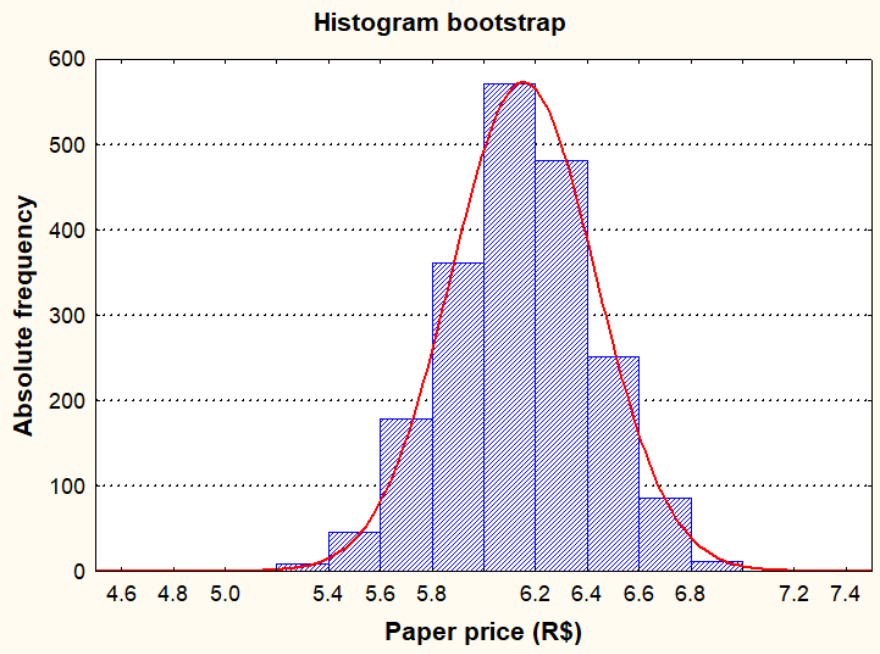

Fig. 4: Histogram bootstrap of paper prices

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The Kolmogorov-Smirnov test showed that the values of plastic prices and bootstrap resampling papers has a normal distribution (Figures 5 and 6). Figures 5 and 6 show that fluctuations in recyclables prices have been significantly attenuated, thus providing reliable statistical analysis. Thus, statistical analyzes based on the bootstrap distribution are notoriously robust, as observed by Efron and Tibshirani, 1993 [6]. Table 3 shows the values of central tendency measurements for the conventional normal distribution and bootstrap of recyclables prices.

Table 3. Conventional arithmetic mean and bootstrap prices of recyclables.

Recyclables	Conventionalarithmeticmean (R$)	Bootstrap arithmeticmean (R$)
Plastic	23.7 ± 2.3	23.7 ± 0.5
Paper	6.1 ± 1.0	6.2 ± 0.2

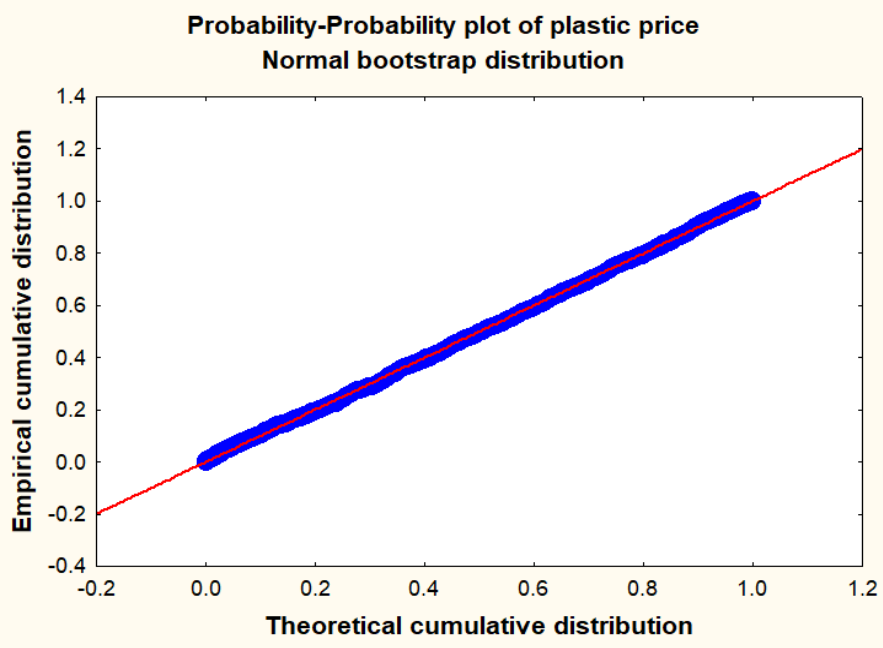

Fig. 5: Probability-probability graph of the normal bootstrap distribution of plastics prices.

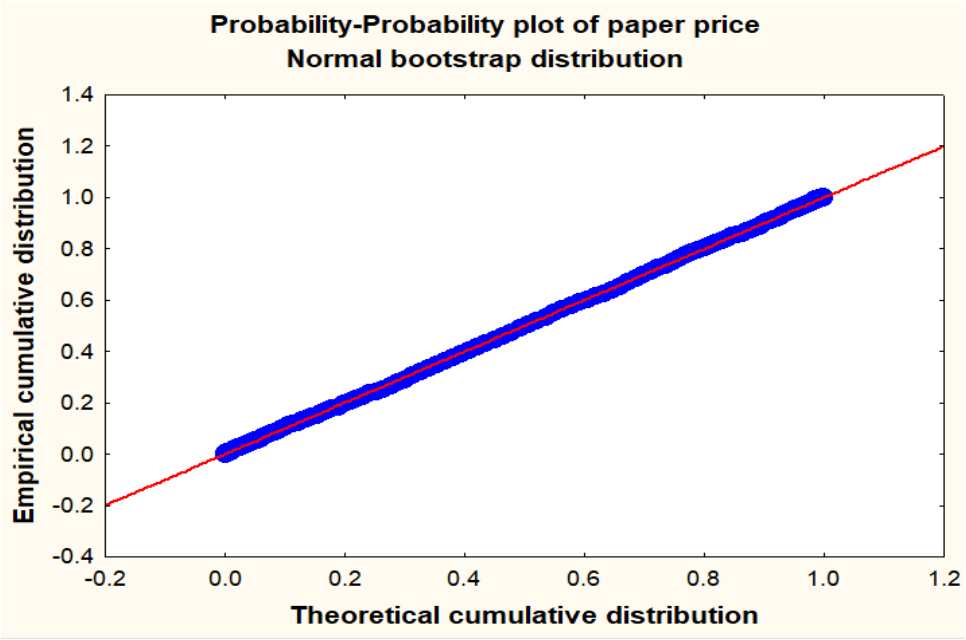

Fig.6. Probability-probability chart of the normal bootstrap distribution of paper prices.

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There was a significant reduction in the dispersion of values around the bootstrap arithmetic mean of recyclables prices (Table 3). On the other hand, there was no change in arithmetic mean values (Table 3). Therefore, the bootstrap arithmetic mean was the most adequate to represent the data set in Table 2. With this, it was possible to obtain more representative confidence intervals in the decision on the average sales price of the recyclables. Table 4 shows the values of the lower and upper limits for the conventional arithmetic mean and bootstrap of the recyclable prices.

Table 4. Confidence intervals for experimental arithmetic mean and bootstrap

Recyclables	Confidence interval of conventional arithmetic mean (R$)	Confidence interval of the arithmetic mean bootstrap (R$)
Plastic	[22.2; 25.2]	[22.4; 24.7]
Paper	[5.5; 6.7]	[5.6; 6.6]

The confidence interval of the conventional arithmetic mean is wider than that of the bootstrap arithmetic mean (Table 4). Therefore, the confidence interval of the average bootstrap is more adequate to represent amplitude in the average prices of recyclables. Thus, the insertion of the bootstrap method into the reverse logistics in a restaurant network was an important statistical tool in decision making within the context of the profitability of the sale of recyclables. According to Efron, 1993 [6], when a set of data is formed by small samples and has fluctuations without occurrence of anomalous values, as is the case of the data presented in Table 2, the values of bootstrap resampling with 2,000 iterations are symmetrical with respect to the distribution (Figures 3 and 4).

IV. CONCLUSION

The bootstrap method proved to be quite efficient in the statistical analysis of the estimate of the sales price of recyclables in restaurant chains. It could be used to decrease fluctuations in values, but also proved to be ideal for constructing a confidence interval in reverse logistics.

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Non-Technical Losses on Injected Distribution Energy: Case Study on Entry Meters, Installed in the Rio De Janeiro State, Brazil

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Abstract *— Commercial or non-technical losses (NTL) on injected energy (regulatory) are primarily related to their fraud and theft in the distribution sectors, and corresponded to the concessionaires installed in Brazil, about 3.46% between 2010 and 2014, or values around US$ 300 million. For the region of Rio de Janeiro, these were, between 2010 and 2013, in the order of 11%. In order to reduce the amount of fraud in the concession area of the region in a case study, the use of drilling tools, the use of magnetic fields for blocking or delaying the meter disk, changes in the terminal contacts, such as electric bridges; the inverted connections of the internal circuits, the lack of neutral, by up to 12% each.*

Keywords *— **commercial losses, electricity meters, fraud, investigation, electricity distribution networks.***

I. INTRODUCTION

Actions to combat fraud in electricity allow the recovery of concessionary revenues and play an important educational effect on the proper use of energy resources, since they deal with a situation affecting all economic classes in the various regions of the country. In this case, commercial or non-technical losses (NTL) on the injected energy (regulatory) are related to their frauds and thefts in the distribution sectors and corresponded, according to ANEEL (2015) [1], to the concessionaires installed in Brazil, about 3.46%, between 2010 and 2014, or more than US$300 million.

For the Brazilian Association of Electric Power Distributors, ABRADEE (2018) [2], the fraud was defined as the direct deviation of energy from the distribution networks to the illegal consumer. In this case, it is registered at the concessionaire, but, promoting adulterations in the electrical supply system of your home, trade and/or industry. With this action, only a portion of its total consumption is paid and has been causing annual losses, in 2018, of the order of US$2 billion [3].

The dissemination of fraud is so significant in the current times that some more popular terms are being employed by the technical community for its classification, such as those of Penin (2008) [4], which transcribed as definition of the theft of energy or NTL, the said popular "cat" and the fraud in its supply, as "rat".

In Penin (2008) [4] assessed, the irregularities caused by the action of the consumer most commonly found in the electrical distribution systems in general, were the direct connection to the secondary network; the deviation in the input extension, prior to the meter; the blocking of the movable element of the meter, by means of access by perforation in the glass lid or the base, by the introduction of objects or materials foreign to the electrical system; the forced displacement of the pointers of the meters; the inverted connections of the cables in the terminals; the opening of the test terminal; the interruption of the operation of the potential coil; the replacement and wear of gears and their teeth; the commitment of its mobile

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element; the demand pointer backlash; the opening or isolation of the calibration key; the isolation or sectioning of the connecting conductors between the measuring key and the meter; the short circuit in the secondary of current transformers; the interruption of demand timing engine power; the inversion of reversed phase sequence in reactive; and the short circuit at the inlet or outlet of the meter. Besides these, according to the author, new situations of fraud were found in the system, such as the current injection into the meter to make its measurement incorrect, with eventual burning of the internal coils.

Minguez (2007) [5], studied the main types of frauds related to electromechanical electrical energy meters by induction, EM, for having been one of the most used types by energy dealers, due to its robustness, simplicity accuracy and performance. The most evident occurrences of both internal and external to the meters were equivalent to that presented by Penin (2008) [4] assessing. Besides these, the author cited the deviation of non-measured electrical current, usually occurring in the terminal box or distribution without the use of a reverse key and, whose fraud was related to the return of voltage when the circuit was disconnected; the locking of the disc swivel from the violation of the protective case; the connection of the input and output conductors through the terminal without going through the measuring equipment; the inverted connection of one or more conductors of the input terminals to the output, or even, the inversion of the coils connections of the measuring equipment; the cheat related to the recorder rotating gears scrapings; and also the exchange thereof in order to change the rotation period; the intermittent alloy and disconnect operations of the secondary measuring circuits; and the handling of the consumption system, with return of the hands, including the disconnect of primary or secondary conductors of the measurement.

Also, for Minguez (2007) [5] the main indications of manipulation or violation, in this case, of the outside of the meters were related to the disruption or adulteration of its seal; the cutting, breaking and melting with glue marks different from the original or from the manufacturer, with characterization of the pierce-type screw removal; the cutting or machining mark of this, which have been chopped, without thread, or with other damage marks; the perforation or cutting of the main lid, indicating its movement of the site; the protection box perforations; and, the changes by cutting, punching, chipping, among other features access to the terminals from the ruler and the meter cover. By the analysis of 3,400 EM of the concession region it was found that the 5 most common types of fraud in the region of analysis, up to 2007, were the violation of the meter cover, by perforation, with 29.85% of the cases; followed by the violation of the lid, by 23.12%; of perforated box, with 9.11%; of the bored base, in 7.97% of the cases and the perforated post, with 7.17%.

The numbers of the violation were also verified by Ortega (2008) [6], when he reported that the concessionaire had in the research period about 3,790,000 of customers at low voltage in 31 municipalities of the state of Rio de Janeiro and was being considered as the 3rd national distributor with a greater number of commercial losses, as a consequence of fraud, mainly in its energy meters, because of defective equipment and clandestine connections.

II. MATERIALS AND METHODS

The analysis of the main manufacturers and the types of meters were carried out from a data collection with the concessionaire, being then made available in a spreadsheet to obtain statistics of the number of events, by manufacturer and type of meter and for comparison with the data published by other authors conducted in about 10 years, in order to visualize the persistence of the problem and if there was any statistical evolution.

The types of fraud were also raised by each manufacturer inspected. Additionally, in this study, the main meters were identified in operation at the concessionaire, in order to subsidize the information with respect to the most practiced fraud methods in the sector, and these were coded.

Types of meters installed in the distribution network of the concessionaire. They were codified by the non-interest of exposing their manufacturers, who can also be considered victims of this whole process of commercial losses of energy dealers, especially in case study.

ME 1, was a power input meter, electronic type, monophasic, class B, represented in 1.62% of the park. It consists of a cyclometric dial, with a maximum rated current, Inmax, of 15/100 A; operates in the voltage range from 120 to 240 V and in the frequency of 60 Hz. It has as an additional feature an LED system that indicates whether there is reverse flow of electric current, that is, an anti-theft system.

ME 2, is represented in the concession park with 6.80% units. It is an electronic meter for the measurement of active and reactive energy with a high degree of precision and can be operated in single-phase, biphasic and three-phase connections. An advantage of the meter is in the form of its data storage, independent, and of the active energy totalizations (kWh) in direct flow, active energy in reverse flow, reactive energy (kVARh)

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inductive and capacitive. Also, two modes of operation related to the totalization of active energy, the ratchet mode and the unidirectional are possible. For data transmission there is an infrared communication output, with device that allows the electronic reading of the registers, the safety data and the current state, from a microprocessed system. The data can be transmitted by auxiliary terminals from an OBIS identification standard port: IEC 62056-61 [7]. The IrDA port can be read at a distance of up to 250 mm and provides important information such as the safety, registers, identification and state of the meter. In its manufacture, security features were worked in the registry and configuration data, by storing them in non-volatile memory, in addition to others. Operates in the temperature and humidity range, regular in Brazil, having a maximum weight of 1.2 kg. The active energy (kWh) of this meter is of direct and reverse type, independent, in the type ratchet or direct and reverse, added to the same record, in the one-way model. It has the accuracy classes B (1%), can work in the operating voltage between 96 and 288 V dc and in the frequencies of 50 and 60 Hz. The model complies with the technical recommendations of the standards ABNT NBR 14519 [8] and NBR 14520 [9], IEC 61036:1996 (with addendum 1:2000) [9], degree of protection IP52 (IEC 60529:1989) [10].

The equipment ME 3, is represented in about 4.85% of the park with electronic meters. As specified by the manufacturer, the electronic single-phase meter has a display for the active energy measurement kWh. As main advantages, it presents a better class of precision, when compared to the single-phase electromechanical meters; operates with low consumption, low starting current and a fraud detection system by means of a reverse active power indication on the LED, from a pulse emitter. The meters are supplied in the following configurations: 120 V 15/100 A, 60 Hz; 240 V 15/100 A, 60 Hz and 120 to 240 V, 15/100 A and 60 Hz. This electronic meter meets the standards ABNT NBR 14519 [8], NBR 14520 [11], NBR 14521 [12], NBR 14522 [13]; IEC IEC 62052-11 [14], IEC 62053-21 [15]; INMETRO RTM 431/2007 [16], and is commanded by a dedicated chip that carries out the product of the instantaneous current and voltage signals, acquired by an analog-to-digital converter that totals the power with its transformation to the energy consumed. As its register is unidirectional, the value of the reverse kWh is added to the direct kWh. It is able to record the active energy in both flow directions (direct or reverse energy), totaling its modules in a single register. In addition, it has LEDs as indicative of reverse consumption, besides indicating phase and neutral currents with different directions or amplitudes when lighting the red light, with the possibility of the accusation of these two conditions of fraud.

The ME 4, is represented by 9.31% of the park, with 3 models of electronic energy meters, being 1 monophasic and the other 2 three-phase. The electronic single-phase active energy meter is recommended for direct energy measurement in the charging of consumers in group "B". It has the ability to register with good accuracy small loads from 6 W, however, does not have sensitivity in relation to the empty gear. On its front face, it features a 5-digit panel that informs the recorded data of the active energy. This, operates in the voltage of 90 to 280 V dc, in 60 Hz, in nominal current of 15 A and maximum continuous of 100 A, being the starting, less than 0.4% of the nominal. The insulation voltages of 4 kV dc, at 60 Hz, 1 min; the impulse of 1.2/50 – 6 kV; and operates at temperatures between-10 to 85 ^{o}C.

The ME 5, with 21.12% of the electric park of the concessionaire, has as one of the products of the same manufacturer the two-way polyphasic electronic meter, multi-functional, for the application of measurement to 2 elements, 3 wires; or 3 elements, 4 wires, which assists in identifying irregularities in the installation, combating commercial losses and recovering revenue from the concessionaire. The equipment shows on the LCD the energy and the active demand; the energies, reactive inductive and capacitive; and the instantaneous values of current, voltage and power factor and meets the recommendations of the standards: IECs 62052-11 [14], 62053-21 [15], 62053-23 [17]; NBRs 14519 [8], 14520 [11], 14522 [13] and INMETRO RTM 431 [16]. The meter has some characteristics such as the event log, the closing of the main lid promoted by chemical fusion, which increases its protection against fraud and greater resistance to mechanical shocks and ultraviolet rays, in addition to other features.

The other three meters installed are electromechanical, with most of their characteristics are similar to those already presented, as the ME 6, with participation in 9.93% of the concessionaire's electric park, the ME 7, with 15.16% and the ME 8 models, with 22.12% of the total installed in park.

III. RESULTS AND DISCUSSION

Table 1, shows the manufacturers and their types of meters with the percentage of frauds observed during the period.

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Table 1. Models and types of electrical, electronic (E) and electromechanical (EM) meters and percentage of fraud observed in the concession Park analyzed.

Meters/damage	ME 1	ME 2	ME 3	ME 4	ME 5	ME 6	ME 7	ME 8
Type of meter	E	E	E	E	E	EM	EM	EM
Percentage in park	**1.62**	**6.8**	**4.85**	**9.31**	**21.12**	**9.93**	**15.16**	**22.12**
Damaged meter	19.9	8.95	9.39	15.76	15.42	4.83	9.61	11.53
Disc locked	14.85	5.43	7.68	8.53	8.2	8.75	16.03	14.11
Potential circuit	0.46	34.4	1.54	15.61	27.65	8.17	4.42	3.68
Bridge between the terminals	13.81	2.69	9.38	17.73	5.83	5.66	5.8	19.77
Register	24.54	8.16	7.74	14.83	13.83	7.78	4.98	11.13
Lack of neutral	8.34	1.63	13.02	16.6	11.54	5.38	5.72	16.54
Inverted connection	11.98	4.86	6.08	11.98	11.63	9.2	17.53	16.32
Overall failures	**93.88**	**66.12**	**54.83**	**99.04**	**94.1**	**49.77**	**64.09**	**92.48**
Total Failures/Park	**1.52**	**4.50**	**2.66**	**9.22**	**19.87**	**4.94**	**9.72**	**20.46**

From the inspection carried out by the laboratory, was verified the main types of frauds listed in the sequence, for some of the meters assessed.

ME 1. In 2013, the product was homologated by CEEE-D and, since then, an average of 50,000 units per year has been acquired. However, with the time of operation in the network, a failure rate was verified in 2,623 meters manufactured between the years 2013 and 2014 that made it inoperable, always breaking the internal power supply.

Of this lot, 1,200 meters were installed in the consumer for a period of less than 4 months, being then withdrawn for analysis. The result of this, showed that approximately 60% of them were with the capacitor damaged; 30% had Zener diode burnt; 15%, there were breakdowns in the varistor; 15% were with the resistor open. Additionally, in some meters, more than one defective component was detected. Problems related to the capacitor of the meter source were also verified by Eletrobras [17].

ME 2. This model has been presenting the following vulnerabilities: a) easy handling to lift the back cover and have access to the internal area of the meter (usually disconnects the circuit of potential); b) ease of internal access by using a drill to reach potential circuit conductors and electronic circuits (Fig. 1).

ME 3. This model has been presenting the following vulnerabilities: a) hole in the lid for the locking of the consumption recorder; b) coil imantation, the magnetic field generator device is placed on the disc brake; c) ease of access to the terminals, promoting wiring bridges to the circuit breaker; d) ease of decoupling the disc; and e) ease of internal access for partial or total scraping of the recorder disk.

Fig. 1. Illustrative image of the ME 2, highlighting the region of easy access of the internal electronic circuit, with the use of drill.

ME 4. This model has been presenting the following vulnerabilities: a) meter with an average duration of 2 years according to the climate (problems of the capacitor, probably due to the high temperatures recorded in Rio de Janeiro); b) use of a drill to reach the electronic circuit (Fig. 2 a and b); c) indirect and direct measurement, with access through the battery compartment to reach the electronic circuit, since the drum compartment has a fragile lid (Fig. 2. c).

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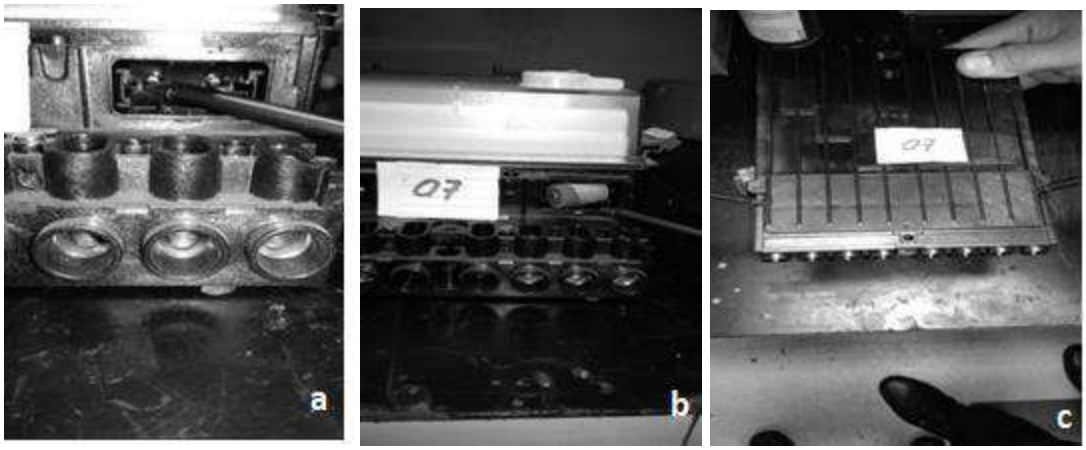

Fig. 2. Illustrative images of the common types of fraud in the ME 4, such as: in (a) and (b) the ease of by drill; and (c) access of the internal electronic circuit through the battery compartment.

ME 5. The models in reference presented the following vulnerabilities: A – easy access to the internal area of the meter, mainly with drill, to reach the conductors of the potential circuit to disconnect it, problem this, solved by changing the internal configuration of drivers; B - access by the optical port; C - coil imantation; D - inner compartment with design that allowed remote control device housing; E - ease of damage to the display by using laser lanterns; F - ease of opening for feed sectioning and/or potential circuit inversion; G - execution of external cabling exchange in the terminals; and H - change of the asset by the reactive (function 03 by function 24) using the optical sensor with the aid of a notebook and specific program.

In Fig. 3, there are four examples of common frauds found in this type of meter installed in the park of the energy concessionaire, being: i) in Fig. 3 A, the perforation of the cradle of the post with drill to reach the potential circuit; (ii) in Fig. 3 B, the ease of access by the optical port; (iii) in Fig. 3 C, internal compartment allowing the installation of a remote fraud control; and in Fig. 3 D, a meter taken from a consumer containing the remote control of fraud.

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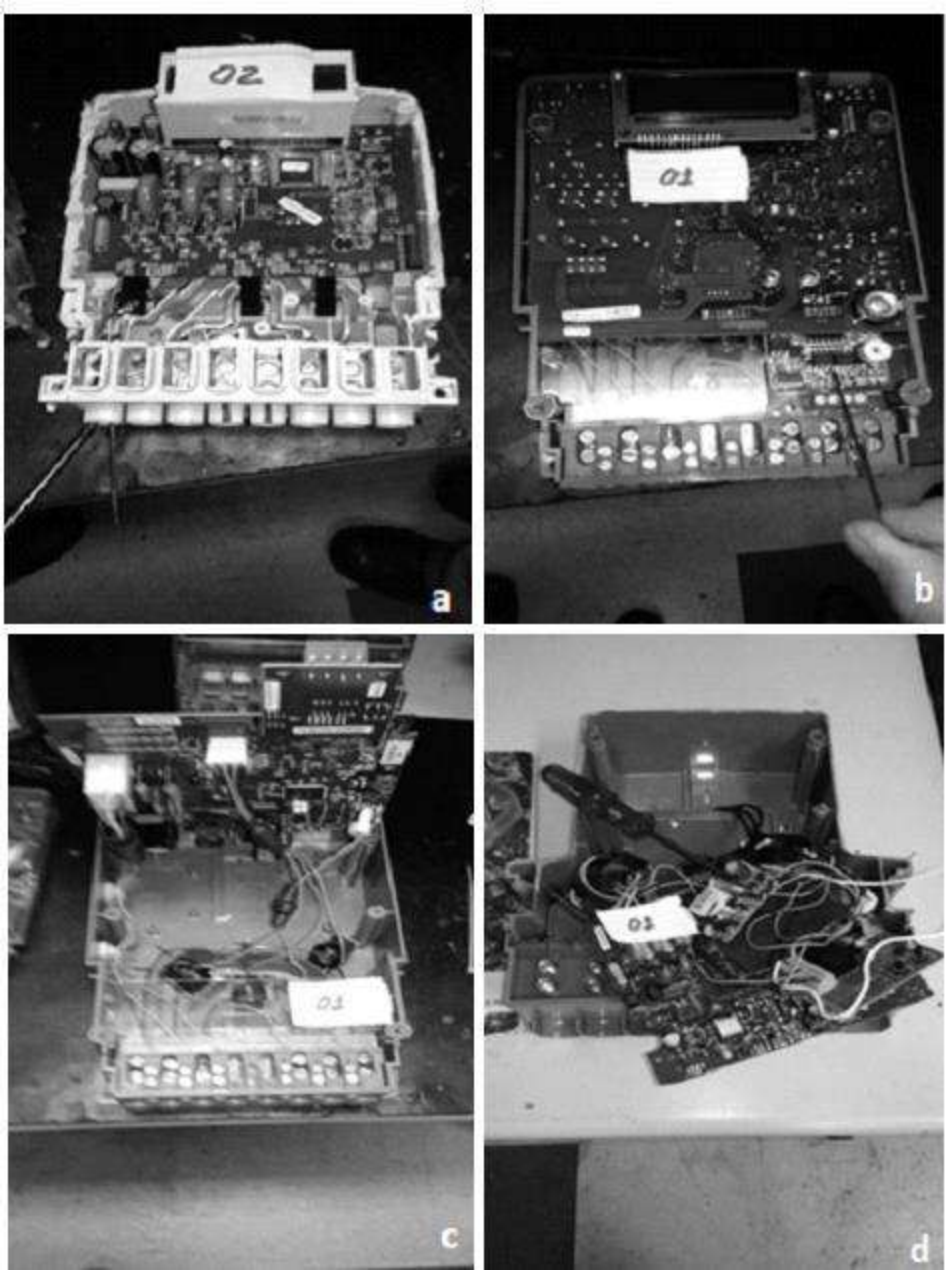

Fig. 3. Illustrative images of the main types of fraud in the ME 5 meter, installed in the concessionaire park, being: a) the perforation of the cradle of the post with drill to reach the circuit of potential; b) the ease of access by the optical port; c) internal compartment that allows the installation of a remote fraud control; and, D) a meter taken from a consumer containing the remote control of fraud.

ME 6. This model has presented the following vulnerabilities: a) glass-topped meter; b) coil imantation-the magnetic field generator device is placed on the disc brake; c) ease of access to the terminals, promoting wiring bridges to the circuit breaker; d) ease of decoupling the disc; e) ease of internal access to the partial or total scraping of the recorder disc from the post and the misalignment of the screw ruler; and f) ease of opening the potential coil. Fig. 4 shows the main access facilities inside the device.

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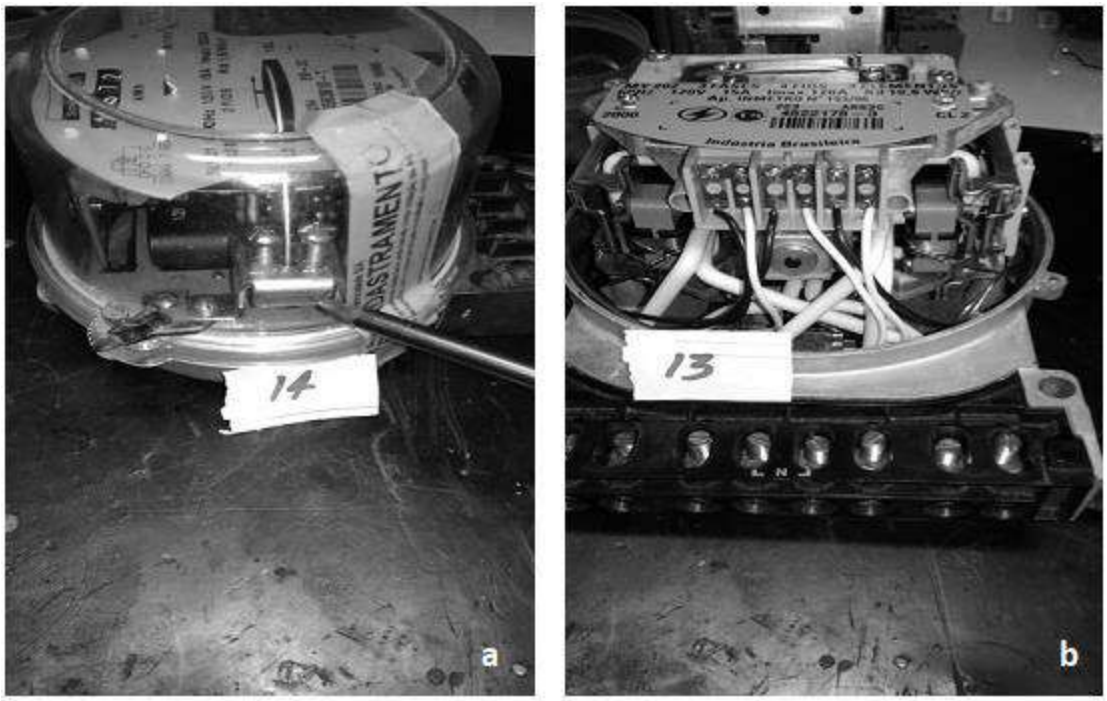

Fig. 4. Illustrative images of the ME 6, highlighting in (a) and (b) the glass lid and the ease of connecting a bridge in the posts.

ME 7. This model (Fig. 5), has been presenting the following vulnerabilities: a) meter with glass top (Fig. 5 a); b) vulnerability also to the imantation of the coil; the magnetic field generator device is placed on the disc brake; c) ease of access to the terminals, promoting wiring bridges to the circuit breaker (Fig. 5 b); d) ease of decoupling the disc; e) ease of internal access to the partial or total scraping of the register disk; and f) ease of internal access by removing screws from the terminals, with decentralization of the screws fixing ruler (Fig. 5 c).

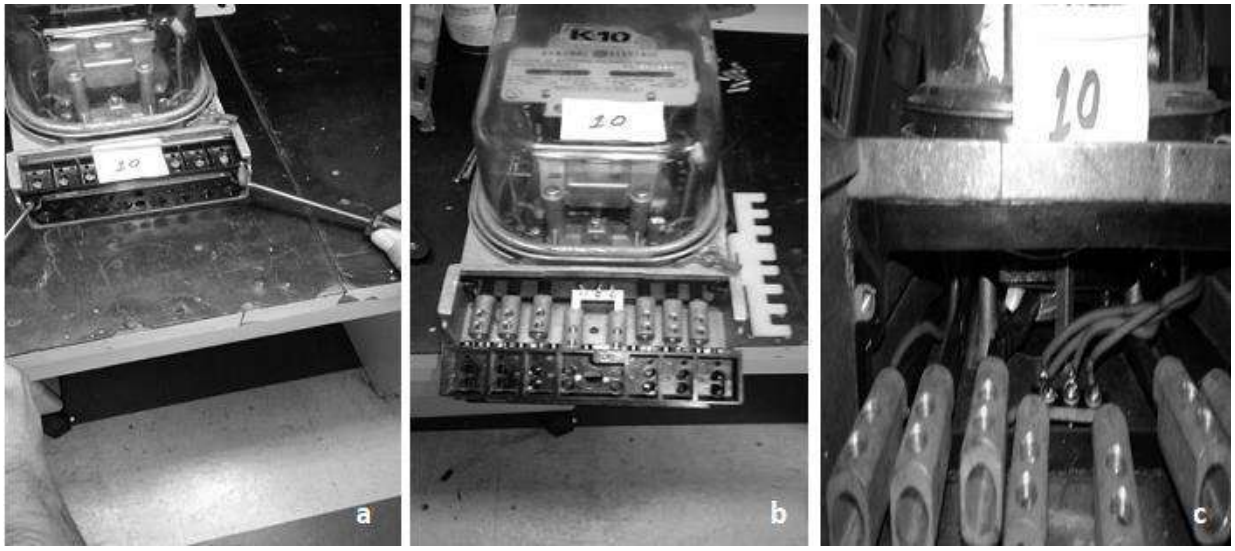

Fig. 5. Illustrative images of the ME 7: (a) the glass cover; (b) ease of connection of a bridge in the terminals; and (c) ease of access to the inside of the meter by removing the screws on the terminals.

ME 8. This type has been presenting the following vulnerabilities: a) hole in the meter cover to access the internal mechanisms; b) total locking of the meter disc; c) possible imantation of the coil with the magnetic field devices available on the market, which are placed to brake the disc; d) Bridge on the terminals on the meter and this for the circuit breaker; e) decoupling of the disc; and f) partial or total scraping of the recorder disc, as illustrated in Fig. 6.

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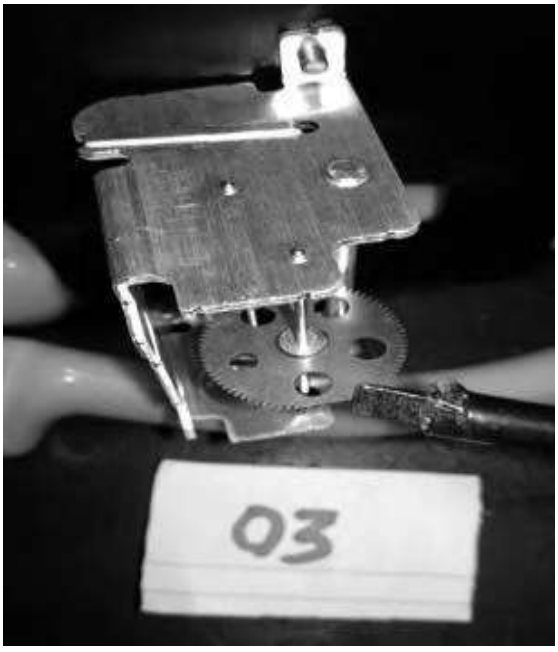

Fig. 6. Illustrative image of one of the common types of fraud in the ME 8, as the change in internal gear, with scraping of the disc.

General considerations. The typologies of fraud were repetitive and depended on the characteristics of the meters, electromechanical and electronic. Also, according to the survey and data analysis was used all type of tool for the damage in the measuring equipment, among others not cited as the use of the hair dryer for the melting of the liquid crystal of the viewfinder, the use of laser for short circuit the electronic seals, the use of drills for access to the discs and the locking of the meters and to reach electronic/mechanical circuits and damage them.

From the revised technical papers of the literature, it could be considered that a large part of the Brazilian energy concessionaires, mainly due to fraud, has been working with innovations and updates of its consumer databases in order to facilitate the automated procedures via geo-referenced identification and analysis software, the type of meter, the profile of consumers and the forms of fraud that stood out most in the area. Also, it was verified a tendency of the use of electronic meters, with the additional deployment of software and algorithms analysis of possible frauds, robberies, cyber-attacks and failures between supply and demand of energy, since even the smart grids are subject to these attacks via external machines. Internal changes in the meters in order to sensor any external interventions such as the application of impact and vibration tools, opening of the lid, perforation by the terminals, opacity of the displays, among others, are also being researched [19-24].

IV. CONCLUSION

In this investigation, were observed the main types of fraud in energy input meters, electronic and electromechanical, in the region of Rio de Janeiro, Brazil, by the consumers of one of the local concessionaires and that represented in the first semester of 2018, NTL of the order of 11% of financial losses. For this purpose, were observed experimentally and by technical and visual inspection, the uses of drilling tools, the magnetic field generators for the blockade or the delay of the meter disk, the changes in the contacts in the terminals, such as the electric bridges; the inverted connections of the internal circuits, the lack of neutral, up to 12%, each. Also, not considered in the statistical data of this research, the uses of hair dryers were observed, in order to cause overheating of the internal electronic circuit, damage by impacts, vibrations, among others technics not identified.

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Electromyographic Activity of the Rectus Abdominis Muscle during Physical Conditioning Exercises: A Systematic Review

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Abstract**—***Purpose: The rectus abdominis muscle is involved in support, containment of viscera, respiration, defecation, urination, vomiting, and assistance during delivery. Many exercises and equipment are used to strengthen the rectus abdominus muscle, which aim to prevent and rehabilitate low back pain, improve athletic performance, or achieve aesthetic standards. Exercises that potentiate electromyographic activity require the recruitment of the biggest number of muscle fibers and are more effective in developing or maintaining strength. Analysis of electromyographic activity allows us to determine the quality of physical exercises for strength training, and to choose and order them properly in a training session. This systematic review has been developed following the protocol registered in the International Prospective Review Record (PROSPERO) under number CRD42018086172. Methods: To identify relevant studies, we searched for articles in the following databases: MEDLINE, PubMed, Europubmed, SciELO, and Google Scholar. The methodological quality of the studies included in the review and the risk of bias were established based on the Cochrane Handbook of Systematic Reviews of Interventions. Results: After analysis of the full texts, 13 studies were considered eligible in the qualitative synthesis and were included for quantitative analysis. Conclusion: We conclude that electromyographic studies are required, with more rigorous methodological criteria, with the objective of reducing the risk of bias and obtaining definitive conclusions about muscle activity and identifying efficient exercises for the development of the rectus abdominis muscle strength. Ventral plank exercises present better electromyographic results for the rectus abdominis muscle and its action.*

Keywords**—***Abdominal Exercises, Electromyography, EMG, MVIC, Rectus Abdominis.*

I. INTRODUCTION

The abdominal muscles are important in that they are directly related to body posture, containment of viscera, help during expiration, defecation, urination, vomiting, and assisting during delivery [1]. The rectus abdominis muscle is important for the positioning of the pelvis and is related to body posture by being indirectly responsible for the lumbar spine curvature [2]. Weakness of the rectus abdominis muscle can cause several disorders associated with posture, such as ptosis, low back pain, and respiratory disorders [3]–[6].

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The rectus abdominis muscle is the main muscle of the anterior wall of the abdomen, characterized by being long and wide, similar to a lane, originating from the symphysis and pubic crest, inserting into the cartilages of the fifth, sixth, and seventh ribs, and xiphoid process of the sternum bone, separated from its homonym by the alba line [7]. The rectus abdominis muscle acts to increase intra-abdominal pressure, trunk flexion, and retroversion of the pelvis[8].

Exercises aimed at abdominal strengthening are widely practiced because they do not only involve aesthetic goals, but also prevent and rehabilitate low back pain, improve athletic performance, and increase resistance and trunk strength for daily activities [9]–[12]

However, a consensus has not yet been reached on exercises that are effective in stimulating the activity of the abdominal muscles, especially the rectus abdominis muscle. Establishing a consensus on this topic would facilitate the dissemination and implementation of standardized training for strength training and physical conditioning, which could result in more effective multi-site training programs, thus improving performance and avoiding injuries in athletes and/or patients.

Decisions on which exercises should be performed in a training program are often based on opinions, personal experiences, and articles that may or may not be based on scientific evidence. Decision-making on which exercises are best under specific circumstances in such a way has led to the use of a wide variety of basic training techniques, with little or no consistency, among strength training specialists. Consequently, exercises that are best suited for activating the abdominal muscles and improving trunk strength are still much debated [13], and yet, there is no evidence-based consensus. Therefore, a systematic review with a consensus on the activity of the rectus abdominis muscle during physical exercises is necessary for specialists in physical conditioning and strength to prescribe appropriate protocols and recommendations to their athletes and patients.

This systematic review aimed to analyze the activation of the rectus abdominis muscle based on the results obtained in electromyographic analyses during the execution of different physical exercises, as well as the morphological and functional characteristics of the volunteers and the technique used in the normalization of the electromyographic signal.

II. MATERIAL AND METHODS

The systematic review protocol of the present study was developed in accordance with the items reported for systematic reviews of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA-P) [14], [15] and registered in the International Prospective Review Record (PROSPERO) under number: CRD42018086172, [16].

1)Study design

It is a protocol for the systematic review of prospective cohort studies, following the guidelines of PRISMA-P. The entire process of study selection is performed by two reviewers and summarized in a PRISMA flow diagram (Fig. 1).

2)Inclusion/exclusion criteria

Cross-sectional studies, case studies, and randomized clinical trials published in English from January 2014 to June 2018 are included in this review.

3)Participants

Healthy individuals who are able to practice physical exercises, aged between 18 and 60 years, were included. No restrictions of gender, ethnicity, or socioeconomic status was applied. We excluded studies with individuals who presented some factor that could interfere in the reliability of the results, such as pregnancy, fracture, osteoporosis, malformations, skeletal deformities, spondylitis/spondylosis, rheumatic diseases, equine tail syndrome, abdominal surgery, tumor, neuromuscular disorders, cardiopathy, neurological dysfunctions, alcoholism, smoking, myopathies, or neuromyopathies, low back pain, abdominal pain or any other type of clinical problem that could interfere with the execution of the proposed exercises.

4)Intervention

Included interventions investigated the electromyographic activation of the rectus abdominis (RA) muscle, regardless of its part, being upper rectus abdominis (URA) or lower rectus abdominis (LRA), and which presented the electromyographic signal normalized by the percentage of maximal voluntary isometric contraction (MVIC%).

5)Results measures

Studies that report the results of the of MVIC% and analysis of the electromyographic signal in the temporal domain of the abdominal musculature in different types of physical exercises are considered. We excluded studies that did not evaluate the MVIC% root mean square (RMS) or those not analyzing the EMG signal in the domain time of the RA muscle. The data collection tools include the analysis of the results obtained through EMG in the exercises performed.

6)Search sources

To identify relevant studies, the following electronic databases are searched: MEDLINE, PubMed, Europubmed, SciELO, Google Scholar. After analyzing

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the main studies, the following keywords were identified for the study: electromyography, electroneuromyography, rectus abdominis, exercises, abdominal muscles (Table 1). Three authors analyzed the title and abstract of the articles. The reference list of relevant studies was examined to identify potential studies to be included.

7)Data collection and analysis

Duplicates are removed, and the references evaluated for eligibility were classified alphabetically, according to the names of the first authors.

Selection process

Two authors independently analyzed the titles and abstracts of the studies identified by the research strategy. Potential eligible studies are reevaluated by reading the full text. In case of disagreement, the opinion of a third author is requested. Following the guidelines (PRISMA-P), a flow chart showed the study selection process (Fig. 1).

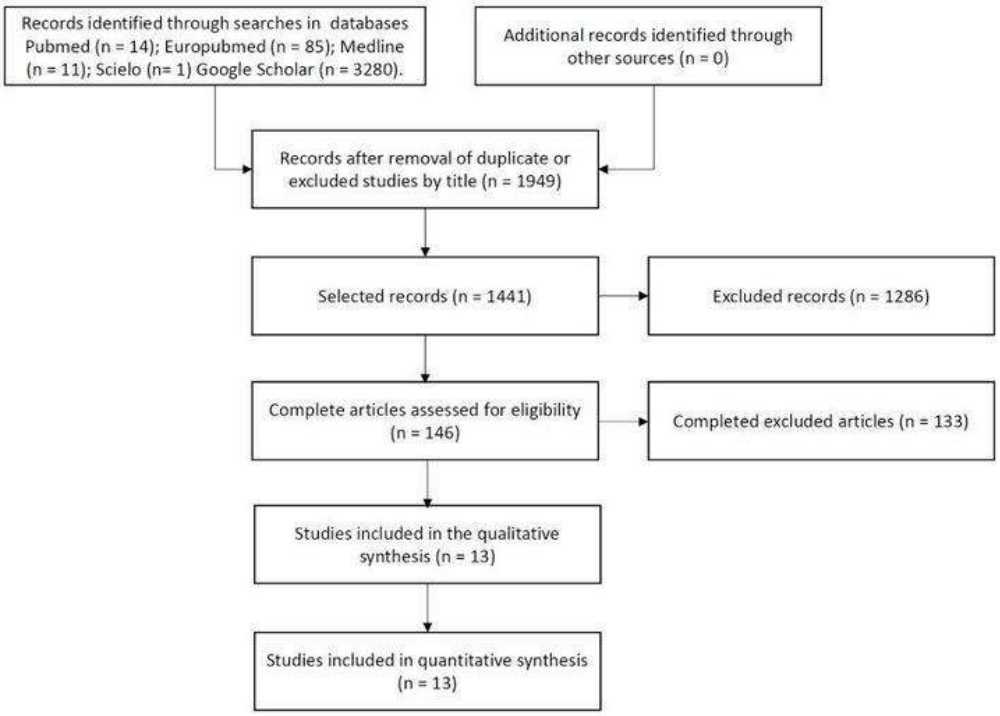

Fig.1. Flow diagram of the study selection process.

8)Data collection process

A reviewer completed the data extraction from the selected studies (study design, year, country, number of participants, volunteer characteristics, age, equipment used, exercise performed, RMS treatment and MVIC%, results, and discussion). A second author verified the accuracy and consistency of all inputs and made relevant clarifications when necessary. A third author mediated possible unresolved disagreements regarding data extraction.

9) Assessment of bias quality and risk of included studies

III. RESULTS

Our search resulted in 3390 citations, and some duplicates were disregarded, leaving 1441 studies that examined the RA muscle. After analyzing titles and abstracts, 146 potentially relevant studies were selected. After analysis of the full texts, 13 studies are considered eligible and are included for further analysis:[18], [19], [20], [21], [22], [23],[24],[25], [26], [27], [28], [29], [30].

A total of 133 studies were considered ineligible, and 42 were excluded that did not study common exercises in physical training, that is, 19 did not clearly analyze the EMG of the RA muscle, 14 measured muscle activity with ultrasonography or magnetic resonance imaging, 2 were not published in the English language, 2 volunteers reported lesions or pain, and 54 EMG signals were not normalized. Data from included studies are presented in Tables 1 and 2.

IV. DISCUSSION

An important finding of this systematic review is that the overall design quality of the included studies is good, but with a risk of methodological bias characterized by a systematic error in the procedures for sample selection and normalization of the EMG signal. Therefore, the evidence base for the EMG activity of the

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RA muscle during physical conditioning exercises studied is not strong despite its widespread use in physical training and rehabilitation communities.

Despite the clear risk of methodological bias of the studies that are included in this review, the current data allow us to conclude that physical exercises are more effective in activating the RA muscle. Our findings indicate that the EMG activity of the RA muscle is higher during ventral decubitus exercises, with the trunk in elevation, known as "ventral plank," and is even greater, with the use of equipment that may generate instability, such as the Swiss ball and sling. Possible explanations for the increased activity of the RA muscle during unstable exercises include the increased need for the RA muscle to stabilize the spinal cord and protect the spinal cord, demonstrating the stabilizing functional characteristic of this muscle [31].

Even with the greater tendency of muscular action in ventral plank exercises, no specific type of exercise is considered to be clearly effective for the development of RA muscle strength in this systematic review. The comparisons between the types of exercises show that the findings are conflicting because the values are between 21% [27] and 43% [18] of MVIC for the same exercise, such as the ventral plank, on a stable surface, in the different studies. Escamilla [32]et al. (2010) classified muscle activity level into low (0% to 20% MVIC), moderate (21% to 40% MVIC), high (41% to 60% MVIC), and very high (above 60% MVIC). Exercises that produce muscular activation >60% of MVIC can be directed to muscle strength training, which evidence the low activity of the RA muscle in the exercises analyzed in this review.

In the exercises performed using equipment to generate instability, the EMG values presented ranged from 28% of the MVIC [18] to 141%[20], suggesting a lack of criteria and quality in strategies of EMG signal normalization, using manual resistance, as proposed by [33]. Being that in a test of voluntary isometric maximum contraction, it should have, at most, 100% of the muscular capacity, making values >100% impossible.

To produce a "real maximum" activation, a good fixation of all involved body segments is very important. Untrained individuals may have trouble producing a true level of contraction in the MVIC test. Machines with fastening belts should be used whenever possible. It is interesting to note that, depending on the volunteer's ability to coordinate, different MVIC tests (exercises and different positions) may produce higher MVIC values. Especially for trunk muscles, trying two or three exercises and checking which could have the highest level of EMG signal may be necessary [34].

When manual resistance is used in MVIC tests, it is believed that there is no "peak" activation of the analyzed muscles, leading to lower MVIC values and, automatically, excessive values in the exercises. Therefore, future studies should prioritize the MVIC protocol with fixed resistance to facilitate the understanding and practical application of the results.

The studies included in this review demonstrate characteristics that limit the quality of the results, presenting a strong methodological bias associated with factors, such as the lack of information on the fat percentage of the volunteers, which are present only in the studies of [20], [21] low training time, small samples, little or no familiarization of the volunteers with the proposed exercises, different inclusion and exclusion criteria, as well as lack of discussion about how safe the exercises are, and grouping and summarizing data that understanding the results difficult.

The surface EMG signal amplitude and frequency characteristics have been shown to be sensitive to intrinsic (muscle fiber type, depth, diameter, electrode location, amount of tissue between muscle and electrode) and extrinsic factors (location and orientation about the area and shape of the electrodes, and the distance between them). Therefore, the amplitude of the EMG signal cannot be analyzed directly [35], making it necessary to use a more robust methodology that investigates and standardizes the volunteers morphologically, the percentage of fat, possibly the thickness of the skin fold in the place of fixation of the electrodes, studying individuals trained in the proposed exercises, application of more than one electromyographic evaluation, allowing the observation of the muscular adaptation at the end of a training.

Given the limitations of available scientific literature on this subject, the physical training specialist should review individual studies with caution when interpreting the results for practical applications. We suggest new research using EMG to elucidate the real contributions of the exercises used in gymnasiums and physical training centers for the development of RA muscle strength, bringing the practice methodology closer to the training environment, thus seeking greater validity externality of the information presented, allowing adequate selection and order of the exercises proposed by the coaches, improving the strength training of the RA muscle for different goals and sports modalities.

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V. CONCLUSION

The need for electromyographic studies, with more rigorous methodological criteria to reduce the risk of bias and to obtain definitive conclusions regarding muscular activity and to identify efficient exercises for the development of RA muscle strength. Ventral plank exercises present better EMG results for the RA muscle and its action.

The muscle is more required when its activity is associated with instability, but the following should be considered: a) adequate normalization of the EMG signal through equipment that effectively identifies MVIC, b) the morphological characteristics related to the percentage of body fat, c) volunteer familiarization with the proposed exercises. Improved research in this area should provide strength training and fitness specialists with additional evidence-based expertise to enable the prescription of basic exercises appropriate to athletes and patients.

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Table 1. Study inclusion criteria, volunteer characteristics, and electromyographical technique for signal collection.

Author	Inclusion Criteria	Exclusion Criteria	N; sex; age; weight; height. (Median)	Exercise studied familiarization	Isometric Contraction Technique (MVIC)	% Body Fat	EMG Technique; Electrodes Placement (RMS signal analysis)
[18]	Healthy subjects	Low back pain, congenital deformities, orthopedic or neurological disease, superficial injury or pain.	n=23; Sex male/female (14/9); age=29±5; weight=66±12; height 170±7.	Untrained	Manual resistance	Not analyzed	Surface electromyography; MU: 2 cm L L-3. RA: 2 cm L to the umbilical scar; OE: 15 cm L to the umbilical scar; OI: 2 cm B and 2 cm M to the antero-superior iliac crest.
[19]	Healthy subjects	History of spinal cord injury or surgery in the last two years.	n=30; Sex male/female (15/15); age=24±2; weight=71±13; height 170±1.	Experience less than 4 weeks of Yoga.	Manual resistance	Not analyzed	Surface electromyography; The Trigno ™ wireless sensors (Delsys®, Boston, MA) were placed parallel to the muscular womb according to Criswell (2011).
[20]	Physically active subjects, vigorous exercise practitioners twice weekly.	Musculoskeletal pain, neuromuscular disorders, or any form of joint or bone disease.	n=20; Sex male/female(13/7); age=20±1; weight=73±7; height 173±7.	Each subject participated in a familiarization session.	Manual resistance	% Body fat 14.1±4.4%.	Surface electromyography RAS: 2 cm L to umbilical scar; RAI: between the navel and pubic symphysis, 3 cm L of the midline; OBLIQ: between the iliac crest and ribs at an oblique angle; LUMB: L 2 cm from L3 vertebra.
[21]	Physically active subjects, vigorous exercise practitioners twice weekly.	Musculoskeletal pain, neuromuscular disorders, or any form of joint or bone disease.	n=20; Sex male/female (13/7); age=20±1; weight=73±7; height 173±7.	Each subject participated in a familiarization session.	Manual resistance	% body fat: 14.1±4.4.	Surface electromyography RAS: 2 cm L to umbilical scar; RAI: between the navel and pubic symphysis, 3 cm L of the midline; OBLIQ: between the iliac crest and ribs at an oblique angle; LUMB: L 2 cm from L3 vertebra.

https://dx.doi.org/10.22161/ijaers.6757 ISSN: 2349-6495(P) | 2456-1908(O)

[30]	Subjects between 23 and 45 years.	Not analyzed	N=18; Sex male/female (9/9); age= male/female (29.9–6.6 years) (27.7-7.7 years) mass: Male/female (73.3–7.2 kg) and (61.1-7.8 kg) and height: (male/female) (178.1-4.3 cm) and (165.0–7.0 cm).	All subjects became familiar with all exercises during a pre-test that occurred one week prior to the test session.	Manual resistance	Not analyzed	Surface electrodes were positioned on the upper and lower rectus abdominis, external and internal oblique, rectus femoris, dorsal muscle, and lumbar paraspinals.
[22]	Subjects with good health, no pain, no participation in any form of sports and able to perform all exercises safely.	Back or lower back pain, abdominal or spinal surgery.	n=20; Sex male/female (14/6); age=25±7; weight=64±11; height 170±8.	Untrained.	Manual resistance	Not analyzed.	Surface electromyography; RA: 3 cm between the xiphoid process and the umbilicus; OE: above the antero-superior iliac crest at the umbilicus level; OI: 2 cm B and 2 cm M of the anterior superior iliac crest; LP: 3 cm L of the spinous process at the level of L3 and L4.
[29]	Subject must not have neurological or musculoskeletal pathology that could influence exercise.	The subject cannot maintain the correct posture during the plank exercise.	n=20; Sex= male; age 30.44±2.65 years; height, 175.55±5.74 cm; weight 70.33±5.24 kg.	Not analyzed.	Manual resistance	Not analyzed.	Surface electromyography for: RA; HI; ASIC; OE.

[23]	No analyzed.	Complaints of low back pain in the last 6 months; history of neuromuscular or orthopedic disease; presence of severe postural abnormality.	n=20;
			Sex= male/female (10/10);
			age= 20 years;
			weight= No analyzed;
			height= Not analyzed
				Not analyzed.	Manual resistance	Not analyzed.	Surface electromyography: 2 cm lateral to the prickly process of L2 to ES. For RA, 5 cm lateral to the umbilicus; to IO, midway between ASIC and umbilicus; For EO, 15 cm lateral to the umbilicus.

https://dx.doi.org/10.22161/ijaers.6757 ISSN: 2349-6495(P) | 2456-1908(O)

[24]	Healthy adults with no history of surgeries and able to maintain a sitting posture for a minute or longer.	Congenital deformities in the back, orthopedic or neurological problems.	n=7; Sex= male/female (6/1); age=22±2; weight=68±12; height 174±7.	Untrained.	Manual resistance	Not analyzed.	Surface electromyography; OE: 3 cm above the iliac crest; RA: 3 cm L at the navel; ES: 5 cm L to L4.
[25]	Be currently active in resistance training programs	Subject to any prior injuries which, in any way, affect muscle activation.	n=20; Sex= male/female (10/10); age=male/female (25.9±5.61/22.8±1.8 years); height=male/female (175.2±8.5/166.1±8.5 cm); weight=male/female (81.3±6.9/63.0±10.4 kg.	A familiarization period was performed one or two days before the test.	Manual resistance	Not analyzed.	Surface electromyography: RA 2 cm to the right of the umbilicus; OE 15 cm laterally to the umbilicus; EE 2 cm parallel from the L-3 vertebrae. RF was positioned vertically near the midline of the thigh.
[26]	Healthy subject, 20 years old	Individuals with medical problems, abdominal or back surgery histories, psychological problems within 12 months prior to this study.	n=20; Sex= male/female (10/10) age= (male/female) (21.9±1.45/20.7±0.48 years), height=male/female (174.7±3.92/164.7 ±3.2 cm), weight=male/female (66.3±6.24/56.6±3.86 kg)	Not analyzed.	Manual resistance	Not analyzed.	Surface electromyography: RA – 3 cm superior to the umbilicus and 2 cm lateral to the midline; ES-3 cm lateral to the level of the spinous process L4/5; EO - an oblique arrangement above the anterior superior iliac crest and lateral to the umbilicus; IO - midway between the antero-superior iliac crest of the pelvis.
[27]	Do not exercise more than twice per week.	Metabolic, cardiovascular and orthopedic complications in the last year.	n=19; Sex male/female (4/15); age=25±4; weight=52±17; height 161±0.6.	Untrained.	Manual resistance	Not analyzed.	Surface electromyography; RA: 3 cm L to the midline; EO: between the anterior superior iliac crest and the thorax at the umbilicus level; ES: 3.5 cm from the midline at the level of the L2 and L4 vertebrae

https://dx.doi.org/10.22161/ijaers.6757 ISSN: 2349-6495(P) | 2456-1908(O)

[28]	Absence of neurological and musculoskeletal diseases, with no limitations of movement in the hip and weakness of the lower limb, with no history of surgery in the trunk and lumbo-pelvic region.	Pregnant, elite athletes, subjects with less than 6 months experience in weight training.	n=15; Sex (male/female) (12/3); age=27±3; weight=68±11; height 172±6.	Untrained.	Manual resistance	Not analyzed.	Surface electromyography; IO: 2 cm M to the anterior superior iliac crest; RA: 3 cm L at the navel; ES 3 cm L to L 3; MF L from the midline of the vertebrae, above and posterior to the posterior iliac crest.

n= voluntary's number; cm= centimeters; L= lateral; B= below; M= midline.

https://dx.doi.org/10.22161/ijaers.6757 ISSN: 2349-6495(P) | 2456-1908(O)

Table 2. Exercises and electromyographic activity from rectus abdominis description of the studies included in this systematic review.

Author	Exercises	Rectus Abdominis Muscle EMG* %MVIC
[18]	G1: plank basic position; G2: basic plank with unilateral hip abduction position; SK1: plank with sling resting on both knee positions; SK2: plank position with sling supported on one knee with unilateral hip abduction; AS1: plank with sling resting on both ankle positions; SA2: plank position with sling supported on an ankle and abduction of unilateral hip;	G1: 43.31 (20.99); G2: 46.01 (22.02); SK1: 28.58 (17.39); SK2: 25.69 (15.76); AS1: 54.49 (26.67); AS2: 63.67 (23.08).
[19]	Chair position (Chair); High Plank (Plank); Dog Face Up (Dog); Warrior posture (Warrior).	Chair: 10.6 (7.5); Plank: 28.2 (15.8); Dog: 12.7 (7.6); Warrior: 9.3 (6.7)
[20]	Bilateral suspended supine plank (B.Sus.B.); bilateral stable supine plank (B.St.B.); unilateral suspended supine plank (U.Sus.B.); unilateral stable supine plank (B.St.B.).	B.Sus.B (RAS): 12 (9); (RAI): 7 (10); B.St.B (RAS): 5 (9); (RAI): 1 (10); U.Sus.B (RAS): 15 (9); (RAI): 11 (11); U.St.B (RAS): 7 (9); (RAI): 5 (10).
[21]	Proned stable plank (St.PP); Suspended plank proned (Sus.PP); Stable scroll plank (St.RP); Suspended rolling plank (Sus.RP); Unilateral stable plank (USt.PP); Unilateral suspended proned plank (USus.PP); Standard lateral plank (St.LP); Suspended lateral plank (Sus.LP).	St.PP (RAS): 32 (4); (RAI): 30 (4); Sus.PP (RAS): 131 (15); (RAI): 93 (10); St.RP (RAS): 100 (12); (RAI): 74 (11); Sus.RP (RAS): 145 (22); (RAI) 122 (32); USt.PP (RAS): 30 (5); (RAI): 28 (7); USus.PP (RAS): 43 (9) (RAI): 37 (8); St.LP (RAS): 26 (4); (RAI): 20 (3); Sus.LP (RAS): 31 (5); (RAI): 30 (4).
[30]	A: Prone in the ball with right hip extension; B: Lying on the ball with the extension of the left hip; C: Prone bridge (board) on the ball; D: Prone bridge (plank) on the toes; E: Prone bridge (plank) on the knees; F: lateral crushing on the ball; G: Side bridge (plank) on the toes; H: Side bridge (board) on the knees; I: Crunch; J: Folded abs	A: RAS-43(21); RAI- 44 (11); B: RAS -41 (24); RAI - 39 (19); C: RAS -49 (26); RAI - 48 (9); D: RAS - 34 (15); RAI - 40 (10); E: RAS - 27 (9); RAI - 26 (9); F: RAS - 21 (11); RAI - 16 (7); G: RAS - 26 (15); RAI - 21 (9); H: RAS - 17 (10); RAI - 14 (8); I: RAS - 53 (19); RAI - 39 (16); J: RAS - 40 (13); RAI - 35 (14).
[22]	Trunk flexion in a Swiss ball. (TFSB); Trunk flexion and rolling the in a Swiss ball (TFRSB); Advanced leg stretched dorsal bridge in the Swiss ball (ALSD); Trunk extension in Swiss ball (TESB); Advanced plank (AP); Side bridge (SB); Advanced quadruped (AQ); The trunk back and forth sitting on a chair (FC).	TFSB (0%–20%MVIC); TFRSB (0%–20%MVIC); ALSD (0%–20%MVIC); TESB (0%–20%MVIC); AP (21%–40%MVIC); SB (21%–40%MVIC); AQ (0%–20%MVIC); FC (0%–20%MVIC).

https://dx.doi.org/10.22161/ijaers.6757 *ISSN: 2349-6495(P) | 2456-1908(O)*

[29]	Plank; Unilateral isometric hip adduction plank (UIHA); Bilateral isometric hip adduction plank (BIHA).	Plank: RA: Rt (38.83±16.43); Lt (41.16±18.19): Rt (42.47±10.66). UIHA Plank: Rt (46.19±18.19); Lt (55.46±17.51); Rt (55.50±13.14); BIHA Plank:Rt (43.41±20.03); Lt (48.77±18.16); Rt (47.78±12.35).
[23]	Position 1 : conventional bridge exercise ; Position 2 : Bridge exercise; shoulder on the stable table of 1/2 knee height ; Position 3 : Bridge exercise; shoulder on the stable table ; Position 4 : Bridge exercise; shoulder on the sling of 1/2 knee height ; Position 5 : Bridge exercise; shoulder on the sling.	RA: P1(18.79±2.75); P2(27.10±3.030; P3(24.53±3.44); P4(45.05±6.28); P5(41.54±6.20).
[24]	TPE: Plank Exercise; UTPE: Unstable Plank Exercise; MPE: Modified Plank Exercise; UMPE: Unstable Modified Plank Exercise.	TPE: Rt. 34.93 (29.44); Lt. 33.12 (26.62); UTPE: Rt. 39.14 (17.69) Lt. 49.82 (21.79); MPE: Rt. 12.82 (6.69) Lt. 15.44 (7.94); UMPE: Rt. 15.03 (5.82) Lt. 15.10 (8.30).
[25]	Exercise 1: Pike [PK]; Exercise 2: BOSU ball [BOSU] Exercise 3: suspension training device [ST], Exercise 4: Swiss ball [SB], Exercise 5: Core Coaster [CC]).	RA: PK 25.57 6 13.25 BOSU 52.26 6 23.87 ST 55.26 6 18.75 SB 47.59 6 21.28 CC 54.01 6 17.96
[26]	A: Bridge exercise on a stable surface; B: Bridge exercise with shoulder on a stable bench. C: Bridge exercise with shoulder on a sling. D: Bridge exercise with the shoulder on a Swiss ball.	RA: A (18.79±2.75); B(24.53±3.44); C(41.54±6.20); D(31.36±3.73).
[27]	1)High plank exercise performed on three surfaces: Plan (PP); Inclined (PI); Decline (PD). 2)Modified Teaser exercise performed on three surfaces: Plane (TP); Inclined (TI); Decline (TD).	1) PP: (21 e 40% MVIC) PI: (< 21% MVIC); PD: (21 e 40% MVIC); 2) TP: (< 21% MVIC); TI: (41 e 60% MVIC); TD: (< 21% MVIC).
[28]	(BE) Bridge exercise; (SLBE) Single-leg-lift bridge exercise; (SLBU) Single-leg-lift bridge exercise on an unstable surface (SLHB) Single-leg-lift hip abduction bridge exercise.	BE: Right 6.58±3.63, Left 6.90±6.06; SLBE: Right10.78±6.37, Left 8.65±6.06; SLBU: Right11.81±7.01, Left 9.62±6.76; SLHB: Right14.56±9.24, Left 10.32±6.45.

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Use of High Resolution Images for Evaluating the Sustainability of Green Areas in the City of Passo Fundo-RS

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Abstract*—The rapid population growth of cities has caused the removal of vegetation cover raising the waterproofing and the occupation of riverine plains. As an important aspect of urban sustainable planning, the provision of green areas at various scales, should reduce pollution and contribute to the physical, social and psychological care of individuals. Planning, implementing and conserving green areas constitute a good of great value, making it essential for the composition of cities. This research aims to identify, quantify, classify the land use and permanent preservation areas (APPs) inserted in the urban perimeter of Passo Fundo through geoprocessing techniques, seeking to understand the reality of these areas. It was developed with the ArcGIS software, creating and manipulating georeferenced spatial data from municipal database and QuickBird satellite. The survey used a supervised classification tool to generate four classes of land use, together with the analysis of APPs, calculating the total area of these APPs and the area of each class of land use. Demonstrating that the municipality is splitted in about 56% of green areas against 44% of gray/constructed areas. Most of APPs presents arboreal occupation, representing 3% of the urban area and about 39% have an anthropical occupation by buildings, street layout and fields. With the analysis of the images was possible to identify, quantify, classify land use and APPs, generating data for the municipal administration develop public policies that aim sustainability, preservation, conservation and recovery of these areas of APPs, as well subsidies the realization of an urban and environmental planning.*

Keywords*—*Environmental planning, Natural resources, Geographical Information System, Urbanization.

I. INTRODUCTION

Anthropical intervention are increasing the current state of environmental degradation. This leads to faster changes in the natural environment, making them difficult to be restored to their natural state.

The fast populational growth in the cities due, mainly, to the improvements in the economic conditions of the population itself leads to a high rate urbanization and the removal of original vegetation, increasing in the impermeable surface área and the occupation of the flood plains.

Life quality in urban environments is directly bonded to several factors that varies from the urban infrastructure, to the social and economic development and the environmental management.

In the environmental case, the public green areas are composed by important elements to the well being of the population, mostly because of the direct influence on the physical and mental health of this population [18]. The substitution of these green and permeable areas by built elements, such as roads and buildings, end up increasing the risk of floods, the warming of urban surfaces and causing the heat island effect [4].

Forests and other types of vegetation present in water bodies margins are considered, by the brazilian environmental laws, through the Law 12.621/12, as Permanently Protected Areas (PPA). This vegetation,

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which develops in the margins of rivers and other water bodies is sensitive due its lack of ability to stay stable and perpetuate itself.

When structured, The riparian vegetation contributes significantly to the balance of the environmental and natural conditions and, thus for the productivity of the society through the stabilization of the soil, acting as a barrier to the pollution, increasing on the water infiltration and purification, increasing water storage in the subsoil, protection of aquatic species, balancing the thermal and chemical features of the water bodies, among other effects [16].

The delimitations of APPs has a high cost, because they usually needs field surveys, certain specific equipments and trained personal. For Stefanes [21], the utilization of Geotechnologies in the delimitations of APPs could facilitate the environmental and resources management processes.

The planning, implantation and conservation of green areas constitute an asset of great value to the community, becoming a important element in the urban composition.

According to Rosset [17], green areas are places where the arboreal vegetation is predominant, e.g. the squares, public gardens and urban parks, among other kinds of areas that provides aesthetical and ecological functions.

For the planning, must be applied georreferencing and analysis tools that allow the processing of the raw data in several steps of the project. In this sense, the application of Geographic Information Systems's technics has become a powerful tool that, when used along with other mapping softwares, allows not only a greater precision of the assessment, but also the ease of maintaining the database updated, leading to an most efficient way to monitor these areas [1; 20].

Besides, the geoprocessing allows that each area can be individualized through its features or digital signatures, so they can be better analyzed, expliciting the acting phenomena of each sector, reducing data interferences and thus obtaining more accurate results [15; 20].

The utilization of remote sensing applied to the study of the urban environment and mostly to the vegetation areas has advanced significantly with the use of high resolution satellite images, which allows a more detailed analysis of this environment [1; 3].

Henke-Oliveira & Santos [8], emphasize the importance of the development of computational technics that contemplates the structural and functional differentiation, what confers a dynamism to the environmental planning by allowing the information assessment to the management of these areas as well as other elements associated to the environmental and life quality.

Therefore, this research has the objective to identify, quantify and classify the land cover and the PPAs within the urban perimeter of Passo Fundo, to better understand the reality of these areas and through the use of geoprocessing tools.

II. MATERIALS AND METHODS

The research was developed in the city of Passo Fundo (28º15'46"S e 52º24'25"W), located in the northern region of the state of Rio Grande do Sul, Brazil, which makes a total area of 783.423 km ². The city has an average elevation of 687 m, with an average annual temperature of 17.5 º C and rainfall index of 1787.8 mm / year. The estimated urban population is 184,826 people and the population density of 235.92 inhabitants per km ² [9].

The survey of the areas of APP within the urban area of Passo Fundo followed a series of complementary steps.

2.1 Definition of raised criteria and the limits distances of APPs

As an initial step in this research, were defined the criteria that would be considered for the survey. From the objective of evaluating the Areas of Permanent Protection referring to banks of rivers and streams, we sought to focus the entire data acquisition and spatial processing techniques in this criteria.

2.2 Obtention of Data Base

After defining the criteria that would be considered in the work was done to obtain georeferenced data that would allow to survey with quality.

To evaluate the arboreal formations present in the urban area were obtained high-resolution images, derived from the QuickBird satellite. These images have a high spatial resolution panchromatic 0.6 m and multispectral of 2.4 m.

Aiming to raise all rivers and streams in the present area of study, we sought to obtain georeferenced data available and to provide quality. The data used for this survey were obtained through the Continuous Vector Cartographic Base of Rio Grande do Sul [7]. This database allowed to obtain a mesh in vector format (. Shp) with full coverage of the study area at a scale of 1:50,000.

2.3 Used Software

To conduct the survey of the areas of APP and vegetation cover of medium and large sized was used the software suite of ArcGIS 10.5, which allows you to manage and operate with spatial data [6].

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Within this suite were used applications ArcCatalog, which allowed the organization of the data base of this study, and ArcMap, responsible for performing space operations, such as creating buffers and classification of images, from the data obtained.

2.4 Defining the Limits of the Study Area

As the objective of the survey aims APPs and vegetation cover present within the urban area of Passo Fundo, was necessary to perform a visual delineation of the region of study.

For this, we carried out a vectorization of the limits of the urban area from images obtained by satellites. Although this procedure being manual, the spatial resolution of the images allows for a very faithful approximation of actual limits of urbanization of the municipality (Fig. 1).

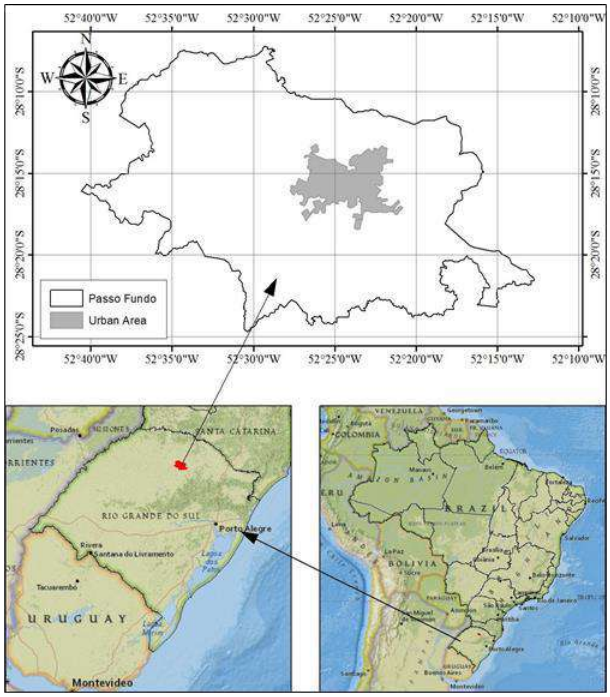

Fig 1: Location of the municipality of Passo Fundo.

2.5 Extraction of Data Base and Classification of the Images

After performing the delimitation of the study area was performed a extraction of data base within defined limits, so just kept the data pertaining to the study area.

The classification of the satellite images aimed at obtaining a mapping of areas with common characteristics within the study area. These areas were classified into four distinct classes, formations Arboreal, Fields, Buildings and Roads / Streets.

To realize this classification, we used a supervised classification technique, which classifies the original image into classes in accordance with a number of samples. These samples aim to obtain statistical parameters of the digital values of each band used of the image.

2.6 Survey of Areas of Permanent Protection.

To obtain the APPs referring to the margins of watercourses present within the urban area of Passo Fundo was held to create buffers. These buffers create polylines parallel to the original lines, for both sides, generating a coverage area depending on the original vector file and the linear distance defined for the buffer. The buffer created was of 30 m on each side of the banks of watercourses.

This entire process was carried out with a eponymous tool, standard for ArcMap, generating a set of polygons in the vicinity of rivers and streams assessed. These polygons are defined as the Areas of Permanent Protection relating to the banks of watercourses.

2.7 Calculations of Total and Partial Areas

Aiming to obtain the total values of the areas of each class of land cover, areas of permanent protection and of the urban area, there was the process of calculating areas of polygons present in each data set.

This calculation of the areas was made inside the ArcMap, resulting in tables containing the total areas of each attribute, which were later used for the survey of land use in urban areas and in the APPs..

The calculation was performed taking into consideration each class of land use and each subclass of the areas of arboreal cover in order to get a representation of these classes and then subclass of woody debris.

2.8 Survey of Land Use in the Urban Area and in the APPs

After the individual calculation for each class of land use and the total area of APPs within the urban area of the municipalitie, was realized the crossing data to obtain the ratio of the total areas of urban area and the total of permanent protection areas and which proportion of land cover in these areas [1].

III. RESULTS AND DISCUSSION

In Fig. 2 we can see the image of the city after the supervised classification, where in the city center (area of high economic movement) is quite impermeable due to the concentration of buildings and civil buildings and the consequent concentration of population, which also expands along the main avenue of the city. In the central area the green areas can be explained due to the location of wooded squares [22].

https://dx.doi.org/10.22161/ijaers.6758 *ISSN: 2349-6495(P) | 2456-1908(O)*

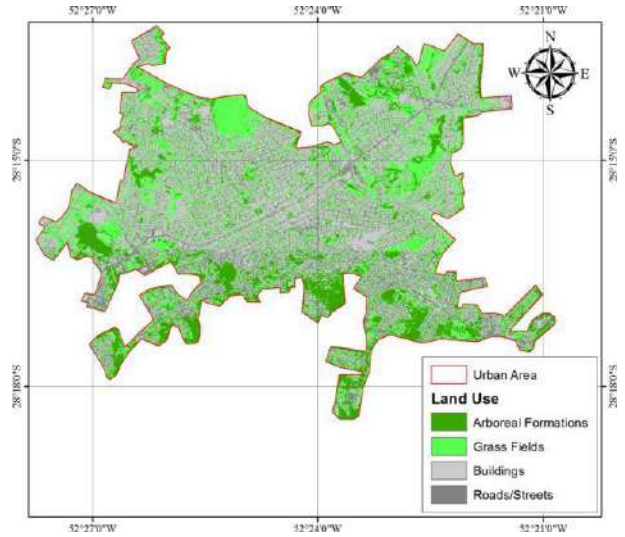

Fig 2: Map with soil classification in the municipalitie of Passo Fundo (Brazil).

This survey showed that the total urban area of the municipality is 4822.6 ha, being this distributed into, woody formations 1421.273 ha, fields 1293.246 ha, buildings 1169.669 ha and streets 938.026 ha. The portion of arboreal formation in the city of Passo Fundo corresponds to 29.47%, fields 26.82%, buildings 24.26% and streets / roads 19.45% (Fig 3).

Thus it can be stated that the sealed area of the municipality is 43.71%, which contribute, among other effects, to floods, and the heat of urban surfaces, causing negative effects on the quality of urban life. While the area of land covered with vegetation corresponds to 56.29% contributing to environmental sustainability by increasing evapotranspiration, improve the infiltration and reduce the runoff of rainwater. Besides that the preservation of vegetable fragments contributes to the improvement of the hydrological cycle and soil conservation, agreeing with statements of Melo et al,[11].

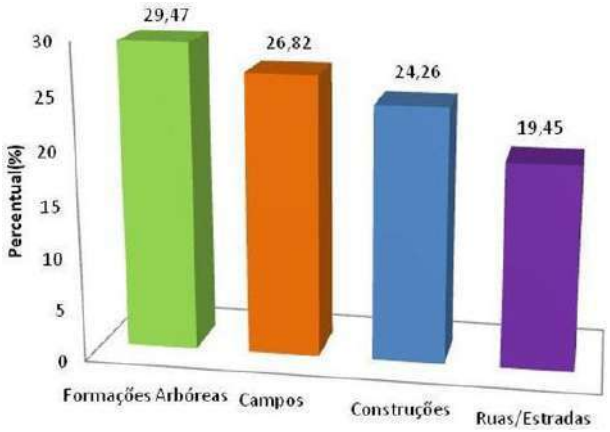

Fig 3: Percentual of land use in urban area

The areas of permanent preservation have an area of 142.2 ha within the municipal city limits, resulting in a representation of approximately 3% of APPs into the relation with the urban area total of the municipality, which are distributed in the following classes of land use: formation arboreal 86.94 ha, fields 38.52 ha, buildings 8.05 ha and roads 8.67 ha (Fig 4).

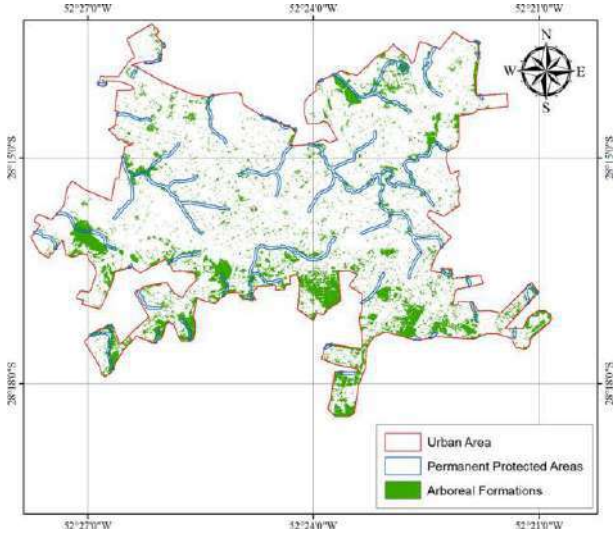

Fig 4: Map from the areas of app in the municipality of Passo Fundo.

Most APPs presents arboreal occupation with 61.14%. Although this is a good indication, is needed to observe that about 39% of APPs in the urban area present an anthropized occupation by buildings, street layout and fields (Fig 5).

The anthropic of these areas favors numerous environmental processes, such as decreased infiltration of rainwater, which increases the volume of water on rivers. These processes increase the capability to generate erosion which can cause instability, siltation of water bodies, reduction in water quality and changes in the water regime.

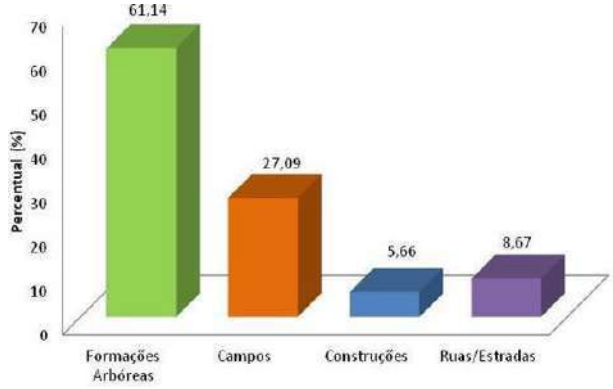

Fig 5: Percentual of land use inside the APPs.

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In addition to the survey of land use in the urban area of the municipalitie of Passo Fundo, was carried out a classification of wooded areas in relation to the areas of each fragment of vegetation (Fig 6). The scenic beauty of the landscape and the leisure, including physical and recreational activities, are also functions of forest fragments embedded as squares, urban and natural parks. Contact with vegetation promotes wellness, improving people's health and quality of life [13].

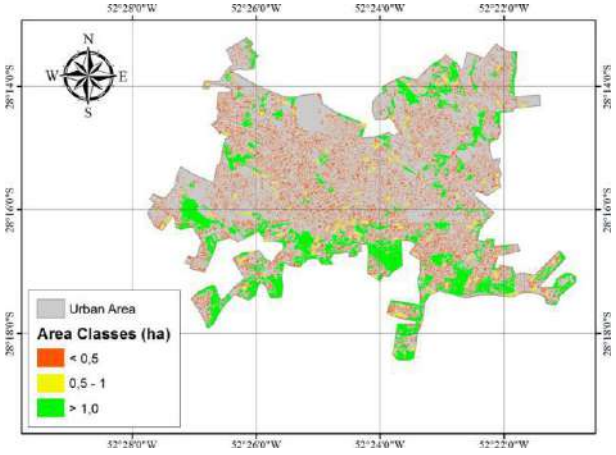

Fig 6: Fragments of vegetation in the municipality.

Along with the mapping was conducted a quantitative survey of these wooded areas. This survey relates the areas of each class with the total area of vegetation fragments (Table 1).

Table 1: Survey of vegetation fragments.

Area (ha)	Count	Representativity
<0,5	657445	99,964%
0,5 - 1	111	0,017%
>1	129	0,020%
Total	**657685**	**100%**

As can be seen in Table 1, most of the arboreal fragments present in the urban area of Passo Fundo have an area of 0.5 ha. The larger fragments, concentrated in great part in the southern region of the urban area and represent only 0.037% of all fragments present in this study area.

These results indicate a large presence of small fragments, which are arranged throughout the urban area. This is possibly due to the removal, almost entirely, of native forest aiming at the expanding of the urban area.

From the ecological point of view, the dispersion of fragments can be positive, since it creates more habitat for the survival of animal species. At the same time, can hinder some natural biological processes such as dislocations, search for food and reproduction [10].

It can be observed that in the map the present fragments in the city are presented barely interlinked. With this occurs with the depletion of forest fragments, which pass through a gradual loss of biodiversity and reduction of ecological functions [2]. The small fragments and isolated tend to impoverishment due to the inability of regeneration [3]. Hence the importance of recognizing the size of the fragments becomes an important factor, due to larger forest fragments and connection between them increase the carrying capacity of the fauna and flora [23].

The fragments even reduced and generally isolated, they are part of a unique ecosystem, holding a considerable wealth of plant species, which are responsible for house and feed some wildlife species [19].

The city of Passo Fundo receives many benefits of existing vegetation on it, because it influences the microclimate and increases the humidity of the air through evapotranspiration, providing a more comfortable environment population, and allow rainwater infiltrating the soil softening the rapid runoff, which is one of the factors that aggravate the formation of floods and inundations [12].

The leaves and branches of trees also act as filters, retaining part of the suspended particulate matter in the air, reducing levels of air pollution, the gas exchanges helps to increase the oxygen level available and contribute, equally, in reducing the amount of carbon in the atmosphere, seen that during their growth these plants capture large amounts of this element [5].

Historically the majority of Brazilian municipalities, had their growth, whether in rural or urban mean, municipal planning without considering the environmental issues. The natural vegetation in most cases, was being replaced by the city or by agriculture [14]. The city of Passo Fundo followed this reality, the urban spot viewed nowadays, was formed at the expense of vegetation that existed there.

Considering that the vegetation is an important factor for environmental quality, because the green areas minimize the effects of excessive waterproofing, regulate microclimate, softening the high temperatures produced by the concentration of the built or paved it must be preserved remnant vegetation of these sites, as well as the municipal administration must develop public local policies aiming at sustainability and recovery of areas of APPs, to meet the needs of society, who lives in an increasingly artificial environments, and avoid the declining of quality to urban life. Creating alternatives from the vegetation for the population that lives in the

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city does not suffer the consequences of the lack of planning.

IV. CONCLUSION

A conclusion section must be included and should indicate clearly the advantages, limitations, and possible applications of the paper. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

The urban area of the city of Passo Fundo presents its area distributed on arboreal formations 29.47%, fields 26.82%, buildings 24.26% and roads 19.45%. The areas of permanent preservation resulted in a representativeness distributed, the following classes of land use: arboreal formation 61.14%, fields 27.09%, buildings 5.66% and roads 6.09%. And the majority of the arboreal fragments present in the urban area of Passo Fundo has an area of 0.5 ha.

The municipality of Passo Fundo receives many benefits of the existing vegetation on it, because it influences the microclimate and increase air humidity through evapotranspiration and allow the water resulting from precipitation infiltrating the soil mitigating floods and inundations.

With the analysis of the images was possible to identify, quantify, classify the land use and (APPs), generating data for the municipal administration develop public local policies that aim at sustainability, preservation, conservation and restoration of these areas of APPs as well as subsidies for the realization of an urban and environmental planning.

Managers can create guidelines of projects using this tool aiming the environmental sustainability.

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Water Wave Profile at Breaker Point

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Abstract— *In this research, a study was done on wave profile and type at breaker point. The study was done using shoaling-breaking model. Output of the shoaling-breaking model becomes the input at water wave surface equation to obtain wave profile. By obtaining the wave profile, the calculation of breaker height becomes more accurate.*
Keywords— ***shallow water wave type, cnoidal wave type.***

I. INTRODUCTION

Wilson (1963) obtained that there are four types of water wave, i.e. Airy's waves, Stoke's waves, Cnoidal waves and Solitary waves. Airy's type, where wave crest is symmetrical with wave trough and wave height is twice of that wave amplitude. This type of wave is found only in a wave with a very small amplitude. Next is Stoke's type, formed in a wave with wave amplitude bigger than wave amplitude of the Airy's type. In this Stoke's type, the wave profile is somewhat asymmetricand the wave height is still close to twice the wave amplitude. In a bigger wave amplitude, cnoidal type of wave is formed. In cnoidal type, the wave profile is asymmetric where the distance between wave trough and neutral line or still water level is very much different with the distance between wave crest and still water level. For a wave with bigger wave amplitude a perfect Cnoidal profile will be formed with wave trough that almost coincides with still water level. This type of wave is also called Solitary wave. Either Cnoidal type or Solitary wave type shows that almost all part of the wave is above the still water level, nevertheless wave height that is twice wave amplitude might occur.

In shoaling-breaking model, some use wave amplitude as the variable and some other use wave height as the variable. For this second type, the formulation was done with an assumption that wave height has a value twice that of wave amplitude. With those four types of wave, then the output of shoaling breaking model that uses wave amplitude as the variable or the model that uses half of the wave heightcan not confirm the wave height. To obtain a certainty of the wave height as the result of shoaling-breaking analysis, the analysis of water wave surface profile needs to be done to obtain a better wave height value.

This research used water wave surface equation of Hutahaean (2019a) to conduct wave profile analysis at breaker point. The equation used wave constant G, wave number $k$and wave amplitude Aas the parameter. The three wave parameters were obtained from shoaling-breaking analysis of Hutahaean (2019b).

At the same time, this research is also a revision on Hutahaean (2019b), where at the research the wave amplitude as the result of shoaling-breaking model was considered has a value of half wave height. Even though it provides a result that is quite close to breaker height from breaker height index equation as the result of laboratory analysis, the result is less than accurate.

II. SEVERAL TYPES OF WAVE

The general form of water wave profile is shown on Fig.1. The form is assymetrical between wave crest and wave trough. If the wave crest elevation against still water level is called η_{max}; whereas the wave trough elevation is called η_{min}, then there is an asymmetry where $\eta_{max} > |\eta_{min}|$, whereas wave height is$H = \eta_{max} - \eta_{min}$.

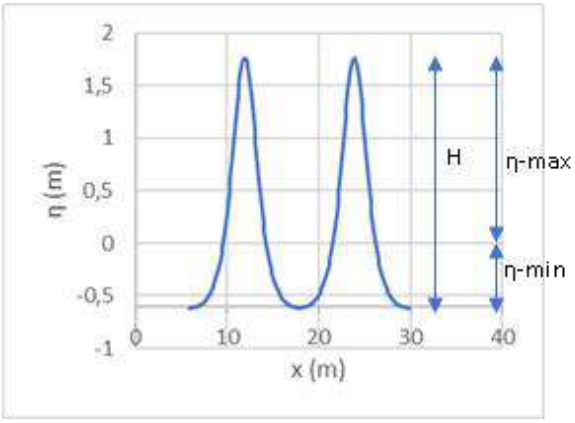

Fig.1. General profile of water wave surface

https://dx.doi.org/10.22161/ijaers.6759 *ISSN: 2349-6495(P) | 2456-1908(O)*

2.1. Wilson Criteria (1963)

Wilson (1963) classified wave based on the value of $\frac{\eta_{max}}{H}$ (Table (1)). Type Airy's waves have the value of $\frac{\eta_{max}}{H} < 0.505$, which shows that the wave form is asymmetrical, where $\eta_{max} \approx |\eta_{min}|$. The second type is Stoke's wave type that is still quite close with the Airy's waves characters. Furthermore, cnoidal waves type is absolutely asymmetrical and the last is solitary waves type, where $\frac{\eta_{max}}{H} = 1.0$.

Table.1: Wilson Criteria (1963)

Wave Type	$\frac{\eta_{max}}{H}$
Airy waves	< 0.505
Stoke's waves	< 635
Cnoidal waves	$0.635 < \frac{\eta_{max}}{H} < 1$
Solitary waves	$= 1$

In the next sections the analysis of wave profile in the deep water is presented, includes the calculation of η_{max}, η_{min}, wave height H and wave height ratio $\frac{H}{A}$ and the depiction of the wave profile using equation (1). The result of the calculations shows a compatibility with Wilson criteria (1963).

2.2. Airy's Waves Type

Airy's waves type have symmetrical profile where $\eta_{max} = |\eta_{min}|$ and wave height $H = 2A$. This type of wave is found only in a wave with a very small amplitude. Table (2) shows the measurement of Airy's wave profile in the deep water for several wave periods with a very small wave amplitude A, where $\frac{\eta_{max}}{H} = 0.503$ was obtained, which shows that it is not really symmetrical, but $H = 2A$ was obtained. The profile of Airy's wave can be seen in Fig. 2.

Table.2: Wave amplitude for sinusoidal wave, in the deep water

T (sec.)	A (m)	$\frac{\eta_{max}}{H}$	H (m)	$\frac{H}{A}$
8	0,017	0,503	0,035	2
9	0,02	0,503	0,041	2
10	0,023	0,503	0,047	2
11	0,027	0,503	0,053	2
12	0,03	0,503	0,06	2
13	0,033	0,502	0,067	2
14	0,037	0,502	0,073	2
15	0,04	0,502	0,081	2

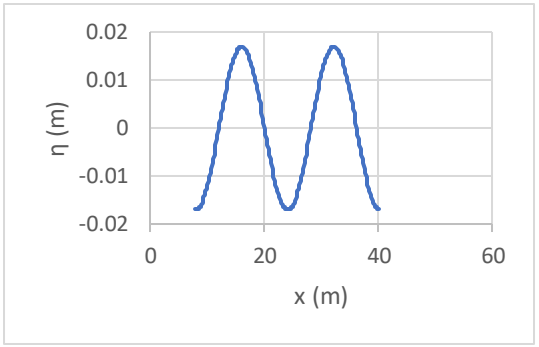

Fig.2. Airy's wave $T = 8$ sec., $A = 0.017$ m, in the deep water.

2.2. Type Stoke's wave.

Table (3) shows wave profile in the deep water with a quite large wave amplitude, with $\frac{\eta_{max}}{H} = 0.635$ that according to Wilson criteria is the maximum limit of Stoke's wave type. The value of $\frac{H}{A} = 2.099$, is still quite close to 2. Therefore, the characteristics of Stoke's wave is that wave profile is asymmetric but $H \approx 2A$, although it is at its maximum limit.

Table.3: Wave profile of Stoke's wave at its maximum limit

T (sec.)	A (m)	$\frac{\eta_{max}}{H}$	H (m)	$\frac{H}{A_{max}}$
7	0,47	0,635	0,986	2,099
8	0,614	0,635	1,288	2,099
9	0,777	0,635	1,631	2,099
10	0,959	0,635	2,013	2,099
11	1,161	0,635	2,436	2,099
12	1,381	0,635	2,899	2,099
13	1,621	0,635	3,402	2,099
14	1,88	0,635	3,946	2,099
15	2,158	0,635	4,529	2,099

2.3. Cnoidal Wave Type.

Table (4) is wave profile in deep water with large amplitude where $\frac{\eta_{max}}{H} = 0.803$ was obtained with the value of $\frac{H}{A} = 2.726 > 2$. Therefore, in this cnoidal wave type the wave profile is asymmetric and $H \neq 2A$. If it is approximated with Airy's waves type there will be a quite large error, in this case is 36.2 %. For a wave with bigger wave amplitude, there will be even bigger error

https://dx.doi.org/10.22161/ijaers.6759 *ISSN: 2349-6495(P) | 2456-1908(O)*

Table.4: Cnoidal wave profile

T (sec.)	A (m)	$\frac{\eta_{max}}{H}$	H (m)	$\frac{H}{A}$
7	0,899	0,803	2,449	2,726
8	1,174	0,803	3,199	2,726
9	1,485	0,803	4,049	2,726
10	1,834	0,803	4,998	2,726
11	2,219	0,803	6,048	2,726
12	2,641	0,803	7,198	2,726
13	3,099	0,803	8,447	2,726
14	3,594	0,803	9,797	2,726
15	4,126	0,803	11,246	2,726

From the illustration of the three waves, for a wave with large wave amplitude, $H = 2A$ can not be confirmed although $\frac{H}{A} = \frac{\eta_{max} - \eta_{min}}{A} \leq 2$ could happen and although the profile is asymmetrical.

III. WATER WAVE-SURFACE EQUATION

In this section, the formulation of water wave surface is a revision of the formulation of Hutahaean (2019a), where some typographical errors occurred. The water wave surface equation is obtained by integrating KFSBC,

$$\frac{\partial \eta}{\partial t} = -\frac{Gk}{\gamma\sigma}\beta_1(\eta)\sigma cos kx sin\sigma t - \frac{Gk}{\gamma\sigma}\beta(\eta)\sigma sinkx sin\sigma t \frac{\partial \eta}{\partial x} \quad .....(1)$$

$$\beta_1(\eta) = sinhk(h+\eta) \quad .....(2)$$

$$\beta(\eta) = coshk(h+\eta) \quad .....(3)$$

$\gamma$is weighting coefficient at weighted total acceleration equation with a value around 2.202-3.0. This research uses $\gamma = 2.483$ (Hutahaean (2019c,d)).

(1) was integrated against time-t where acccording to wave number conservation, i.e. at $z = \eta$, $\frac{\partial k(h+\eta)}{\partial t} = 0$(Huatahean (2019a)), which means that $\beta_1(\eta)$and$\beta(\eta)$have constant values against time t, thus the integration of the first term right side of the equation was completed by integrating $sin\sigma t$,

$$\eta(x,t) = \frac{Gk}{\gamma\sigma}\beta_1(\eta)coskxcos\sigma t - \frac{Gk}{\gamma\sigma}\beta(\eta)\sigma sinkx\int sin\sigma t\frac{\partial \eta}{\partial x}dt$$

The integration of the second term right side of the equation will be completed using partial integration method, as follows

Assume a function of $f = cos\sigma t\frac{\partial \eta}{\partial x}$. This $cos\sigma t$function was used so when it was differentiated against time t, $sin\sigma t\frac{\partial \eta}{\partial x}$will be formed, i.e.

$$\frac{\partial f}{\partial t} = -\sigma sin\sigma t\frac{\partial \eta}{\partial x} + cos\sigma t\frac{\partial^2 \eta}{\partial t\partial x}$$

This differential equation was multiplied with $dt$and integrated against time t,

$$f = -\sigma\int sin\sigma t\frac{\partial \eta}{\partial x}dt + \int cos\sigma t\frac{\partial^2 \eta}{\partial t\partial x}\,dt$$

Substitute $f$and the first term right side was moved to the left and $f$was moved to the right and both equations were divided by σ,

$$\int sin\sigma t\frac{\partial \eta}{\partial x}dt8 = -\frac{1}{\sigma}cos\sigma t\frac{\partial \eta}{\partial x} + \frac{1}{\sigma}\int cos\sigma t\frac{\partial^2 \eta}{\partial t\partial x}\,dt$$

The integration of the second term right side of the equation can be completed the same way, but with an assumption that $\frac{\partial^3 \eta}{\partial t^2\partial x}$ is a very small number, the integration can be completed by integrating just the$cos\sigma t$ element.

$$\int sin\sigma t\frac{\partial \eta}{\partial x}dt = -\frac{1}{\sigma}cos\sigma t\frac{\partial \eta}{\partial x} + \frac{1}{\sigma^2}sin\sigma t\frac{\partial^2 \eta}{\partial t\partial x}$$

Substitute the result of integration,

$$\eta(x,t) = \frac{Gk}{\gamma\sigma}\beta_1(\eta)coskxcos\sigma t - \frac{Gk}{\gamma\sigma}\beta(\eta)sinkx\left(-cos\sigma t\frac{\partial \eta}{\partial x} + \frac{1}{\sigma}sin\sigma t\frac{\partial^2 \eta}{\partial t\partial x}\right)$$

Working on an assumption that $\frac{1}{\sigma}sin\sigma t\frac{\partial^2 \eta}{\partial t\partial x}$is a very small number and can be ignored,

$$\eta(x,t) = \frac{Gk}{\gamma\sigma}\beta_1(\eta)coskxcos\sigma t + \frac{Gk}{\gamma\sigma}\beta(\eta)sinkxcos\sigma t\frac{\partial \eta}{\partial x}$$

The equation was differentiated against horizontal-x axis.

$$\frac{\partial \eta}{\partial x} = -\frac{Gk}{\gamma\sigma}\beta_1(\eta)ksinkxcos\sigma t + \frac{Gk}{\gamma\sigma}\beta(\eta)kcoskxcos\sigma t\frac{\partial \eta}{\partial x} + \frac{Gk}{\gamma\sigma}\beta(\eta)sinkxcos\sigma t\frac{\partial^2 \eta}{\partial x^2}$$

or

$$\frac{\partial \eta}{\partial x} = \left(-\frac{Gk}{\gamma\sigma}\beta_1(\eta)ksinkx + \frac{Gk}{\gamma\sigma}\beta(\eta)kcoskx\frac{\partial \eta}{\partial x} + \frac{Gk}{\gamma\sigma}\beta(\eta)sinkx\frac{\partial^2 \eta}{\partial x^2}\right)cos\sigma t \quad .....(4)$$

In accordance with the provision at the velocity potential equation where there is $t$function only,$x$function onlyand$z$function only, then at the water wave surface using variable from velocity potential equation, water surface

https://dx.doi.org/10.22161/ijaers.6759 *ISSN: 2349-6495(P) | 2456-1908(O)*

equation also has variable that is t function only an x function only, so it can be stated that the general form of (4) is,

$$\frac{\partial \eta}{\partial x} = f(x)cos\sigma t$$

In this equation $f(x)$ is just a function of x. $f(x)$ in (4) is,

$$f(x) = \left(-\frac{Gk}{\gamma\sigma}\beta_1(\eta)ksinkx + \frac{G\,k}{\gamma\sigma}\beta(\eta)kcoskxcos\sigma t f(x) + \frac{Gk}{\gamma\sigma}\beta(\eta)sinkxcos\sigma t\frac{\partial f}{\partial x}\right)$$

Bearing in mind $\beta_1(\eta)$ and $\beta(\eta)$ should be constant against time t and against horizontal x axis. In the second and third terms right side of the equation there is a function of time t, i.e. $cos\sigma t$, then the term shouldn't be there. Therefore $f(x)$ is,

$$f(x) = -\frac{Gk}{\gamma\sigma}\beta_1(\eta)ksinkx$$

Thereby

$$\frac{\partial \eta}{\partial x} = -\frac{Gk}{\gamma\sigma}\beta_1(\eta)\,ksinkxcos\sigma t$$

Substitute this equation to (1),

$$\frac{\partial \eta}{\partial t} = -\frac{Gk}{\gamma\sigma}\beta_1(\eta)\sigma coskxsin\sigma t + \left(\frac{Gk}{\gamma\sigma}\right)^2\beta(\eta)\beta_1(\eta)\sigma ksin^2kxsin\sigma tcos\sigma t$$

is integrated against time t. Integration will be completed by bearing in mind wave number conservation , thus integration was done by integrating only sinusoidal element and bearing in mind that $sin\sigma tcos\sigma t = \frac{1}{2}sin2\sigma t$,

$$\eta(x,t) = \frac{Gk}{\gamma\sigma}\beta_1(\eta)\,coskxcos\sigma t - \frac{1}{4}\left(\frac{Gk}{\gamma\sigma}\right)^2\beta(\eta)\beta_1(\eta)ksin^2kxcos2\sigma t$$

.....(5)

To determine the values of $\beta_1(\eta)$, $\beta(\eta)$, an approach was done that water surface equation is sinusoidal, i.e.

$\eta_0(x,t) = Acoskxcos\sigma t$ .....(6)

Therefore, the approach of hyperbolic function is $\beta_1(\eta) = \beta_1(\eta_0)$, $\beta(\eta) = \beta(\eta_0)$.

$$\eta(x,t) = \frac{Gk}{\gamma\sigma}\beta_1(\eta_0)coskxcos\sigma t - \frac{1}{4}\left(\frac{Gk}{\gamma\sigma}\right)^2\beta(\eta_0)\beta_1(\eta_0)ksin^2kxcos2\sigma t$$

.....(7)

IV. THE CALCULATION OF G, k AND A AT BREAKER POINT

The calculation of G, k and A at breaker point was done using shoaling-breaking model (Hutahaean (2019b)). In principle, the model is a transformation analysis of G, k and A from the deep water to breaker point.

4.1. The calculation of G and k in Deep Water

To calculate G and k two equations were needed. KFSBC and surface momentum equation, with the formulation can be seen in Hutahaean (2019b).

Wave number k in the deep water was calculated using the following equation,

$$\gamma^2\sigma^2 = gk - \frac{gk^2A}{2} \text{.....(8)}$$

g is gravitation velocity, whereas A is wave amplitude. This equation is a quadratic equation of wave number k where k can be calculated with a simple equation, i.e. finding the root of the equation. Wave amplitude maximum at (8) is (Hutahaean (2019a))

$$A_{max} = \frac{0.91g}{2\gamma^2\sigma^2} \text{ .....(9)}$$

Therefore, wave amplitude in (8) should be smaller or less than A_{max}.

Furthermore, deep water depth should be determined which is the starting point of shoaling-breaking analysis where wave amplitude A is known as input of the model. Deep water depth is calculated with,

$$h_0 = \frac{1.65\pi}{k_0} = 1.65\,\pi A_{max} \text{ .....(10)}$$

The coefficient of 1.65 was obtained from the calibration of the breaker depth of the shoaling-breaking model against breaker depth of SPM (1984), Hutahaean (2019b).

After wave number k was obtained, wave constant G was calculated in the deep water with the following equation

$$\gamma\sigma G\beta\left(\frac{A}{2}\right) = gA \text{ .....(11)}$$

Where wave amplitude A is known.

4.2. Shoaling-Breaking Model Equations

In the shoaling-breaking analysis, there are 3 (three) variables that change along with the change in the depth, i.e. k, A and G where there is a dependency among the changes of the three variables.

To calculate the three variables, three conservation equations were used, and the formulation of shoaling-

https://dx.doi.org/10.22161/ijaers.6759 *ISSN: 2349-6495(P) | 2456-1908(O)*

breaking equations in this section can be seen in Hutahaean (2019b).

The first equation is the result of the substitution of KFSBC and energy conservation equation to wave number conservation equation, i.e.:

$$\left(\left(h+\frac{A}{2}\right)+\frac{Gkf}{2\gamma\sigma}\right)\frac{\partial k}{\partial x}=-k\frac{\partial h}{\partial x}+\frac{\mu G k^3 f}{2\gamma\sigma}$$

.....(12)

$$f=\left(\beta_1\left(\frac{A_0}{2}\right)-(1+\mu)\beta\left(\frac{A_0}{2}\right)\frac{kA}{2}\right)$$

.....(13)

(12) and (13) were formulated using velocity potential at the sloping bottom, where in this case,

$$\beta(\eta_0)=\beta\left(\frac{A_0}{2}\right)=\alpha_0 e^{k_0\left(h_0+\frac{A_0}{2}\right)}+e^{-k_0\left(h_0+\frac{A_0}{2}\right)}$$

.....(14)

$$\beta_1(\eta_0)=\beta_1\left(\frac{A_0}{2}\right)=\alpha_0 e^{k_0\left(h_0+\frac{A_0}{2}\right)}-e^{-k_0\left(h_0+\frac{A_0}{2}\right)}$$

....(15)

$$\alpha_0=\frac{1}{2}\left(\frac{1+\frac{\partial h}{\partial x}}{1-\frac{\partial h}{\partial x}}+\frac{1-\frac{\partial h}{\partial x}}{1+\frac{\partial h}{\partial x}}\right) \quad .....(16)$$

$\frac{\partial h}{\partial x}$is bottom slope with negative value. After $\frac{\partial k}{\partial x}$is knownthe second equation is done, i.e. energy conservation equation

$$\frac{\partial G}{\partial x}=-\mu G k \quad .....(17)$$

$$\mu=\frac{2\frac{\partial k}{\partial x}}{\left(3\frac{\partial k}{\partial x}+4k^2\right)} \quad .....(18)$$

After$\frac{\partial G}{\partial x}and\frac{\partial k}{\partial x}$were known $\frac{\partial A}{\partial x}$ can be calculated using the third equation, i.e. KFSBC,

$$\gamma\sigma\frac{\partial A}{\partial x}=\left(\frac{\partial G}{\partial x}k+G\frac{\partial k}{\partial x}\right)f \quad .....(19)$$

The calculation of$\frac{\partial k}{\partial x}$, with(12), was done iteratively.At the beginning of the calculation, μin (18), is not known since $\frac{\partial k}{\partial x}$has not been known, as initial approximation equation$\frac{\partial k}{\partial x}=-\frac{k}{h}\frac{\partial h}{\partial x}$was used andμwas calculated with (18) and by obtaining the new $\frac{\partial k}{\partial x}$from (12), μwas recalculated with (18). This calculation is repeated until a stable $\frac{\partial k}{\partial x}$is obtained where, in general, stability is achieved after 5 times iteration. After stable$\frac{\partial k}{\partial x}$andμare obtained, $\frac{\partial G}{\partial x}$is calculated with (17) and$\frac{\partial A}{\partial x}$with (19). Furthermore, wave number, wave constant and wave amplitude are calculated at the point $x+\delta x$using Taylor series, i.e.

$$k_{x+\delta x}=k_x+\delta x\frac{\partial k}{\partial x}$$

$$G_{x+\delta x}=G_x+\delta x\frac{\partial G}{\partial x}$$

$$A_{x+\delta x}=A_x+\delta x\frac{\partial A}{\partial x}$$

V. THE RESULT OF THE MODEL

5.1 Illustration of the Result of Shoaling-Breaking Model

As an illustration of the result of shoaling-breaking model, shoaling and breaking analysis was done for the wave with wave period of 8 sec, with deep water wave amplitude $A_0=1.056$ m, obtained from (6). Sea bed slope $\frac{dh}{dx}=-0.005$,the result of the model is presented in Fig.3., where at the beginning there is shoaling, i.e. the enlargement of wave - amplitude A, followed by breaking. Output of the model at breaker point includes: breaker amplitude $A_b=1.402$ m, breaker depth $h_b=3.15$ m, breaker wave number $k_b=1.4355$, wave constant $G_b=0.00139$.

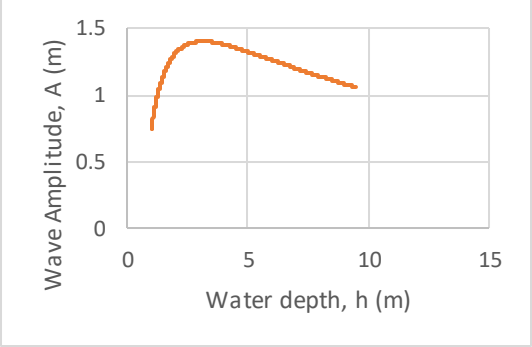

Fig. 3. Wave amplitude as the result of shoaling-breaking model

5.2. The Calculation of Breaker Height H_b

As has been stated before, the output of shoaling-breaking model is breaker wave amplitude $A_b$that must be changed into breaker height H_b.

The calculation of $H_b$was done using water wave surface equation (1). With wave parameter input at breaker point, i.e. A_b, h_b, $k_b$andG_b, the elevation of wave crest η_{max}, the elevation of wave trough η_{min}were calculated, then$H_b=\eta_{max}-\eta_{min}$. From the example of the result of shoaling-breaking in fig.3, breaker height $H_b=2.522$ m was obtained, with the value of$\frac{H_b}{A_b}=1.798$, where$H_b\neq 2A_b$. The wave profile at breaker point is presented in Fig.4.

https://dx.doi.org/10.22161/ijaers.6759 *ISSN: 2349-6495(P) | 2456-1908(O)*

which shows the almost perfect cnoidal shaped of wave profile.

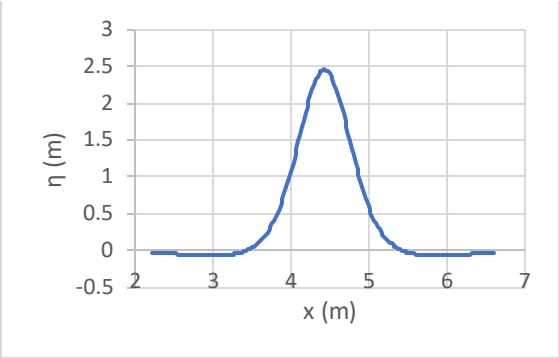

Fig. 4. Wave profile at breaker point

The value of $\frac{H_b}{A_b} = 1.798$ is quite close to $H_b = 2A_b$. Therefore in Hutahaean (2019b), H_b model was found to be quite close with the breaker from empirical equation formulated from laboratory observation.

5.2. Calibration and Adjustment of the Result of the Model

As a comparison of the result of the model, breaker height index equations from 5 (five) researchers were used and for the comparator breaker height, the average value of breaker height produced by the five breaker height index was used. The breaker height index (BHI) equations that were used are equations from Komar and Gaughan (1972), Larson, M. and Kraus, N.C. (1989), Smith and Kraus (1990), Gourlay (1992) and Rattana Pitikon and Shibayama (2000). As a comparator of the result of breaker depth, equation from SPM (1984) was used.

The adjustment of breaker height from the result of the model with the result of breaker height index equation was done by changing the value of wave constant G_b, and that in order for the breaker height to be correspond to breaker height from breaker height index, G_b from the result of shoaling-breaking model must be multiplied by 0.76.

Whereas breaker depth of the output of the shoaling-breaking model was also determined by the choice of deep water depth or the initial depth that was used. The result of the calibration of breaker depth model with breaker height form SPM (1984) shows that by using deep water depth $h_0 = \frac{1.65\pi}{k_0}$ breaker depth that corresponds to SPM (1984) was obtained.

5.3. Some of the Model Results

In this section, model was done for several wave periods, with deep water wave amplitude from (6), and the result of the calculation is in Table (5) and Table (6). Adjustment with the result of breaker height index (BHI) equation was done with a process that has been discussed in sub-chapter (5.2), i.e. by multiplying wave constant G_b with 0.76. The result is that breaker height model is very close with breaker height from BHI, where breaker height from BHI is the average values of 5 breaker height index equations as stated in (5.2).

Whereas breaker depth, the result of the model is very close to breaker depth from SPM (1984), that was obtained using deep water depth $h_0 = \frac{1.65\pi}{k_0}$

Table (6) shows that the model produces the value $\frac{H_b}{h_b} = 0.801$ for all wave period, which is very close to the result of BHI equation, i.e. $\frac{H_b}{h_b} = 0.802$.

Table.5: The Result of Shoaling-breaking Calculation

T (sec.)	A_0 (m)	H_b (m)		h_b (m)	
		model	BHI	Model	SPM
7	0,809	1,93	1,929	2,411	2,406
8	1,056	2,522	2,52	3,15	3,142
9	1,337	3,194	3,19	3,988	3,977
10	1,65	3,943	3,938	4,922	4,909
11	1,997	4,77	4,765	5,956	5,94
12	2,377	5,675	5,67	7,09	7,07
13	2,789	6,659	6,655	8,32	8,297
14	3,235	7,722	7,718	9,65	9,622
15	3,714	8,862	8,86	11,08	11,046

Table.6: The Result of Shoaling-breaking Calculation (continued)

T (sec.)	A_b (m)	$\frac{H_b}{h_b}$		$\frac{H_b}{L_b}$	$\frac{H_b}{A_b}$
		Model	BHI		
7	1,073	0,801	0,802	0,569	1,798
8	1,402	0,801	0,802	0,569	1,799
9	1,775	0,801	0,802	0,569	1,8
10	2,191	0,801	0,802	0,569	1,8
11	2,651	0,801	0,802	0,569	1,799
12	3,155	0,8	0,802	0,569	1,799
13	3,702	0,8	0,802	0,569	1,799
14	4,294	0,8	0,802	0,569	1,798
15	4,929	0,8	0,802	0,568	1,798

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Wave steepness at breaker point is $\frac{H_b}{L_b} = 0.569 = \frac{1.788}{\pi}$, which is very close to or similar to the analytical result as shown as follows. In (10) there is a breaking characteristic when:

$$f = \left(\beta_1\left(\frac{A_0}{2}\right) - (1+\mu)\beta\left(\frac{A_0}{2}\right)\frac{kA}{2}\right) = 0$$

$\beta_1\left(\frac{A_0}{2}\right)$ and $\beta\left(\frac{A_0}{2}\right)$ is the value in the deep water where $\frac{\beta_1\left(\frac{A_0}{2}\right)}{\beta\left(\frac{A_0}{2}\right)} \approx tanhk\left(h + \frac{A_0}{2}\right) = 1$, then breaking occurs when

$$\frac{kA}{2} = \frac{1}{1+\mu}$$

or

$$\frac{A_b}{L_b} = \frac{1}{(1+\mu)\pi}$$

The value $\frac{H_b}{A_b} = 1.80$, obtained

$$\frac{H_b}{L_b} = \frac{1.80}{(1+\mu)\pi}$$

With an assumption that the bottom slope is very small,

$$\frac{H_b}{L_b} \approx \frac{1.80}{\pi} = 0.572$$

It shows that the numerical result is very close to or similar to the analytical result which also proved that $\frac{H_b}{A_b} = 1.80$ is a good value.

VI. VI CONCLUSION

Wave profile at breaker point is cnoidal-typed wave, where wave crest is not symmetrical with wave trough. Interpreting the result of shoaling-breaking model should perform analysis on water wave surface profile. As an approximation,a criteriathat at breaker point the relation $\frac{H_b}{A_b} = 1.8$ applies with wave steepness $\frac{H_b}{L_b} = 0.572$ can be used.

Water wave surface equation that was used can produce wave types that corresponds to the Wilson criteria (1963), and compatible enough with the shoaling-breaking model that was used. However, further research is still needed because adjustment should still be done on wave contant G of the shoaling breaking model. Further research is still needed in shoaling-breaking model as well as water wave surface equation.

The calculation of wave force in a structure, should take into account the cnoidal-shaped wave profile, so that a better estimation on the location point of wave force is needed. Furthermore, the planning of coastal construction elevation should take into account the asymmetry wave profile so that a parameter as big as half the wave height cannot be used.

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State and Urban Structure: Study of Financing Mechanisms for the Implantation of Sanitary Landfills in Small Municipalities in Brazil

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Abstract**—***The objective of this study is to identify possible financing sources for the implantation of sanitary landfills in small municipalities in Brazil. It also seeks, through a preliminary study, to verify the extent to which there are financial resources, whether from the state or of private origin, capable of leveraging, in the context of small cities, the works necessary to fulfill the objectives established in the National Plan of Solid Waste, which falls under Law no. 12,305, August 2, 2010. The initial assumption with regard to financing is that while there are suitable alternatives to meet the needs and demands of municipalities, there are inconsistencies between the institutional entities of the Brazilian federation, and efficiency in the implementation of the sanitary landfills that need to be improved in the federative agreement. The research question is situated in a theoretical framework that can be categorized as analysis of public policy. The study is of a qualitative approach. The relevance of the theme lies in the benefits that achieving a landfill would provide to the environment and public health in Brazilian cities. The result of the test indicates possible viable options of official resources for the execution of sanitary landfill implantation carried out by local governments of cities with up to fifty thousand inhabitants.*
Keywords**—** ***Municipality. Federation. Source of financing. Landfill. Public policy.***

I. INTRODUCTION

The issue of landfill implementation in municipalities entered the government agenda upon the enactment of Law No. 12.305, on August 2, 2010, which established the National Policy on Solid Waste (NPSW[i]), based on the premise that the absence of daily treatment of solid waste produced by society as a whole constitutes a relevant factor for the public health indicators of the population and undermines the dignity of human beings (BRAZIL, 2010a).

Federal Decree No. 7,404, from December 23, 2010, which regulates Law No. 12.305, from August 2, 2010, establishes in Article 2 that the NPSW portion of the National Environmental Policy is linked to the national guidelines for basic sanitation and the Federal Policy of Basic Sanitation , pursuant to Law No. 11,445, from January 5, 2007, with Law No. 11,107 from 6 April 2005, and to the National Environmental Education Policy, regulated by Law No. 9795 from April 27, 1999 (BRAZIL, 2010b).

In accordance with Article 30 of the Federal Constitution, each municipality is responsible for designing and delivering, either directly or under concession or permission, the public services of local interest. Thus, the realization of the NPSW is under municipal jurisdiction. Therefore, the Act establishes the obligation of drafting a Municipal Integrated Solid Waste Management Plan - ISWMP. Data from the Ministry of the Environment show that only 33.5% of Brazilian municipalities reported having an ISWMP and that 59% of Brazilian cities still live with dumping grounds, which

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means that more than 81,258 tons of waste per day are going to an inappropriate place (BRAZIL, 2015c).

This situation is worse in small towns. A survey by the Brazilian Institute of Geography and Statistics - IBGE points out that 67% of municipalities with up to 50,000 inhabitants maintain final disposal of municipal solid waste (MSW) improperly in dumps or controlled deposits. Brazil has 5,570 municipalities and of those, 4,918 are in the range of up to 50,000 inhabitants, so it can be concluded that there are 3,295 cities without adequate landfills. 32.28% of the population lives in these cities, representing 65,996,669 Brazilians (BRAZIL, 2015e).

The NPSW has four ambitious goals: close urban landfills by the end of 2014; send only non-recyclable waste[ii] to landfills; invest in selective collection, recycling and reuse, and; implement reverse logistics[iii]. The objectives have not been achieved in this initial period.

The achievement of the goals set out in the NPSW by municipalities, especially small ones (population less than 50,000), was compromised by the lack of budgetary resources. Statistics produced by the National Confederation of Municipalities (2015) confirm that municipalities have been failing to receive considerable resources as a result of Union Revenue Decoupling (URD[iv]) and due to the federal tax exemption fiscal policy, adopted by Brazil in 2008.

Grievances of the URD are added to an excessive concentration of financial power in the hands of the Federal Government, identified in Table 1; since the decoupling increases the tax burden of social and economic financial contributions, it only enhances the negative effects to the federal pact and to the necessary distributive balance between resources and obligations of federal entities.

Table 1 - Taxes collected and distributed among federal entities

Members of the Federation	**Direct collection[v]**	**Available collection[vi]**
Union	66.63%	55.64%
States	26.59%	25.07%
Municipalities	7.78%	19.29%
Brazil	100%	100%

Source: Secretariat National Treasury - STN and IBGE in 2014 (MULTI CITIES, 2016)

The balance of the National Public Sector, in 2014, released by the National Treasury of the Ministry of Finance shows that, of all taxes collected in Brazil, 66.63% go to Union coffers, 26.59% is allocated to the States and only 7.78% belongs to the 5,570 municipalities. After the division of resources among federal entities (the Union for the states and municipalities and the State for their respective municipalities), because of the federal pact, explained below, this picture changes, but not to the point of reversing the percentages significantly. (MULTI CITIES, 2016).

All these data and information explain the difficulties for the municipalities, especially the smaller ones, with regards to their real capacity to sustain obligations and duties compared to the competition of the State, the Union or agents in the private sector.

Thus, the present study seeks to verify to what extent there are financial resources, whether through the state or of private origin, that are able to leverage, in the context of small towns, completion of the work required to fulfill the objectives set out in the National Plan for Solid Waste mentioned in Law No. 12,305 from August 2, 2010. The initial assumption is that there are financial alternatives able to meet the needs and demands of these municipalities. The relevance of the issue is found in the benefits that the realization of a landfill provides for the Brazilian cities' environment and public health.

II. IMPLANTATION OF LANDFILLS IN CITIES: PUBLIC POLICY?

The aim here is to place the issue of landfill implementation in small towns within a theoretical framework that serves as a reference to examine issues related to financial sources and their consequent attachment to the planning and public budgeting processes.

Heidemann (2009) argues that when the economy was in crisis, during the gap between the two world wars, states and governments had to promote the development of societies. In this sense, the political action of governments in the market, identified by liberals as intervention, occurred in two ways: by creating laws that laid out specific directions, from political order to economic initiatives (regulatory action); and direct state involvement in the economy (business function). This is where so-called government policies arise that were later conceptualized as public policy.

The development of a society in political and administrative terms, results from decisions made and implemented by the governments of national, sub-national and supranational states in conjunction with the other forces of society, especially market forces. These decisions and actions of government and other social

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actors, as a whole, constitute what is known by the generic name of public policy (HEIDEMANN, 2009).

The author makes it clear, however, that the safest notion of public policy depends on the meaning and scope of the term "policy". The term policy has several meanings. As a more operational meaning, policy is conceived as actions, practices, frameworks, and guidelines, based on laws and undertaken as state functions through the government, to address general and specific issues of society. In this concept of public policy, the state exercises its more practical and direct presence in society, particularly through planning, which requires policies previously defined either generally or horizontally (economic policy), or those with a sectoral impact (health and sanitation policies, for example).

Other researchers have also contributed to the composition of the definition of public policies. Easton apud Heidemann (2009, p. 29) says that public policy means "the official allocation of values for an entire society." H. Lasswell and A. Kaplan define public policy as "a program designed with goals, values and practices" (cited by HEIDEMANN, 2009, p. 29). Thomas R. Dye, "Public policy is whatever governments choose to do or not to do" as cited by (HEIDEMANN, 2009, p. 30).

Bucci (2006) in the pursuit of building a concept of public policy in the field of law, proposes that public policy is the government program of action that results from a procedure or set of legally regulated procedures – electoral procedures, planning procedures, government proceedings, budget procedures, legislative processes, administrative proceedings, judicial process – to coordinate the means available to the state and private activities, to carry out socially relevant and politically determined goals. As an ideal type, public policy should aim at achieving defined goals, expressing the selection of priorities, the means necessary to achieve it and the period of time after which achieved results are expected.

For Heidemann (2009, p. 31), "a perspective of public policy goes beyond the perspective of government policies, to the extent that the government, with its administrative structure is not the only institution serving the political community, that is, promoting public policy. "Thus, an association of residents, non-governmental organizations (NGOs), concessionaires and other civil society associations are also included among agents of public policy.

Moreover, under the capital's social function, the entrepreneur himself and executives of private companies may be agents of public policy, within their social responsibility. Thus, society, in order to enjoy the public services it needs, can no longer rely on the state alone in its traditional sense, since other actors can take the initiative to assume governance functions to solve problems of common nature, always under the essential coordination of government in a co-production of public good (HEIDEMANN, 2009).

Public policies are developed, according to Heidemann (2009), from a conceptual cycle comprising at least four steps: policy decision to address previously studied social problems; implementation, because without actions policies are merely good intentions; verification of demand (whether or not the parties initially interested in the policy are satisfied), and; evaluation of policies with regard to their continuation, improvement, redesign or simple discontinuity.

Policy decisions reflect, to a greater or lesser degree, the theory of collective decisions, the core of the modern theory of democracy that Bobbio speaks of (2000), and the public good which gives substance to the majority of decisions is the development of society in its various definitions and socio-political dimensions. The phase of the implementation of public policies has not received due attention by academic studies. According to Kurt D. Cline (cited HEIDEMANN, 2009), the problem of implementing a policy should be conceived as an effort to obtain cooperation between persons required to promote them, and not merely as a management challenge to provide the best conditions for communication between such people.

This means that "cooperation presupposes a decision-making approach of a participatory and dialogic nature, not just a managerial approach of communicative efficiency" (CLINE cited HEIDEMANN, 2009, p. 37).

According to Heidemann (2009), in order to evaluate the degree of satisfaction produced by a particular policy, it is necessary to verify the impact of the program or project on the targeted public because these beneficiaries are the creditors of satisfaction and accountability and thus, they should be the main concern of the managers of the programs/projects undertaken. Quality of service depends largely on the direct and transparent relationship between service providers and their respective beneficiaries.

The formulation of public policy can also be seen from the perspective of the actors involved and their forms of action and interaction. This is the theme of the Inter-American Development Bank Report - IADB, on economic and social progress in Latin America; the 2006 version is the result of joint work of a large group of researchers and practitioners of the Department of Research and the Department of Sustainable Development of this multilateral financial institution in

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the Americas. The focus of this report is not the content of public policy, or its effects on important economic and social variables, but the process by which these policies are discussed, approved and implemented, especially the form of interaction between the actors involved (STEIN et al., 2007).

In capitalist, democratic countries with a presidential system of government, as is the case of Brazil, the process of adoption and implementation of public policies occurs in socio-political spaces that include the participation of a variety of actors, such as presidents, his ministers, technicians, voters from small rural communities, going through congressmen, judges, leaders of opinion, businessmen etc. The complex interaction between these actors is influenced by the institutions and each country's political practices, which helps to explain why the reforms are lasting in some countries, why some countries are able to change easily with policies that are not working well and why some adjust better than others when circumstances require. In addition to the political institutions and practices, the report also points to other factors that influence the quality of economic and social policies: history, beliefs, and the attitudes of citizens and leaders (Stein et al., 2007).

The Inter-American Development Bank Report reveals that the effectiveness of public policies depends on how are discussed, approved and executed. So rather than focusing on the substance and direction of certain policies, the report focuses on the critical processes that shape these policies, putting them into practice, from conception to implementation, and how they are supported over time.

This comes from the premise that the processes of discussion, negotiation, approval and implementation of policies can be as important as the specific content of the policies themselves. Adopting a strictly technocratic approach in policy formulation certainly suppresses these stages of discussion, negotiation, approval and implementation, incorporating in its essence the disorderly world of politics. The report considers the political process and policy formulation to be inseparable, and if this reality is not taken into account when promoting any policy change, there is the risk of failure and frustration (STEIN et al., 2007).

This report highlights the idea that the policy-making process is a dynamic game among actors that interact in what can be called arenas. Some actors are official, such as political parties, chiefs of the executive branch, government teams, legislatures, courts and other bureaucratic officials, and their roles in policy formulation are set forth in the Federal Constitution and subsidiary legislation.

Governors and mayors, as leaders of sub-national (or sub-regional[vii]) governments, are also domestic policymaking game players, both in their function of implementing policies, and in their political function within parties and the party system. Subnational actors can influence the process of formulating national policies through different channels. In the implementation phase, they can influence the obstruction, delaying or redefining of national policies, or they can also make use of some of their regional or local policies as strategic arms in negotiating with national authorities. Finally, the exact role played by subnational actors in the national policy-making process is dependent on their incentives and the formal and informal rules governing their involvement in this process (PAYNE; ECHEBARRÍA, 2007).

Judiciary power is becoming more important, both in public policies and the political landscape of Latin America, particularly in Brazil. Similarly, the relevance of the role of civil society actors in the formulation and implementation of public policies is notable, including: companies, the media, trade unions, social movements, academic scholars and experts (actors of knowledge); this can also be seen in the research findings of Payne and Echebarría (2007).

Thus, since the installation of sanitary landfills in small towns in Brazil, as required by law, presented as a public policy at the local level, it is necessary to examine how this connects with the process of public planning and budgeting and which financial sources can be identified in order to make it viable.

III. PUBLIC POLICY AND GOVERNMENT BUDGET

Public spending in Brazil follows a system of planning established by the Constitution of 1988. It is an integrated system based on the Multi-Year Plan - PPA, Budget Guidelines Law - LDO and Annual Budget Law - LOA, including legislation applicable to the Federal, State, Federal District and Municipality levels, which organizes state financial activity and instrumentalizes the achievement of government actions.

Government action is made possible by financial activity developed by each federal entity, understood as the process of acquisition, management and use of financial resources. The rationalization of this financial activity with regards to revenue, expenses, budget and public credit, are present in the planning and budget tools established by the Constitution.

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This process leading to the programming of government actions is complex and involves a set of tools and factors that are not always directly controllable by the Government. On the one hand, there is the fact that public needs to be addressed by government action are endless, taking into account the complexity and diversity of the goals set out. On the other, the financial means available to the State are scarce. Given this extreme situation, unlimited needs versus limited resources, defining the actions needed to be reflected in public policy requires intense creative elaboration by governmental entities. Creative elaboration involves adapting and/or developing new ways to solve problems and how to overcome challenges in order to achieve positive results for the whole of society (individuals, households and businesses).

From the perspective seen in Complementary Law Nº. 101, of May 4, 2000 (Fiscal Responsibility Law), which introduced into Brazil the responsibility of the institute in public management, government action requires planning, transparency, compliance to limits, fiscal balance, achievement of goals, cost control and evaluation of results.

Three forms of state planning are identified in Brazil, each with a specific focus: urban planning, whose goal is to organize the development of cities; planning as a tool to direct (or promote) the economic activity of the state, and; planning and budgeting techniques intended to regulate the financial activity of the state.

The ordination of the development of cities is the highlighted purpose for government planning. The urban development policy in Brazil is seen in Articles 182 and 183 of the Federal Constitution. This policy, which is performed by Municipalities in accordance with the general guidelines set out by the union, has as its objective the full development of the social functions of the city and to ensure the well-being of its inhabitants.

Each city's Master Plan, prepared by the municipal executive and approved by the local legislature, is the basic instrument of policy development and urban expansion. Law No. 10,257, from July 10, 2001, known as the City Statute, regulates articles 182 and 183 of the Federal Constitution.

Among the basic guidelines contained in the City Statute for the achievement of urban policy are: democratic management through participation of the population and organizations representing various segments of the community in the formulation, implementation and monitoring of plans, programs and urban development projects; planning the development of cities, the spatial population distribution and economic activities of the municipality and the territory under its area of influence, in order to avoid and correct the distortions of urban growth and its negative effects on the environment; integration and complementarity between urban and rural activities, in view of the socio-economic development of the municipality and the territory under its area of influence.

Law No. 10,257, from July 10, 2001, also established the main tools that can be used to achieve the Foundation's goals. They are: national, regional and state planning of land use and economic and social development; planning of metropolitan regions, urban agglomerations and micro-regions; municipal planning, in particular the master plan, guidelines for land use and environmental zoning, a multi-year plan, budget guidelines and the annual budget; participative budget management; sectoral plans, programs and projects; plans for economic and social development; legal and political instruments; prior environmental impact assessment - EIA and prior neighborhood impact assessment - NIA. According to Mukai:

> The master plan is an integral part of the municipal planning process, as long as the multi-year plan, the budget guidelines and the annual budget incorporate the guidelines and priorities contained therein "[viii] (2005, p. 19)

On January 1, 2003, the Ministry of Cities was created with the hope of combatting social inequalities, making cities more humanized spaces and increasing the population's access to housing, sanitation and transport. For this purpose, the Ministry encourages municipalities to create new practices of territorial planning and democratic management by releasing funds and providing technical support to cities.

The second approach reveals the planning focused on modeling the economic development of the country and is provided for in art. 174 of the Federal Constitution. The state should exercise fiscalization, incentive and planning, which is binding for the public sector and indicative for the private sector. To achieve this function, the State, using specific regulatory framework, should establish the guidelines and basis for planning balanced national development, which embody and make compatible the national, regional and sectoral development plans.

The three branches of state planning - urban planning, economic planning and control of the financial activity of the state – are integrated through the multi-annual plan - MAP, the Budget Guidelines Law - BGL

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and Annual Budget Law - ABL[ix]. In other words, based on the Federal Constitution and Complementary Law No. 101 from May 4, 2000, it follows that these three instruments of government planning in an integrated and cyclical manner, express the economic, financial and urban policies of the federative entity, though each has a specific function in the government's planning system. The Charter Policy and Fiscal Responsibility Act establish the need for integration and compatibility between them, both vertically (MAP conditions BGL, which conditions ABL), and horizontally (MAP conditions BGL and ABL over the four years of its term), in all of the federal entities.[x]

There is a key concept in this government planning and budget system, which is the program, considered the only integrating module between plan and budget. In terms of structure, the multi-annual plan ends in the program and the annual budget starts in the program, which integrates these documents from the outset, without the need, therefore, to seek reconciliation between diverse modules (BRAZIL, 2014th).

The program is the organizational tool of government action that articulates a set of actions that contribute to the achievement of a common predetermined goal, measured by indicators established in the plan, aimed at solving a problem or answering particular needs or demands of society. Organization of Government actions in the form of programs aimed at providing greater rationality and efficiency in public administration and increasing the visibility of the results and benefits generated for society, as well as increasing transparency in the use of public funds (BRAZIL, 2014a).

The process of implementation of landfills in Brazilian municipalities (including small ones), since it is considered a public policy, is set as a mandatory item of each City's Master Plan and the formulation and implementation of this project must take place in coordination with the cycle of these three government planning and budget tools.

IV. SOURCES OF FUNDING FOR SMALL MUNICIPALITIES

Based on the Country's Political Charter (the Federal Constitution), Complementary Law No. 101, from May 4, 2000 (Fiscal Responsibility Law - FRL) and Law No. 4320 from March 17, 1964 (Statute of Financial Law), it is possible to demarcate three normative axes from which can be identified some alternative funding to carry out public works and services in small municipalities in Brazil. Firstly, there are intergovernmental transfers (from the Union to the states, Federal District and municipalities; from the state to the municipalities located in their territory). Secondly, there are loans that can be made through national and international financial organization fundraising. Thirdly, there are partnerships that can be implemented between the Public Administration and the private sector

Intergovernmental transfers have their nature and content delimited according to the conceptual framework of the Federative Republic of Brazil, the name assigned to the country, which is formed by the indissoluble union of the states, the Federal District and the municipalities, according to Article 1 of the Constitution.

The political and administrative organization of the Federative Republic of Brazil, comprising the union, the states, the Federal District and the municipalities, all autonomous, under the Federal Constitution, determines how public expenditures are financed and the distribution of costs between these federal entities, i.e. establishes the jurisdiction that each federal entity has to institute tributes (taxes, fees and contributions), to generate their own revenues as well as the duty of each one in terms of public policy.

The Brazilian federal system is cooperative in nature. The meaning of this statement is as follows: the Union establishes and collects taxes within their jurisdiction; some of this revenue stays with her and the rest is distributed among the states, Federal District and municipalities, according to legal and constitutional determination. Each state, in turn, establishes and collects taxes within its jurisdiction; a portion remains with the state and the rest is shared between the municipalities situated in its territory. Therefore, the municipality establishes its own taxes, but the revenue remains fully within the municipality. Such division among each of these federal agencies is intended to take care of expenses which are also distributed among them, according to the Federal Constitution.

There are two types of union fiscal transfers: compulsory transfers which are subdivided into Constitutional[xi] and Legal[xii], and Discretionary Transfers[xiii], subdivided into four: voluntary transfers, those through civil society organizations, those by delegation and specific transfers. For the analysis of our study we will limit ourselves to the discretionary voluntary type of transfers - which are those that carry out the delivery of resources to Federative Entities for cooperation, assistance or financial aid, that are not based on constitutional or legal requirements. In other words, voluntary transfers are thus called because they depend

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on the decision or will of the grantor, and aim towards common interest works or provision of services. The legal instruments for the implementation of voluntary transfers are transfer agreements and term agreements which pass between Federative entities and public agencies. (BRAZIL / STN, 2016).

As shown above, the constitutional and legal transfers, plus each city's own revenues are insufficient to support the implementation of landfills in the municipality, which make voluntary transfers important and relevant to meet this demand.

Within the latter kind of transfers, appropriations in the general budget of the Union are allocated to the Ministry of Cities (BRAZIL, 2015a) and to the National Health Foundation (BRAZIL, 2015f). This financial aid consists of specific programs[xiv] that are also intended for small municipalities, with specific landfill deployment goals in their respective constituencies. In this sphere, there are still funds from the parliamentary amendments, which are the amounts included in the general budget of the union by the Federal Deputies and/or the Senators to benefit projects and actions in their territorial origins in accordance with Amendment No. 86 to the Federal Constitution from March 17, 2015.

Procedures for access to those resources by municipalities are in Federal Decree No. 6,170, from July 25, 2007, which provides for the norms on transfers of federal funds through transfer agreements, Ministerial Decree No. 127 from May 29, 2008 and Ministerial Decree No. 507 from November 28, 2011, governing the implementation of that Presidential Decree (BRAZIL, 2007).

With regard to loans, the National Bank for Economic and Social Development - BNDES supports and provides to municipalities, through the Integrated Multi-Sectoral Urban Project - IMUP, credit lines aimed, among other purposes, towards environmental sanitation, consisting of projects that have as their target water supply, sewage, solid waste and/or urban drainage (BRAZIL, 2015d).

With credit loans open to the public sector, in addition to compliance with the internal norms of the BNDES, the access to financing is established in Resolution No. 43 from December 21, 2001, from the Federal Senate, which regulates the carrying out of domestic and foreign loans, by the states, Federal District and municipalities, including the granting of guarantees, their limits and conditions of authorization.

With regard to partnerships between the public administration and the private sector, Di Pietro (2015) presents a set of technical and legal solutions based on Brazilian law that enable the execution of works and the provision of public services through competition of companies and/or non-state sector organizations.

The modalities of partnerships vary depending on the type of administrative activity to be developed by the Government. The author points out, in accordance with specific administrative laws, instruments of partnership, such as concession of public services, concession of public works, sponsored concession, administrative concession, the management agreement, the partnership agreement, etc. It is up to each municipality, according to their local peculiarities, to verify the suitability of any of these instruments according to their needs.

As a summary of the alternatives available, with which small municipalities can expect to enable their investments in urban infrastructure (including the installation of landfills), the following can be enumerated:

(1) voluntary transfers originating from the Union or its respective state, which can be made through agreements and transfer agreements and require minimal (modest) financial contribution from the municipality;

(2) public sector loans, long-term and subsidized financial trusts, offered by the main fostering state agency in the country, BNDES;

(3) partnerships that can be made with companies and/or private sector organizations. It seems of fundamental importance the active force of actors participating in the cycle of public policies, utilizing their capabilities of articulation to make some of these public affairs become a reality, as is evidenced by the IDB report (STEIN et al., 2007).

V. LAW 10,305/2010 AND THE REALITY OF SMALL MUNICIPALITIES

Law 10,305/2010 is an opportunity for change in the model of Brazilian society; a new proposal for civic and collective behavior towards human sustainability. From Art. 1:

> The National Policy on Solid Waste is established, providing for its principles, objectives and instruments as well as on the guidelines for integrated management and the management of solid, including hazardous, waste, for the responsibilities of generators and the public authorities and the applicable economic instruments.
> § 1st Public or private individuals or legal entities who are responsible, directly or indirectly, for the generation of solid waste shall be subject to compliance with this Act and to develop actions

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related to integrated management or solid waste management (BRAZIL, 2010a).

Scheduling and implementing all the challenges of the law with the reality of Brazilian cities is not a simple task, rather it is complex, challenging and necessary.

For Municipalities two obligations with specific deadlines were determined as a result of the enactment of the National Policy on Solid Waste (NPSW). The first, with a deadline of August 2, 2012 was as follows:

> Art. 18. The preparation of a municipal plan for the integrated management of solid waste, as provided by this Law, is a prerequisite for the municipalities to have access to or control over the resources of the Union for the projects and services related to urban sanitation and solid waste management, or to be benefited by incentives or funding by federal agencies for this purpose (BRAZIL / NPSW/ 2010a).

The second deadline was August 2, 2014 for all municipalities meet "Art. 54 - The final environmentally sound disposal of non-recyclable waste". Or rather, the implementation and building of landfills in all Brazilian municipalities was expected to occur in a period of just four (4) years.

Few small cities managed to meet these deadlines, when the mayors of the country, along with the National Confederation of Municipalities - CNM - requested an extension deadline. The request of municipal officials was met through Senate Bill. - PLS 425/2014, which was approved and has already been sent to the House of Representatives for deliberation, extending incrementally, the deadline for municipalities to adapt to the project proposed by the Law. The project proposed:

> Capital and metropolitan municipalities will have until July 31, 2018 to end the use of dumping grounds. Border municipalities and those with over 100 000 inhabitants, based on the 2010 Census, can have the deadline extended until 2019. Cities with between 50 and 100 thousand inhabitants will have until July 31, 2020 and *those with under 50 thousand inhabitants, have until July31, 2021*. The Union will need to issue supplementary rules on access to federal funds for this kind of work (BRAZIL, 2014th, emphasis added).

All inconsistencies with regard to expenses and revenues determined by the Union to the Municipalities expose the lack of diagnosis of the Union, with its members of the federation, because the municipalities do not have today nor will in 2021, in this case, small municipalities, funds to cover the construction, installation, implementation and maintenance of landfills. Investment costs necessary for this project include, a priori, collection and transportation of waste, land acquisition, project design, environmental licensing and finally construction of the landfill.

Installation costs of landfills according to GVF - Getúlio Vargas Foundation and ABETRE - Brazilian Association of Waste and Wastewater Treatment Companies/2007 - corrected by the National Index of Construction Cost - INCC through 06/2014[xv], are divided into three phases: for installation - 5% of the total investments in the landfill, for operation and maintenance - 85% of investment (with an expected life of 20 years) and for the closure and post-closure - 10% of investment. The estimated value for the implementation of a small Sanitary Landfill (100 t/day) is 5.2 million.

To contextualize the cost of implementation of a landfill in small municipalities, it is necessary to quantify these municipalities in Brazil and especially in the state of Rondônia, which is the subject of the proposed article, in Tables I and II.

Table 1 - Distribution of municipalities by population group in Brazil

Group Number	**1**	**2**	**3**	**4**	**Total**
City Size	**Small**	**Medium/Small**	**Medium/Large**	**Large**	
Number of Inhabitants	**up to 50,000**	**50,001 to 100,000**	**100,001 to 500,000**	**Over 500,000**	
Numbers of municipalities per Population Group	4910	351	267	42	5570
Percent of municipalities by population group	**88.15%**	**6.30%**	**4.79%**	**0.75%**	**100.00%**
Total municipal population by population group	66,156,815	24,365,691	54,513,413	62,625,010	207660929

https://dx.doi.org/10.22161/ijaers.6760 *ISSN: 2349-6495(P) | 2456-1908(O)*

Municipal Population Percentage by population group	**31.86%**	**11.73%**	**26.25%**	**30.16%**	**100.00%**

Source: Fabiano; Barbosa; Uchôa - IBGE adaptation - June 1, 2017.

Table 2 - Distribution of municipalities by population group in the state of Rondônia

Group Number	**1**	**2**	**3**	**4**	**Total**
City Size	**Small**	**Medium/Small**	**Medium/Large**	**Large**	
Number of Inhabitants	**up to 50,000**	**50,001 to 100,000**	**100,001 to 500,000**	**Over 500,000**	
Numbers of municipalities per Population group	45	4	2	1	52
Percent of municipalities by population group	**86.55**	**7.69**	**3.84**	**1.92**	**100.00%**
Total municipal population by population group	749 258	297 082	240 012	519 436	1805788
Municipal Population Percentage by population group	**42.49**	**16,45**	**13.29**	**28.76**	**100.00%**

Source: Fabiano; Barbosa; Uchôa - IBGE adaptation - June 1, 2017.

The small municipalities with up to 50,000 inhabitants, identified in Tables I and II make up most of the municipalities in Brazil (88.15%) and in the state of Rondônia (86.55%). Of the total population,31.86% of Brazilians and 42.49% of Rondonians live in these municipalities. That being said, it is clear that the Solid Waste Public Policies aimed at the implementation of sanitary landfills in Brazil must necessarily go through these municipalities.

Therefore, it is important to consider the financial reality of these municipalities - would they have the necessary budgetary allocation in order to invest in the integrated management plan of municipal solid waste and the implementation of the landfills? Law No. 12,305/2010 establishing the National Policy on Solid Waste in Brazil did not consider this hypothesis, but forced all municipalities to implement Articles 18 and 54 of that legislation.

The financial scenario of the municipalities in general does not support this requirement, especially small municipalities. In Rondônia, the state with the second best per capita income in the Northern region of Brazil[xvi] also finds it difficult to perform NPSW as demonstrated in Table III, with the municipality Nova Mamore/RO and the description of its Available Revenue as an example[xvii].

Table 3 - Description of Available Revenue for the Municipality Nova Mamore/RO for executing the NPSW

REVENUE	**VALUE**
Gross revenue	**61,885,196.33**
Capital revenue	- 2,667,281.19
Intra-budgetary revenue Chains (employers' social contributions)	- 2,694,008.18
Current revenue	**56,523,906.96**
FUNDEB deductions and Social Security Contributions	- 6,804,026.32
Net Revenue Stream - RCL	**49,719,880.64**
RELATED REVENUE[xviii]	**VALUE**
Cost contribution to the Public Lighting Service (COSIP)	- 474,563.03
Financial revenue	- 2,747,584.20
Resource transfers from the National Health System - SUS - Transfers Fund to Fund.	- 3,248,726.87
Resource transfers from the National Social Assistance Fund - FNAS.	- 536,326.71
Resource transfers from the National Education Development Fund - FNDE.	- 1,079,906.20

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Share of the Intervention Contribution in the Economic Domain - CIDE.	- 77988.68
State Resource transfers to Health Programs - Fund to Fund Transfers.	- 59525.08
Covenant transfers	- 3,296,227.23
Total Related Receipts	**11,520,848.00**
EXPENSES	**VALUE**
Municipal Legislative Expenses (City Council)[xix]	- 1,792,967.34
Payroll Expenses[xx]	- 25,100,080.86
Total expenditures	**26,893,048.20**
Sum of Related Revenues and Expenses	- 38,413,896.20
Total revenue available	**11,305,984.44**
% of disposable income on gross revenue	**18.26%**

Source: Budget Execution Report Summary - RREO, Fiscal Management Report - RGF and annual balance sheet, Municipality of Nova Mamore - RO (Executive Branch), 2016 SICONFI - System of Accounting and Fiscal Information from the Public Brazilian Sector /STN.

Table 4 - Available Revenue from Municipalities by population range of the state of Rondônia

Group Number	**1**	**2**	**3**	**4**	**Total**
City Size	**Small**	**Medium/Small**	**Medium/Large**	**Large**	
Number of Inhabitants	**up to 50,000**	**50,001 to 100,000**	**100,001 to 500,000**	**Over 500,000**	
Number of municipalities per Population group	45	4	2	1	52
Average value of Available Revenue by population group	**6,614,372.33**	**30,112,343.10**	**31,825,713.21**	**334,721,540.04**	-
Percentage of Available Revenue per population group based on gross revenue	17.26%	16.06%	12.97%	24.59%	-

Source: Budget Execution Report Summary - RREO, Fiscal Management Report - RGF and annual balance sheet, SICONFI - System of Accounting and Fiscal Information from the Public Brazilian Sector /STN, 2016.

The reality described in Table III in the city of Nova Mamore/RO, is not an exception but the rule, because of the 45 municipalities with up to 50,000 inhabitants in the state of Rondônia identified and analyzed in Table IV, only an average of 17.26% of its "left over" revenue is available for implementation of the NPSW. It is noteworthy that of this small percentage of Available Revenue that is "left", the mayors have to apply at least 15% in stocks and public health services[xxi] and 25% of revenues from taxes on Education[xxii] on the RCL, as well as a huge list of other mandatory and fixed monthly expenses that the municipal fiscal officials have to pay.

This table shows the budget constraint on investments by municipalities, especially small ones, not to mention the fact that the vast majority of municipalities invest much more than their constitutional obligation into public health and education.

In the state of Rondônia, with the exception of the Municipality of Porto Velho (capital city), the 51 remaining municipalities do not have financial autonomy to implement their priority agendas. Nelson Nery Costa conceptualizes financial autonomy as "the allocation of income and the freedom to act" (2012, p. 59). According to Regina Ferrari, "it is the ability to have one's own revenue to pay for a necessary expense" (2005, p 92.). For Jose Mauricio Conti, Financial Autonomy has three essential features in obtaining resources, which are:

> *Independence* - In obtaining resources, this must exist so that one federal entity need not be subject to another in order to get the funds that it needs.
> *Sufficiency* - Of the funds raised, a sufficient amount is essential for government officials to be able to meet public needs under their responsibility. After all, if the Constitution dictates the purpose, it must also provide the means.
> *Efficiency* – Efficient collection of funds in terms of practicality, convenience and economic viability in order for each beneficiary to receive the most appropriate tax amount for their scopes. (2011, p. 189)

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The current president of the Federal Supreme Court - STF, Minister Carmen Lúcia Rocha says that political autonomy is linked to financial autonomy: "There is no political independence without financial independence and this is not achieved without foresight and the constitutional guarantee of one's own sufficient resources for autonomous political action for the benefit of each one of the federated people " (ROCK, 1996, p. 254). In this sense, Régis Fernandes Oliveira (2014, p 111) states: "Today the fiscal pact is askew. There is a clear imbalance in favor of the Union. "

Therefore, Rondonian Municipalities without financial autonomy are not free to set their own policies, or even public policies imposed by the federal government, as is the case with the NPSW. In this sense, local governments are unable to effectively govern.

VI. FINAL CONSIDERATIONS

Based on everything that has been herein explained, it is challenging to achieve all the objectives and guidelines of the National Policy on Solid Waste. Based on the numbers presented, current solid waste management by the government is not consistent with environmental sustainability and public health.

The NPSW lacks investments and funding for its implementation and maintenance, respectively. Even with serious operational difficulties in the short-, medium- and long-term, this sector policy, as it's called in its legal framework, offers the opportunity for the city and its population to evolve together in the manner in which they deal with the solid waste produced in their urban space.

Brazil is mostly a country formed by many small municipalities. This is shown through the data from IBGE in 2015, cited in the introduction. Of the total number of Brazilian municipalities, 88.30% have less than fifty thousand inhabitants. In this part of the country live 65,996,669 Brazilians, which is equivalent to 32.28% of the entire country's population. The leaders of these municipalities have practically the same difficulties managing their solid waste policies, particularly with regard to the lack of technical and financial resources. Supporting the NPSW in these cities is urgently needed by the States and the Union.

Among the various obstacles that arise in conducting this process, we conclude that four of them, if overcome, can greatly contribute to the success of the NPSW:

(1) The first would be the final approval of the Senate Bill (PLS 425/2014) extending the deadlines of Law No. 12,305, from August 2, 2010, in stages, so that cities can become suited to the NPSW, and the Proposed Amendment to the Constitution (PEC 172/2012), which forbids federal law from assigning charges or providing services to the states, the Federal District or the municipalities without the corresponding financial support for their implementation.

(2) to make the rules of procedure that operationalize the access of municipalities to federal funds more flexible, as described in Federal Decree No. 6,170, from July 25, 2007, Ministerial Decree No. 127 from May 29, 2008, and Interministerial Ordinance No. 507 from November 28, 2011.

(3) funds derived from agreements through the parliamentary amendments, with their high levels of corruption, often impose on the municipal government, since through direct union spending through amendments, parliamentarians may favor companies that financed their campaigns, practicing cronyism, carrying out electioneering, among many ethical, political and legal delinquencies, all while the main role, the institutional responsibility of the Parliament is not to spend, but supervise the government and approve the budget; it characterizes a double-dose dilapidation of the parliamentary function.

(4) hold units accountable for noncompliance with the deadline for environmentally sound disposal of solid waste; the obligations of solid waste management in Brazil are above all: the Federal, State and Municipal governments, the Corporate sector and society. Thus, municipal officials are only penalized by administrative improbability; hence, they are compelled to sign the so-called Terms of Conduct Adjustment (TCA) with the State Prosecutor.

Finally, this study indicates the possibility of viable options of public resources for the execution of projects to implement landfills carried out by the governments of municipalities with up to fifty thousand inhabitants.

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[i] The National Solid Waste Policy willhenceforthbecalledonly PNRS.

[ii]Solidwastethat, afterhavingexhaustedallthepossibilities for treatmentandrecovery for availableandeconomicallyviabletechnological processes, show no otherpossibilitythanthe final disposalenvironmentallyappropriate. (Law No. 10,305 / 2010).

[iii]Economicand social development tool characterizedby a set ofactions, procedures andmeanstoenablethecollectionandrecoveryofsolidwastetothe business sector, for reuse in its cycleorotherproductioncycles, orotherdisposalenvironmentallyappropriate. (Law No. 10,305 / 2010).

[iv] The Dischargeof Union Revenues (DRU) is a mechanismthatallowsthe federal governmentfreely use 20% ofall federal taxes linkedbylawtofundsorexpenses.

[v] Volume ofresourcesearnedbyeachlevelofgovernment for thecollectionofown taxes.

[vi] Volume ofresourcesearnedbyeachsphereofgovernmentafter direct more intergovernmentaltransfersstorage.

[vii]In Brazil, sub-regional governmentsthestates, the Federal Districtandthemunicipalities, andthe Union isthenationalState as establishesthe caput ofArticle 18 oftheConstitution: "The politicalandadministrativeorganizationoftheFederativeRepubli cofBrazilcomprisesthe Union, thestates, the Federal Districtandthemunicipalities. "

[viii]To Villaça (2005, p. 10), theideaof Master Planhas spread amonguswithgreatintensityandspeedgoingtobeadopted, defendedandhonoredbythe elite ofBraziliansociety, especiallybyarchitectsandengineerslinkedtourbanproblems, political , severaluniversitycourses, entrepreneurs (mainly real estate) andthepress. Oursocietyissoakedthewidespreadideathatthe Master Plan (in thebroadconception) is a powerful tool for thesolutionofoururbanproblems, theessentialfact, andlargely, ifsuchproblemspersistisbecauseourcities do nothavehaveachievedandapplythismiraculous Plan. It isamazinghowaninstrumentthatalmostneverexisted in practice, mayhaveacquiredprestigesizebythe elite ofthe country.

[ix]Multiyearplan - PPA establishes, for theperiodof four years, byregion, guidelines, objectivesandgoalsofgovernment for capital expendituresandotherresultingtherefromand for thoseregardingcontinuousprograms; (2) the budget guidelineslaw (LDO), understandsthegoalsandprioritiesofpublicadministration, including capital expenditures for thefollowing financial year, guidesthedraftingoftheannual budget lawprovides for changes in taxlawsandestablishesenforcementpolicyoftheofficial financial anddevelopment agencies; (3) theannual budget law (LOA) comprisesthe fiscal budget regardingthePowersofthefederatedentity, its funds, agencies andentitiesof direct andindirectadministration,

[x]The timetable for theachievementoftheplanningand budget cycle, withinthe Union, set out in paragraph 2 ofArticle 35 oftheActConstitutionalProvisions (Federal Constitution): the PPA project, tobeeffectiveuntiltheendofthefirstyear in office subsequentpresidential, willbeforwardedupto four monthsbeforetheendofthefirstyearandreturned for sanctionuntiltheendofthelegislativesession; the LDO projectwillbeforwardeduptoeightand a halfmonthsbeforetheyearendandreturned for sanctionuntiltheendofthefirstperiodofthelegislativesession; the LOA oftheprojectwillbeforwardedupto four monthsbeforetheendofthe fiscal yearandreturned for sanctionbeforetheendofthelegislativesession.

[xi]They are thosearising from constitutional law, are regulated by law and carried out automatically, taking place between federal entities. (BRAZIL / STN, 2016).

[xii]Are thosewhoseobligationarises from specific law and specific regulations, occurring between Federative loved and private non-profit entities. (BRAZIL / STN, 2016).

[xiii]Discretionarytransferswerecreatedbecauseofthescope, complexity, diversityandgeographicalextentofthedemandsofthepopulatio n for utilities, whichmadethegovernmentformulatedecentralizinginstrumen tsofpublicactions, directedtoprogramsorwell-definedpriorityinitiatives. Thus, this category of transfers is performed based on clear objectives, often explained through implementation projects, which leads to the need to enter into a legal instrument between the parties, and granting one another beneficiary. (BRAZIL / STN, 2016).

[xiv]The MinistryofCities, Municipal Solid Waste Program. The National Health Foundation (FUNASA), environmental sanitation program for municipalitieswithupto 50,000 inhabitants.

[xv]Availableat: <.http://www.mma.gov.br/mma-em-numeros/residuos-solidos> Access onOct 15. 2016.

[xvi] IBGE - PNAD, 2016

[xvii]Freeorunlinkedrevenue.

[xviii]Linkedrecipeisonefromwhosetaxorcontributionamountscollec ted are directedbylaworbytheConstitution, to a certainexpense. All contributions are by definition linked to some sort of expense. However, although the Constitution determine the taxes of affectation in item IV of art. 167, also effective tax binding in several of its devices (MENDES, 2009) and (MENDES JR, 2010, p. 10).

[xix]SC / 1988 - Art 29a.. The total expenditure of the Municipal Legislative Branch, including subsidies of Councilors and excluding expenses inactive, may not exceed the following percentages, relative to the sum of tax revenue and transfers provided for in § 5 of article. 153 and in arts. 158 and 159, effectively realized in the previous year: I - 7% (seven percent) for municipalities with population of up to 100,000 (onehundredthousand) inhabitants.

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[xx]The total personnelexpenditures in eachcalculationperiodand in eachmunicipalityofthefederation, maynotexceed 54% percentageof net currentrevenue. (Art. 20, item III, b. Of Law No. 101/2000).

[xxi] CF / 1988 - Art 198 - § 2 (...) Municipalities apply annually spend on public health care resources minimum of 15% derived from the application of calculated percentage of: III - in the case of municipalities, the product the collection of taxes referred to in art. 156 and of the resources in arts. 158 and 159, section I, paragraph b § 3.

[xxii] CF / 1988 - Art. 212. (...) The municipalities apply annually, never less than twenty-five percent, at least, the resulting tax revenues, understood from transfers, in themaintenanceanddevelopmentofeducation.

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Technologies transmission between micro and small phytocosmetic companies in the Amazon State and developing knowledge institutions

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Abstract *— The phytocosmetics market requires that companies have the capacity to develop new technologies with lower costs and time to launch, which demands skills that often small and medium sized companies do not have, requiring a process of transferring knowledge and technology. It has historically been noted that innovation is not merely an external technological shock, but a process within companies, which includes endogenous learning, feedback, and incremental modifications over a period of time. This article aimed to understand the mechanisms used by Amazonian phytocosmetics companies to transfer knowledge and technology that contribute to their productive, management and marketing processes. The research was carried out in companies, installed in Amazonas State, producing phytocosmetics such as cosmetics, personal hygiene products and perfumes, which have in their composition some ingredient derived from the Amazonian biodiversity, except handling pharmacies. It had a qualitative and exploratory character. The Multiple Case Study was used as a method to understand the nature and complexity of a given phenomenon, which occurred simultaneously in several institutions. It was found that companies in the phytocosmetics segment develop relatively simple knowledge related to marketing, technical activities and scientific knowledge. The companies prefer to establish partnerships with chosen suppliers according to their reputation in the market. There is no defined channel of transferring technology and the main mechanism of knowledge transfer used are the training that are generally well assimilated, but little incorporated work practices.*

Keywords *— **Phytocosmetics, research and development, knowledge, Amazon State, enterprises.***

I. INTRODUCTION

Technological development is considered as a determining factor for global competitiveness. Therefore, developing countries need to build mechanisms to increase capacity for development and / or application of new technologies to improve profitability, make better use of natural resources, and be more markets competitive [1,2,3,4]. The increasingly market demanding reflects the growing complexity of product development. The advances of new technologies and the need for constant innovations, linked to their costs, are factors that contribute to the competitiveness of organizations. To operate in these environments, companies need to be able to develop new technologies with lower costs and time to launch, which demands skills that often small and medium business do not have. The process of transferring knowledge is related to product, or process, or applications. It is usually a complex process composed of innumerable variables. Technology means technical knowledge related to engineering, production, organizational structures, skill and behavior patterns that reflect the product or process and tools (procedures, equipment and facilities) used to provide products and services to the market. Technology is not static, but implies continuous innovation to increase profitability, growth, sustainability and competitiveness. Transfer does not only mean a movement from one entity to the next, but also encompasses exchange, cooperation, partnerships and collaboration [3].

It is becoming increasingly important that micro and small businesses interact with agents from different segments that can foster innovation, enabling them to

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share complementary knowledge and skills, thereby improving their performance in technology transfer [5].

It has historically been observed that innovation is not merely an external technological shock, but a process within companies, which includes endogenous learning, feedback, and incremental modifications over a period of time. Innovation and diffusion of technology are, therefore, not easily separable. It is not only influenced by intellectual property rights, licensing and imports /or acquisitions, but also depends on capabilities to improve technologies, participation in networks of producers, suppliers, users and research institutions, which are necessary to enable continuous learning [4].

Like any micro, small and medium-sized enterprises, phytocosmetics producers in the Amazon State have management, financial, technical and scientific limitations and need strategies that allow them to remain competitive in the market. They are family-run businesses with traditional management. Most of them use manual production techniques with a low degree of technological aggregation and have partnerships with several agents, but public or non-profit institutions have played a prominent role, mainly in the provision of physical spaces and funding for research and development. Even in the face of Amazon State efforts, many bottlenecks need to be overcome so that bio-business, more specifically phytocosmetics, gain market prominence and promote the socioeconomic and environmental development in the State.

For all the facts presented, this article aimed to understand how the mechanisms are involved to carry out technology transfer and to contribute to the technology transmission literature of micro, small and medium sized phytocosmetics companies in the State of Amazonas, Brazil.

II. TRANSFERRING TECHNOLOGY IN MICRO AND SMALL COMPANIES

Last survey conducted by SEBRAE (2014) indicates that small enterprises (micro, small and medium sized enterprises and individual entrepreneur) have their own importance in brazilian economy. In trade, small enterprises represent 53.4% of brazilian GDP (Gross domestic product). In industry GDP, the participation of micro and small enterprises (22.5%) is already close to medium-sized enterprises (24.5%). In the services sector, more than a third of national production (36.3%) originates in small businesses. These data demonstrate the importance of stimulating and improving smaller enterprises in the country that, despite the economic relevance, have their competitiveness compromised by the increase of international competition, environmental, technical and organizational constraints, focusing their efforts to meet the demands of local markets [6]. Competitive markets require increasing complexity of product development, breakthroughs in technology and constant innovations linked to their costs, and to operate in these environments, companies require skills that often small and medium-sized enterprises do not have [4].

Technology can be understood from a implicit or codified perspective. It can be a product, a process, applications, or skills. Technology means knowledge (ideas, engineering and technical know-how), skills (competence, organizational structures, and behavior patterns) and tools (procedures, equipment and facilities) used to provide products and services to the market. Technology is not static, but rather implies continuous innovation to increase profitability, growth, sustainability and competitiveness [3, 7, 8, 9].

Transferring technology indicates the movement of technology from one place to another - that is, between people, organizations, or even countries. Transfer consists of (1) materials, end products, components, equipment and plants; (2) projects, models, and know-how to create the desired capacity; and (3) know-why and information to innovate and adapt existing technology. Transfer does not only mean a movement from one entity to the next, but also encompasses exchange, cooperation, partnerships and collaboration. It is often a complex, dynamic process and success is not always guaranteed [3, 9]. The complexity of transferring technology process is aggravated by economic, political, technological, cultural, social, and organizational factors [9]. They seek efficient channels and make case assessments in different countries and segments [10, 11,12, 13, 14, 15, 16, 17], reflecting the economic and social growth of countries, especially developing countries [4, 7].

Studying the process of transferring technology in micro, small and medium-sized enterprises can be a complex challenge considering that each company has its own style, influenced by social, economic, cultural and technological factors. The style of business management is characterized by strategic priorities of the owners or managers that can conduct the administration of the business in different ways and, consequently, to different relationships and interests within a business environment [6].

Human factors are fundamental for the generation and transmission of expertise. Personal motivation, opportunity to learn, confidence, commitment, persistence, and ability to absorb and receptivity are significant variables in the process, in addition, the

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organization must develop skills and abilities in technology and management through training and mentoring; establish links with other government programs and departments to obtain funding and additional support; provide access to information and markets; establish infrastructure; negotiate contracts with suppliers and customers; monitor and evaluate the progress of the process, work in networks [3, 11, 12, 15].

Still referring to human factors that influence the transferring technology process, Lee e Win (2004), show that informal relations between colleagues provide for the free exchange of information and consists of a first link between research and development institutions and industry. It can be a mechanism to create the confidence needed for the transferring technology process [14]. Informal relationships are essential for the generation of knowledge, present and necessary for the effective process of technology transfer. Perry *et al* (2010), stresses the importance of channeling the relations of groups, or informal relations, that can stimulate the process of innovation in the organization.

Among external factors that may influence the process of technology transfer include government infrastructure and financing policies, translated by science, technology and innovation policies; technology transfer services available, standards, testing, certification; patenting; strategic business alliances; development of entrepreneurship; financing and risk capital, trade barriers [3, 4, 7, 9, 11].

Beukman (2011), adds that the success of a technology transfer process encompasses pre-implementation studies and post-implementation support. This event could be observed in reports of technology transfer for testing of validation for cosmetics performed in Europe. After all the planning, training and after the process, follow-ups were done to validate the results, observing if the standard developed by the process's laboratory was maintained in laboratories that received the technology [18, 19, 20]. There are vast channels through which technology is transferred. The technology transfer channel is the connection between two or more social entities, in which the various mechanisms can be activated. International channels include: foreign direct investment; technical licensing agreements between foreigners and local companies; imports of intermediate goods and capital; education and training in advanced technology; project contract; technical consulting services by foreign companies, joint development [8, 11, 14].

Vasconcelos (2008), mentioned that transferring technology mechanism is any specific form of interaction between two or more social entities during which the technology is transferred. When the interaction has a continuous character, the mechanism can be treated as a channel [21]. Judging the performance of a transferring technology process is another challenge. There is a multitude of actors involved in the process and depending on who will judge the performance and results according to criteria, they are often antagonistic with traditional efficiency measures. The problem, then, is the complexity associated with the various levels of interest, involvement and intervention of the individuals or groups affected and connected to the transference [7]. Not only is judgment complex, the implementation of transferring technology projects in micro and small enterprises has been challenging, but essential to promote business innovation [11, 14].

Innovative companies must anticipate the market must be customer focused, enrich the product in terms of different characteristics compared to competing products, in order to obtain a superior product in terms of quality. Innovation results from being part of your business strategy and relying more on developing new forms of work - incremental innovation, rather than radical innovation [15]. Innovative companies do not always have resource and development structures, but through transferring technology with knowledge-building institutions they achieve innovation.

Tidd*et al*., (2005), describe the innovation process is composed of the following phases: 1. Research - search for relevant signs about risks and opportunities for change, both in the internal and external environment; 2. Selection - based on the strategic vision of the company's development, decide which signals should be answered; 3.Implementation - translation of the potential of the idea to produce a novelty and launch of this in the internal and external market. This item requires attention to several aspects such as: Acquire knowledge resources with other institutions; 4. Execute the project in conditions of uncertainty that require constant resolution of unforeseen problems; 5. Maintain long-term adoption and use, or analyze the original idea and modify it; 6. Learning.

III. INDENTATIONS AND EQUATIONS

Innovation can be developed by companies based on the generation of expertise or "in cooperation with other companies or public research organizations [22]. In this respect, technical institutes and universities play an essential role not only as creators of knowledge, innovation and technologies, but also as training and qualification of staff and promoter in economic and social changes [23, 24, 25].

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The process of transferring technology from the academic *milieu* to the companies can occur from the following situations: (a) By means of the creation of companies of technological base by the researchers, using their scientific knowledge developed and improved in the academic institution; (b) By collaborative research, through which research projects are defined and conducted together; (c) By the contracted research and by means of consultancy based on knowhow, ordered by the industry next to the academy; (d) For the development and exploitation of intellectual property rights; (e) By transferring through human resources such as cooperation in undergraduate and graduate programs, training.

The cooperation between universities and companies is a phenomenon that occurs at several levels, since it is determined by the characteristics of the individuals that are part of these actors, as well as by the organizational and institutional context in which they work and increasingly it has had relevance [26]. Despite the gains, cooperation between universities and companies is not so common, but should be stimulated as companies can reduce their research and development risks, diversify their products, reduce time to market, rate project costs, acquire new skills , introduce technological changes. Universities can offer more streamlined supports for long-term research; aid for the production of useful new knowledge; expansion of educational experience and employment opportunity for students; possibility of interaction with industry engineers; access to specialized equipment of companies and dissemination of research work developed by the university [27, 28].

Lima (2004), developed a study that aimed to identify, characterize and propose elements that made up the process of technology transfer between university and company in Florianópolis, state of Santa Catarina (Brazil). In this study, the members of the reference structure were: Human Talents - Profile of the cooperation agents, conceptual characteristics of cooperation, institutional mechanisms of Interface with the community, structural elements of cooperation and, as a complementary issue, management skills for the cooperation Agents and can be classified within the four categories [29]: (1) The nature and characteristics of knowledge necessary for the transfer of technology; (2) The absorptive capacity of partners; (3) Partner behavior; (4) The type of alliance between the partners.

In the first, the nature and characteristics of expertise required for the transfer of technology include indicators such as the type of knowledge used by the organization (technical / scientific / traditional), the level of codification of company knowledge (tacit or codified) and the level complexity of knowledge. In the second category, absorption capacity, are aspects related to the ability of companies to assess the utility of knowledge, assimilate and put into practice. This process, as Saad (2002), Tambunan (2007) and Jogada (2010), is not an easy process, taking into account those involved in the process and under which perspective the process can be analyzed. The higher the level of interaction, the more the transferring process is facilitated. The company's information sharing policies, where the higher the level of restriction of information sharing, the more difficult the process becomes. Level of interest shown by partners, intensity of contact and trust. The higher these indicators, the easier the process.

The types of alliances, fourth category, refer to the perceived advantage gained by the organization in the transfer process, as well as its ability to innovate. A positive perception tends to create the capacity of the organization to repeat the partnership, as well as allows it to make incremental innovations to the process, according to its necessity. Closs*et al*. (2012), reflecting on the process of transferring technology from universities and research institutions to companies, having as a specific case the PUCRS (Pontifícia Universidade Católica do Rio Grande do Sul), presented that in Brazil, in addition to the factors conditioning the transfer of technology in general, there are facts related to the low maturity of the national policy to encourage cooperation between universities and companies, institutional policies and procedures for transfer management.

The main difficulties in the process of interaction between university and business are: the present bureaucracy, the researchers' lack of knowledge about the structure of the university, the unavailability of time, the focus on article production, lack of knowledge about intellectual property, lack of knowledge about the process of interaction, lack of culture and lack of conversation [30].

In this context, the present study aimed to understand the mechanisms used by the involved actors to carry out transferring technology and to contribute to the literature of this matter in micro, small and medium sized phytocosmetics companies in the State of Amazonas.

IV. METHODOLOGY

The research was qualitative and exploratory. The Multiple Case Study was used as a method to understand the nature and complexity of a given phenomenon, which occurred simultaneously in several institutions. Multiple case studies were chosen because they allow for more dense research, increase external validity and contribute

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to more realistic results [31]. The case studies were carried out in companies that produce phytocosmetics (cosmetics, personal hygiene products and perfumes, which have in their composition some ingredient derived from the amazonian biodiversity) installed in Amazonas, except handling pharmacies (TABLE 1).

Initially, a survey was carried out on the scientific, technological and market bases of companies producing cosmetics, personal hygiene products and perfumery with active components / principles from the region, where a population of 15 companies was identified.

Table 1 - Phytocosmetics companies participating in the study.

Seq.	Companies	Participant
1	Amazon Ervas	Yes
2	Amazon Green	Yes
3	Anna Morena Fitocosmeticos da Amazônia	Yes
4	Aroma Ativo	Yes
5	Beleza da Floresta	Yes
6	Bella Cabocla Produtos Naturais Da Amazônia	Yes
7	Bioessencia - Anauá	No
8	Cheiro Amazônico	Yes
9	Emporio& Aromas da Amazônia	No
10	Gotas da Amazônia	Yes
11	Harmonia Nativa	Yes
12	Amazon Biocare - N. L. Mayer	Yes
13	Natus - Esponjas Vegetais da Amazônia	Yes
14	Pharmakos d´Amazonia	Yes
15	Pronatus do Amazonas	Yes

All companies were invited to participate in the study. Of the 13 (thirteen) companies that participated only 03 (three) companies did not mention a partnership with some institution that promotes knowledge.

Methods of data collection

Based on the existing literature on the transferring technology process, a semi-structured interview script was developed with open and closed questions that could answer aspects related to the categories identified according to Khamseh e Jolly (2008), according to Table 2. The application of the instrument had an average duration of 50 minutes.

Table 2 - Categories and Indicators that influence the transferring technology process raised.

CATEGORIES	INDICATORS
Nature and knowledge characteristics	Code Level (shape)
	Type
	Complexity
Capacity of knowledge absorption	Assimilation
	Evaluation
	Use
Behavior of partners	Interaction
	Attitudes
	Level Of Protection
	Contact
	Information Sharing
	Confidence
Alliance type	Got Advantage

E-mail and telephone conversations were also used as a means to clarify doubts and supplement data. Data collection was performed between March 2014 and February 2015.

Personal interviews, considered as a vital source of information in case studies, were structured with key informants within each organization (managers), were recorded in order not to lose any information that might be relevant to the work and later transcribed for text editor and spreadsheets.

Tabulation and data analysis

The recorded interviews were transcribed and analyzed with the help of text editors and their analysis was through the content. Attention was paid to the aspects related to the categories, indicators and mechanisms used for technology transfer. Analyzing the content of the interviews, key words were identified and tabulation was repeated in electronic spreadsheets to better understand the results.

V. RESULTS AND DISCUSSIONS

Nature and characteristics of knowledge

Through this research it was verified that the companies of the phytocosmetics segment develop expertise in this types of knowledge: marketing, technicians and scientists. Figure 1 shows that among the marketing knowledge mentioned, we found two companies, one of the organizations declared to work in the development of packaging that aggregate the concept of sustainability and maintenance of the quality of its products, as well as the marketing differentiation. The

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other organization that mentioned marketing knowledge, referred to knowledge related to its public and the square (where it makes its products available for commercialization).

As for technical knowledge, they mentioned the improvement of products and processes and adaptation of machines and equipment to meet their production lines. Product improvement activities usually consist of replacing inputs in production, seeking better stability and product quality. As for the scientific knowledge, they mentioned the search for new techniques of raw material production, development and use of natural dyes.

The development of new products is also mentioned by eight companies, however, some have as a starting point similar products available in the market.

Only one company claimed not to develop any kind of knowledge. He said that the company, located in the DIMPE (Distrito Industrial de Microempresas e Empresas de Pequeno Porte) belongs to a Mexican group, that all processes are developed by the matrix, only produce according to protocols sent to the organization.

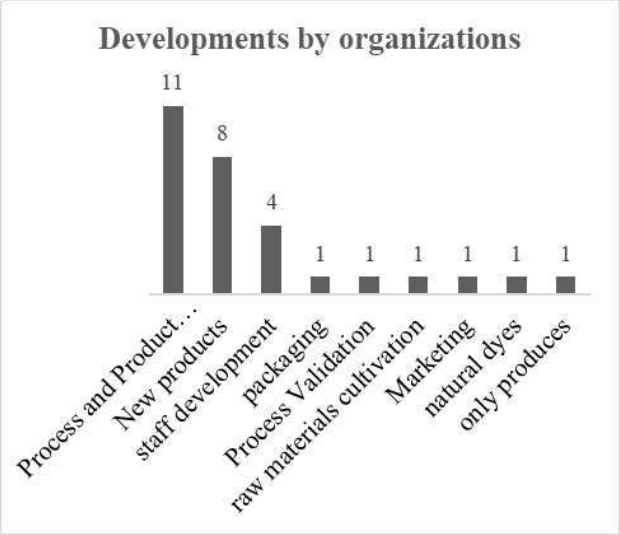

Fig.1: Developments by organizations

The technical procedures related to production are mostly in the coded form. This means that there are production procedures formally elaborated through protocols, a requirement of ANVISA (AGÊNCIA NACIONAL DE VIGILÂNCIA SANITÁRIA). Figure 2 below represents the percentage of companies that reported registering their work knowledge. It was also verified that 62% of the companies declared to have a formal policy of secrecy about their production processes with their employees.

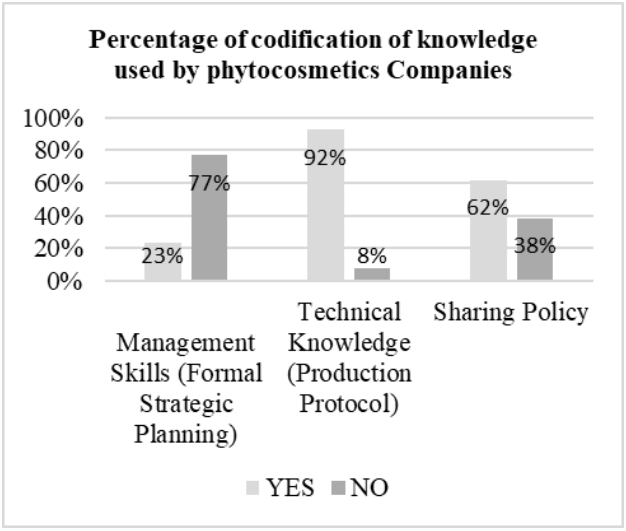

Fig.2: Percentage of codification of knowledge used by phytocosmetics Companies

Regarding the complexity of the knowledge used in the process of production and management of phytocosmetics, only 15% of the companies interviewed declared to be complex. Although its production process is simple, requiring low production technology, approximately five managers mentioned the difficulty encountered in the process of obtaining ANVISA licenses for installation and production of their companies, referring mainly to the bureaucratic process. Still considering the complexity of knowledge required for the production of phytocosmetics, only 23% of the companies interviewed reported on the importance of Biotechnological processes for their production processes, although a greater number recognize the importance of Biotechnology for the "tip" cosmetic segment.

Ability to absorb knowledge

The ability to absorb knowledge is related to the capacity for evaluation that consists of identifying which types of knowledge can be sources of improvement for the organization, how the organization can assimilate the knowledge that is passed on and what is learned, how effectively can apply in the organization. According to the managers' statement, the new knowledge enters their organizations through the process of training the human resource's organization, through the contracting of technical consultancies, through research in partnership with institutions that promote knowledge and in some cases through the acquisition of equipment properly adapted to their needs. Generally receive reports via email about opportunities and if they have interest, seek participation. Almost all cases, the interest came from the managers who went in search of partners to obtain knowledge. Regarding the level of assimilation of

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knowledge, managers stated that in most cases the level of assimilation is very good, but, not always the acquired knowledge is employed in the organization as shown in Figure 3.

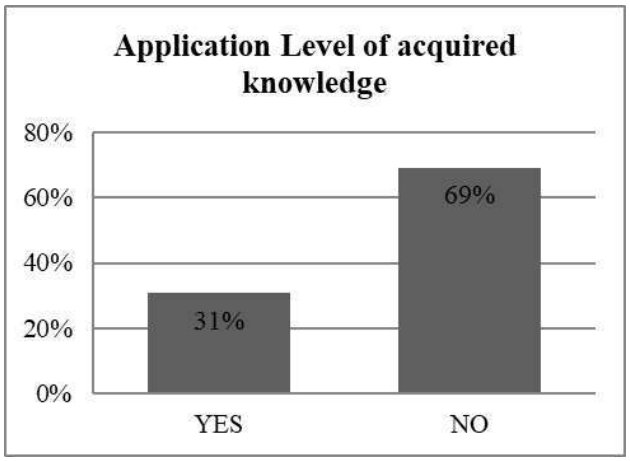

Fig.3: Level of application of knowledge acquired by phytocosmetics companies.

When asked as to the reasons why the rate of full application of knowledge was low, corresponding to only 31% of companies that fully apply the foreground, they replied "the training was far beyond my reality"; "The training was very generalized, could not apply everything"; "Our reality is still very different from the theoretical models presented"; "We do not have sufficient resources for the implementation of the knowledge". These observations may have occurred due to the absence of partners who have exclusive proposals for the phytocosmetics segments or the level of most of the projects currently installed in the State. These observations may have occurred due to the absence of partners who have exclusive proposals for the phytocosmetics segments or the level of most of the projects currently installed in the state.

Partner Behavior

Figure 4 presents aspects related to the perception, behavior of the managers in relation to the partners that the companies have or already possessed. The level of secrecy in the process of sharing information is high in 69% of the companies interviewed. In addition, 62% of them have formal policies for sharing their employees' information with employees of other organizations or third parties.

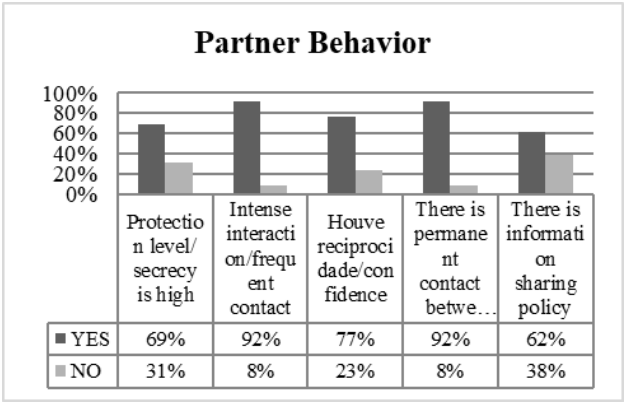

Fig.4: Partner Behavior

During the process implementation, the object development in the partnership, interaction and contact were frequent in 82% of respondents. Reciprocity and trust were high for 77% of the companies interviewed. It was found that managers prefer to develop partnerships with suppliers to companies in the same segment. These partners, in almost all of the interviewees, are chosen according to their reputation in the market.

Types of alliances to transfer knowledge / technologies

It was verified through the interviews with the managers of the phytocosmetics companies that the knowledge-building institutions with which they possessed, or had already owned, a partnership were: Fundação Centro de Análise, Pesquisa e Inovação Tecnológica – FUCAPI; Universidade Federal do Amazonas – UFAM; Instituto Nacional de Pesquisas da Amazônia – INPA e Centro de Biotecnologia da Amazônia – CBA and as shown in Figure 5.

Fundação Centro de Análise, Pesquisa e Inovação Tecnológica – FUCAPI was established in 1982, based on a joint initiative of the Federação das Indústrias do Estado do Amazonas - FIEAM, Centro da Indústria do Estado do Amazonas - CIEAM and Executive Group Interministerial of Components and Materials - Grupo Executivo Interministerial de Componentes e Materiais, linked to the Federal Government. Private institution, non-profit, is focused on the development of research and technological services and increase the competitiveness of companies and organizations in the Amazon region.

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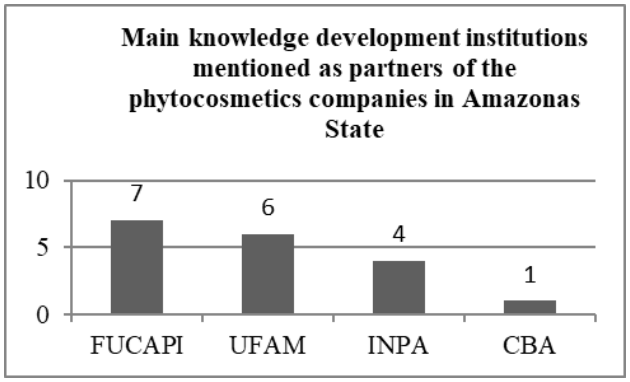

Fig.5: Main knowledge development institutions mentioned as partners of the phytocosmetics companies in Amazonas State.

Develops activities in the educational and technological dimensions, working in the areas of information technology and communication, environmental technologies, basic industrial technology, product technology and management technologies [32]. The managers of the phytocosmetics companies mentioned their partnerships with FUCAPI through technical courses in the cosmetics segment, contracting technical services for laboratory analysis and in the physical and technical support through the Institution's Incubator. According to the interviewees the institution already has a recognition in the market and, faced with the needs found in the market, seek the support of the institution. As for the manager who attended the technical course offered by the institution, he declared that maintains contacts with classmates and some teachers, but no formal contact with the institution. The groundwork process at FUCAPI, according to another manager, was preceded by several phases, to adapt the profile of the enterprise to the services that the incubator would offer.

Universidade Federal do Amazonas – UFAM created in 1909 under the name of Free University School of Manáos, currently has 18 teaching units, between institutes and colleges. It currently offers 96 undergraduate and 39 undergraduate courses accredited by Capes. There are a total of 31 Masters and 8 Doctorate courses. At the *Lato Sensu* postgraduate level, there are more than 30 courses offered annually [33]. Some managers of phytocosmetics companies installed in Amazonas participated in undergraduate and graduate programs at the University. One of the managers is a retired professor and researcher at the institution. It was mentioned as a partner because two companies are looking for improvements in their packaging and in their formulations. The two research cases mentioned by the managers of the phytocosmetics companies together the university were agreed directly with the researchers, where what weighed for the partnership process was the friendship with the researchers. Some managers interviewed recognize the importance of the institution in their business segment, however, they claimed they did not have time to go after partners at the University, besides not knowing who they should or could look for.

Instituto Nacional de Pesquisas da Amazônia – INPA - since its implementation in 1954, INPA has been conducting scientific studies of the physical environment and living conditions of the Amazon region to promote human well-being and regional socioeconomic development. Currently, INPA is a world reference in Tropical Biology [34]. INPA was mentioned as a possible partner by a phytocosmetics company manager who would be interested in non-exclusive licensing of patents that the institute possesses. Due to the change in administration of INPA's technological extension and innovation coordination, the process would be undergoing revision. Another manager mentioned personal contact with an institute researcher who, according to him, gave him guidance on plant species that could be used as a cosmetic.

Centro de Biotecnologia da Amazônia – CBA is a technological center, which was created in 2002, within the scope of the Programa Brasileiro de Ecologia Molecular para o Uso Sustentável da Biodiversidade - PROBEM, with objective of implementing, through technological innovation, conditions for the development or improvement of amazonian biodiversity processes and products, including: Integrated action with the university and public and private sector research centers (Rede de Laboratórios Associados – RLA), Increased technological density in the industrial sector (Parque Bioindustrial na Região Amazônica), Promoting environment favorable to innovation (supply of technological services); development and dissemination of value-added biotechnological products and processes throughout the production chain [35]. The partnership was at an informal level, where there was an exchange of solvent analyzes, items for maintenance of equipment, since the CBA had no legal personality or means for formal agreements.

Informal relations between colleagues facilitate the free exchange of information and consists of a first step of linking institutions to create the confidence necessary for the transferring technology process [14, 21, 36].

Regarding the perception of the interviewees respecting the partnerships held with the institutions that develop knowledge / technologies, only 1 declared dissatisfaction and reported the distrust with the staff of the development institution. Regarding the concern with

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innovation, the managers of the companies surveyed presented as favorable aspects the market demand for products from the Amazon region, as well as the diversity of products that can be offered due to the local biodiversity. The main obstacles mentioned are the dysfunctions of bureaucracy, lack of specific resources for investments and lack of applied research. It was found that the main reasons that led companies to innovate are the need to differentiate products, increase process efficiency and improve sales. They are more concerned with incremental innovation than radical innovation [15, 37]. Despite obstacles and opportunities and different levels of engagement in the innovation process, entrepreneurs consider themselves innovative because they are always in search of "news" to serve their consumers. All the small innovations implemented in the process, in the product, in the management or in the marketing implemented by the managers brought gains of production and productivity, reflecting in increased sales. The greater engagement of managers and / or owners in the development of new products, processes and working methods, the more innovative the company will be [15].

Mechanisms of technology transfer

Table 3, summarizes the main knowledge-development institutions mentioned in the study, the main channels and mechanisms of technology transfer identified and the situation of the partnership.

Table 3 - Partners of phytocosmetics companies and transferring technology mechanisms.

INSTITUTION	CHANNELS	MECHANISMS OF TRANSFERRING TECHNOLOGY	SITUATION OF THE PARTNERSHIP
FUCAPI	Education and training	Qualification of human resources	Formal
	Consultancy / technical services	Analysis services	Formal
	Incubation Center / Parks	Incubation	Formal
UFAM	Joint development contributions of innovations	Research and development	Informal
	Consultancy / Services Technical	Analysis services	Informal
	Education and training	Qualification of human resources	Formal
INPA	Licensing	Non-exclusive patent license	In Analysis
	Contratos de desenvolvimento conjunto de inovações	Research and development	Informal
CBA	Consultancy / Technical Services	Analysis services	Informal

It was verified through the interviews that all the participating companies have some concern regarding the process of qualification of the employees and of the managers themselves. Figure 6 graphically shows the main points addressed by the interviewees. In 10 of the companies interviewed, the main way to remain qualified is through external courses and events (held outside the company). Lectures, fairs and courses of different hours were mentioned. Two managers emphasized that they only participate in courses outside the state, considering them to be of better quality. On-the-job training is the practice adopted by 69% of the companies interviewed. In this modality the training are carried out within the companies themselves, often in the production line itself. As responsible for the application of the training were mentioned that the instructors are the managers themselves, the responsible pharmacists and the more experienced colleagues. It is important to note that only one company uses only the on-the-job training, the others work with a combination of internal and external training techniques.

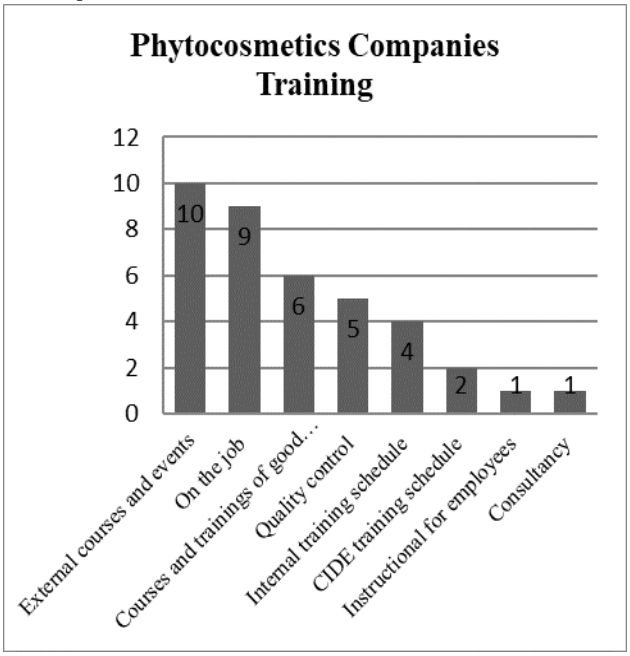

Fig.6: Training in Phytocosmetics Companies

For 46% of the companies interviewed, the training focus is directed to the ANVISA courses of good practices (related to production protocols and manipulation of inputs) and 38% of them reported on the importance of this process for the quality control of their products. Only 6 companies reported having a defined training schedule for the year, the others carry out the process according to the need. Of these companies, 4 have their own schedules and 2 are included in the training schedule of the hatchery to which they are linked. Of the companies interviewed only one declared to carry out training through specialized consultancies and only one declared to encourage employees to seek external courses in the area to qualify, offering as a counterpart the release of the employee to carry out the course. During the interviews, entrepreneurs were asked why they did not strengthen their relations with research and development

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institutions in order to improve their products and make them more competitive in the market. Figure 7 represents the key words mentioned by the managers. It is observed that 07 companies (54% of respondents) stated that research and development are not organizational priorities at this time.

Companies are worried about staying in the market unstable and competitive. The research and development of new products meet the market demand (38% of companies). The contact network of 31% of the interviewed managers are fundamental for the development of their products. They seek partners / acquaintances in the segments required to develop or improve products to obtain information and establish formal partnerships, including hiring laboratories that can develop formulas, test and validate protocols.

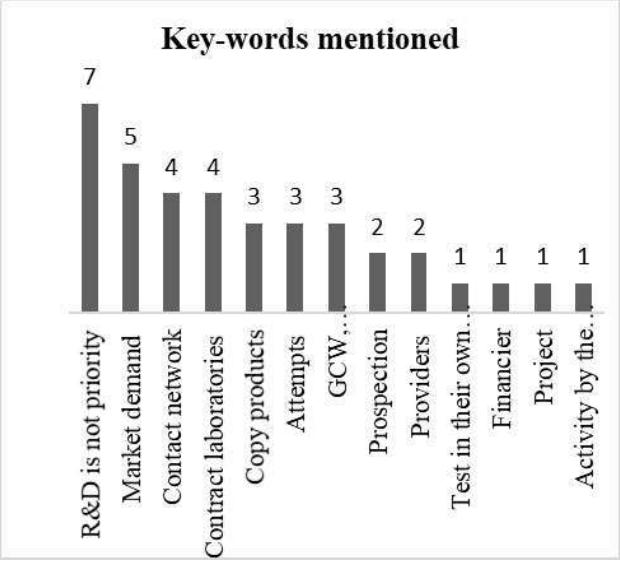

Fig.7 - Main key words mentioned - R & D

For 3 respondents, their organizations search the market for products that have high demand and "copy" them, developing the products through successive attempts until they find a combination that propitiates the commercialization of the product. The technical and scientific prospecting was mentioned by two managers who use a technical and scientific database to seek information that supports the process of developing new products. Two other managers mentioned the role of raw material suppliers in product development. According to them, suppliers inform them of the inputs they have developed or are using and the companies, from there, through trial or hiring laboratories develop or adapt their products. Only one company declared that they design projects, seek funders, and test their products in their own laboratories before sending ANVISA accredited laboratories as a way to reduce costs. One company stated that all research and development activity occurs in the matrix. One of the main factors that the companies researched presented for an investment decision-making process in R & D is capital, as verified by Cribb, (2009). They are concerned with the marketing issues of their products, including looking for new and varied ways of doing business, from traditional practices to e-business via social networks [38].

VI. CONCLUSION

It was found that, in general, there is no defined channel of technology transfer between the knowledge producing institutions and the micro, small and medium sized phytocosmetics companies of the State. Some transferring technology mechanisms used by them have been identified, which are mainly the training of human resources, the provision of technical services, research and development of products or processes that are underway and incubation of companies. It is important to note that most of these mechanisms are still at the level of informality. The relationship is mainly based on the friendship between researchers and entrepreneurs.

Research and development is not a priority issue in the companies studied, but they recognize FUCAPI, UFAM, INPA and CBA as the main research and development institutions in their segments. The companies surveyed carry out partnerships mainly with suppliers that are chosen according to their reputation in the market. The main mechanism for obtaining knowledge is training which is generally assimilated but not incorporated into productive practices. The major knowledge developed by the phytocosmetics companies are in the marketing, technical and scientific areas, which are not always formalized.

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Environmental Education as a Tool for health Assurance on Environmental Jutaí-AM

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Abstract *— Connections between sanitation, public health and environment runs through the environmental knowledge, and provides to the men the understanding of it. Thus, the present study aimed to perform a diagnosis of the current environmental sanitation situation in Jutaí, Amazonas state, as a way of implementing an environmental education program as a tool for Environmental Health assurance in the city. The data were taken in available database of the Brazilian Institute of databases of Geography and Statistics (IBGE), the Ministry of Cities (National Secretariat of Environmental Sanitation) and in information research in municipal administrative sectors bodies. The physical and social characterization of the city was carried out through information provided by municipal administration and government. The guidelines of Environmental Education project will be proposed based on a Participation-Action Proposed Method for the Knowledge Construction - PROPAAC. As results, analysis presented that city water supply is underground, through pipe wells. Moreover, is remarkable that Jutaí has no sewage network. Solid waste gathering covers 90% of the city, held by a pickup truck purchased in 2012 and waste final disposal occurs in the open dumpsite. Thus, was observed that Jutaí is among the worst county of Amazonas state regarding to the sanitation system. Therefore, the effective implementation of environmental sanitation services and investments in environmental education programs in the city are proven necessary.*

Keywords *—* ***Environment. Sanitation. Public health.***

I. INTRODUCTION

The quality of life and health of the human being are closely linked to sanitation, because ineffective implementation of these sanitation systems can cause economic, social and environmental damages [1].

Serious problems such as failure to meet drinking standards, intermittent supply, which consequently jeopardize the quantity and quality of water supplied to the population, as well as deficient collection and inadequate disposal of solid serious environmental problems that directly affect public health [2][3].

By affecting public health, there is an increase in drug costs and hospital admissions. However, when adequate sanitation conditions are in place, the health status of the population is improved, since environmental sanitation has a direct effect in reducing many diseases by breaking the vicious circle established when the patient is medicated and returned to the unhealthy environment [4].

According to the National Health Foundation (2004) "for every R $ 1.00 invested in the sanitation sector, R $ 4.00 is saved in the area of curative medicine." However, what is observed is a mismatch between this information and public policies in Brazil when comes to basic sanitation. Evidence of this is the absence of a general sewage network that until 2008 reached a range of 53% of the population, affecting mainly the health of the population [5].

In this regard, it is possible to affirm that sanitation actions are indispensable for the quality of life, and if we look beyond the material, we will see that these actions are associated with the fundamental rights of human dignity.

Thus, based on discussions of this kind, interest arose for a research that sought unprecedented results of environmental sanitation data in the county, data that can support public policies directed at the quality of life of the people who live there.

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II. ENVIRONMENTAL EDUCATION A TOOL FOR ENVIRONMENTAL SANITATION

In a society at risk, Environmental Education is called to raise awareness about the socio-environmental risks that arise from the relation of man to nature, leading us to believe that it is capable of causing individuals to review their conceptions and habits [6].

Nevertheless, it can be said that Environmental Education is increasingly necessary, since society should not only take the present into account, but rather evaluate their actions so that there will be no consequences in the future, since only then can sustainability prevail. Regard sustainability is measured by the ability to conserve natural capital, allowing natural resources to be refined and even more so that it can be enriched for future generations [7].

Thus, Environmental Education as a tool for environmental sanitation would contribute to the maintenance of sanitation programs proposed by public policies, being an important part of improving the quality of life of our current populations, just as it was important in ancient civilizations.

Looking for a history of the question of sanitation, it is known that in antiquity Greco-Roman civilizations were the first to develop important sanitary criteria for the search of collective health, the Romans were pioneers in sanitation actions reaching a high level of knowledge [8]. However, in the middle ages there was a radical rupture of the man with the knowledge and with industrial growth, the lack of hygienic habits worsened causing a great sanitary regression, resulting in successive epidemics of diseases linked to the lack of sanitation [9].

But only in the last century, that began to have a greater concern with the quality of the water, this based on discoveries that were undertaken by several scientists who showed the relation between the water and the transmission of several diseases [8].

In Brazil the concern is expressed in the Federal Constitution 1988, in which it is mentioned that health is considered a right of all by law and an obligation of the State, and that it is also the responsibility of it to offer the necessary actions so that this right is guaranteed, as well as sanitation actions.

In this sense it is important to clarify that basic sanitation differs from environmental sanitation, since the former includes a set of services, infrastructures and operational facilities for drinking water supply; sewage treatment; urban cleaning and solid waste management to drainage and urban storm water management. Whereas environmental sanitation goes further, it encompasses the set of technical and socioeconomic public health actions, aiming to achieve increasing levels of environmental sanitation, where it is comprised by the adequate supply within the standards of potability, sanitary sewage, solid waste, atmospheric emissions, rainwater, vector environmental control, environmental control of land use and occupation, control and preventions of the excessive noise and even hygienic behavior that reduces disease risks and prevents contamination, with the purpose of promoting the improvement of the population's living conditions [10-12].

Thus, it can be affirmed that basic sanitation is inseparable from the concept of health, since it promotes preventive public health and consequently reduces the need for hospital search, because of less chances of contagion by various diseases [8].

III. METHODOLOGY

3.1. STUDY AREA

The research was carried out in the county of Jutaí, which is located in the Southwest region of the State of Amazonas, in the Northern region of Brazil, the county extends for 69,457,415 km², located at 99 meters of altitude, with the geographical coordinates of the county Latitude : 02 ° 44 '49' 'South Longitude: 66 ° 46' 01 " West, with an estimated population of 17,964 inhabitants, with an HDI of 0.516 [13]. Just below (figure 1) it is possible to observe the location map of the county under study.

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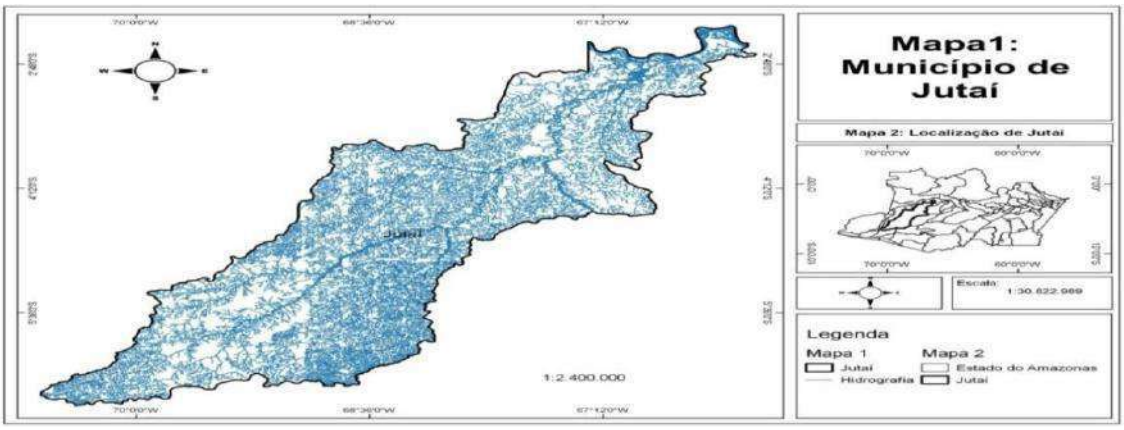

Fig.1- Location Map of the County of Jutaí- AM.
Source: Authors, (2019).

3.2. INFORMATION'S BASE AND DATA COLLECTION

The methodology of [14], with direct observation (direct observation in loco) and indirect observation (documentary research and bibliographic research) was used to carry out the physical and social characterization and diagnosis of environmental sanitation in the county.

The data collected for the elaboration of the physical and social characterization of Jutaí-Am were based on information provided by the municipal administration and government of the county, such as: Municipal Secretary of Environment, Municipal Secretary of Education, Regional Education Coordination, Municipal Secretary Health Unit, Hospital Unit and Health Surveillance Foundation. Bibliographical research and virtual information were also carried out on databases of reference sites, such as the Brazilian Institute of Geography and Statistics - IBGE and the Health Information Book of Amazonas - Ministry of Health.

The data collection for the elaboration of the diagnosis of the county was carried out considering a detail of the public services of basic sanitation, as foreseen by the Federal Law nº 11.445 of 2007 and survey of the health services.

In this way, we tried to structure the diagnosis of this county based on the information provided by the municipal administration and government as well as the information collected in the databases of the Brazilian Institute of Geography and Statistics [13] as it will be presented:

- Water Supply and Sanitary Sewage Services: the information was provided by the Municipal Water Department, the body responsible for water supply in the county; Secretary of Environment, Secretary of Infrastructure, responsible for the components of Municipal Sanitary Sewage.
- Drainage and Rainwater Management Services: these data were obtained from the Secretary of the Environment and the Infrastructure Secretary.
- Urban Cleaning and Solid Waste Management: these data were collected through the Secretary of the Environment, which works along with the Infrastructure Secretary. All this information was confronted by data obtained by IBGE.
- Health Services: Health Department of the county.

The information provided by the municipal administration and government was collected through on-site visits through photographic records of the study system, document collection, interviews and semi-structured questionnaires carrying the representatives of the administration and government, backed by the Term of Free Clarification signed by each representative of the systems already mentioned.

The methodology of [15], which proposes a method based on the Proposal of Participation-Action for the Construction of Knowledge (PROPAAC), was developed after the study of the results obtained in this research).

IV. RESULTS AND DISCUSSION

4.1. PHYSICAL AND SOCIAL CHARACTERIZATION OF THE MUNICIPALITY OF JUTAÍ-AM

The county of Jutaí is bordered by the counties of Juruá, Fonte Boa, Carauari, Eirunepé, Itamarati, Benjamin Constante, Santo Antônio do Içá, Amaturá, São Paulo de Olivença and Tocantins. It has a rainy and humid tropical climate which is a characteristic that dominates the Amazon region, hydrographically speaking the county belongs to the Alto Solimões basin [10].

Regard to the local development, we can highlight the vegetal extractivism, which is known as the

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main economic activity absorbing large plots of local labor and characterized as a traditional activity, where the wood explorations stand out, contributing to the formation of income and generating foreign exchange for the county. In the county has pottery, bakeries, carpentry, mechanical workshops, pharmacies, hairdressers, seamstresses and restaurants among others. The following tourist activities that stand out in the county: Jutaiense Carnival with traditional Block "The Bacabeiros"; Festival of the Sardine, futsal championships, handball and field soccer and as a tradition the celebration of the festivities in honor of São José Operário patron of the county [10].

According to information provided by the Municipal Department of Environment, the county's headquarters is located on the right bank of the Solimões River, located on solid ground, with flat topography, the infrastructure of the municipality is still precarious, the streets are not all paved, there is no urban transport services (buses), but it has electricity service, fixed and mobile telephony and local radio station.

The county has a (01) Police Station, where there are a (01) Civil Delegate and twelve (12) Military Police Officers. The county has approximately twenty medium-sized commercial establishments and seventy small establishments, three banking correspondents, four hotels and some pensions, as well as restaurants and snack bars.

When it comes to Education, Jutaí has 06 Municipal Schools in the urban zone and 106 Municipal Schools in the rural area, which only offer basic education and early childhood education. For the educational complementation, the county counts on 03 State Schools in the headquarters and 01 in the rural zone that work with the secondary education and elementary school, all the schools added a total of 551 teachers in the year 2015. From the analysis of the data 1), there is an increase in the number of students graduating in the last 5 years in the Municipal Education Network, with a low drop in the number of graduates only in the year 2012 compared to the year 2011. While in the State Network, a decrease over the years equivalent to 15.51% in the year 2015 compared to the year 2011, this was due to questions of tuition adjustments and transfers of students to other municipalities.

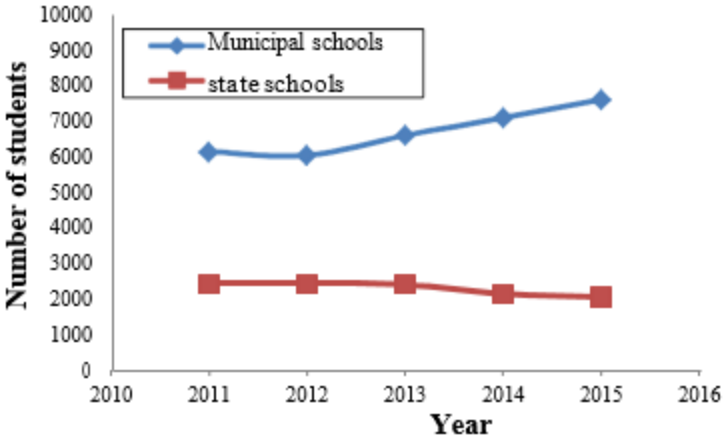

Fig.2: Graph - Number of Final Students 2011 to 2015.
Source: Authors, (2015).

4.2 DIAGNOSIS OF ENVIRONMENTAL SANITATION IN THE MUNICIPALITY OF JUTAÍ-AM

In the case of environmental sanitation in the county of Jutaí, according to [13] the sanitation system is divided into adequate, semi-adequate and inadequate, in which the surveys carried out in the databases between 2000 and 2010 showed that in the county of Jutaí in 2000, only 07 of the 3,165 households had an adequate sanitation system, 902 households had a semi-adequate sanitation system and 2,260 homes with inadequate sanitation. Studies carried out in 2010 show that there was a small increase that indicates approximately 10 houses with adequate sanitation system, an increase was obtained indicating 1,91 residences with semi adequate and inadequate sanitation.

Observing these data it is possible to affirm that the county under study is among the worst counties in terms of adequacy in the sanitation system, so it is possible to affirm the absence of policies regarding

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sanitation in the county. Corroborating this information, the [12][16] name the lack of sanitation in the counties of the State of Amazonas, in which it highlights the proportion of counties with sewage treatment of less than 10%, in which the state of Amazonas presented (4.8%).

In relation to the services of water supply in the county, the system of abstraction of water is underground, realized through tubular wells. According to data provided by the Municipal Environment Secretariat, the wells are divided according to table 1:

Table 1- Tubular wells in the county of Jutaí-AM.

Wells	SECTOR / IGHBORHOOD	HOUSES SUPPLIED
I	center	358
II	Good pastor	320
III	Block of Sand	249
IV	Beira Rio	160
V	San Francisco	110
VI	PX. Hospital	210
VII	Saint Peter	380
VIII	Saint José	290
Total		**2.077**

Source: Municipal Environment Secretariat, (2016).

The total number of homes supplied according to data provided by the Municipal Department of the Environment was 2,077 households, but the last [13] states that the total number of homes supplied by the general network was 1,991 households and that the number total of permanent private households in the municipality is 3,165. There was a discrepancy between the data on water supply provided by The Secretary and the data available at the IBGE, with the conclusion that The Secretary does not have effective control of the number of houses receiving water. Additionally, it is verified that approximately 70% of the households are supplied by the general network while the others are supplied by other sectors as shown in figure 3, according to IBGE data.

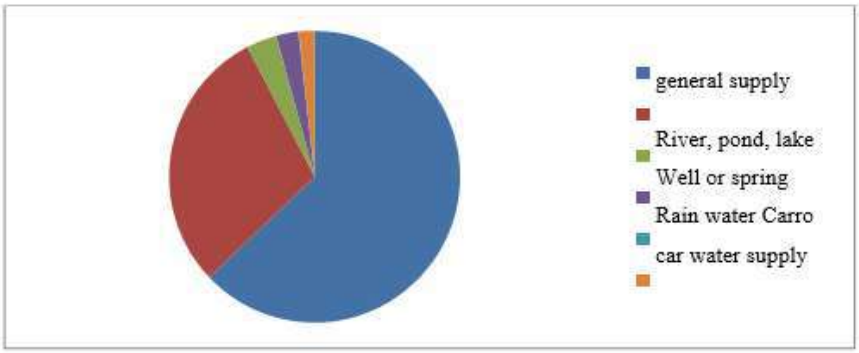

Fig.3: Chart: Sources of water supply.
Source: IBGE, (2010).

According to the county's water department, there is no continuous monitoring of potable water standards distributed to the population, since some of the wells that supply are operating for more than 30 years. A worrying fact is the inexistence of the charge for this service since the year 2002, since it is believed that if there was a charge, many problems would be alleviated, after all, to maintain this type of service is expensive and what is observed is that the city hall alone can not afford those expenses, which makes the service inefficient.

Data from the [17] confirm that the water from the county's tubular wells is being distributed to the population with a demand of approximately 3,548 cubic meters per day without any type of treatment. This contradicts the information of the Department of water of the county, which ensures that there is a simple

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disinfection by chlorine in the water distributed. This makes us worried about the health of the Jutaian population, since untreated water directly implies obtaining waterborne diseases, which is confirmed by the information of Brazil [19][20].

According to the [18], in the Amazon, only 17 municipalities have satisfactory water supply conditions to meet future demands; about the others, the investments for the necessary works result in approximately R $ 823.2 million in all the state.

In this way, the distribution of water with adequate quality and quantity for the population consists of the basic sanitation basic procedure, since it ensures the health and well-being of a society.

According to information from the Municipal Environment Department, reinforced with data from the [17], they affirm that in Jutaí there is no sanitary sewage network, a scenario faced by most of the cities of the state of Amazonas, a statement supported by information from the [18], which states that only 11 of the 62 counties in the state have the sewage collection system.

Data from the [13] indicate that permanent private households have bathrooms or toilets, according to Federation Units, Figure 4 shows which depletion systems are used in the urban and rural areas in the county.

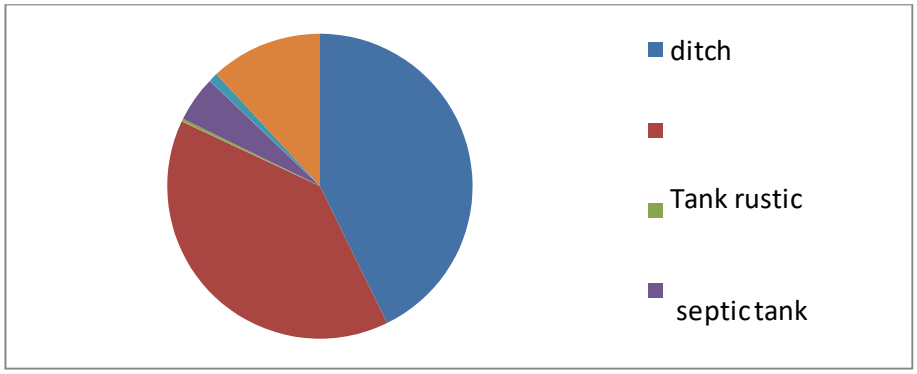

Fig.4: Graph:- Exhaust systems used in the municipality of Jutaí-AM.

Source: IBGE, (2010**).**

Based on the above data, it can be observed that 75.64% of the population use these alternatives of sanitary sewage, since the study area does not have a network of exhaustion. Because they contaminate groundwater, representing a high risk of disease spread, especially when installed in the vicinity of tubular wells.

The [18] indicates a vacuum in terms of improvements in the sanitary sewage service, where it is possible to observe the lack of this service in much of the North Region, highlighting the city of Manaus in Amazonas.

It is observed that the lack of sanitary sewage networks is a reality that affects every country, especially the county of the State of Amazonas as is the case of Jutaí. The treatment of sewage is aimed at improving local sanitary conditions, reducing pollution and contamination foci, conserving natural resources, reducing diseases caused by water contaminated by waste, reducing significantly the resources used to treat diseases, which are related to the lack of an efficient solution of a sanitary sewage, among others [22].

In relation to urban drainage and storm water management services, it is a system that comprises a series of measures aimed at minimizing risks to the population, aiming to reduce damages caused by floods, especially in lower areas prone to flooding, enabling urban development in a harmonious and sustainable way.

According to the [17], the drainage and management of rainwater in the county of Jutaí is absent in the types of collection networks (separator, unitary or mixed). The management of this service is carried out by the municipal city hall, through the infrastructure secretariat, in which according to the responsible agency, the coverage of urban drainage systems is 50%.

According to the [18] in the state of Amazonas, only 22 counties have an urban drainage system, which is aggravating problems with flooding from unnatural causes. On the other hand, the IBGE warns that 40.8% of the counties in the country had numerous problems due to large floods, and that in Amazonas these cases are more serious, due to the counties being the banks of the rivers of the region.

Flooded environments are conducive to proliferation of vectors and venomous animals (rats, snakes, mosquitoes) because they find shelter and food due to inadequately disposed residues on the site, which increases the

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possibility of disease transmission.

Regarding urban cleaning and waste management, it was verified that the final disposal of solid wastes is a visible problem in the county of Jutaí, according to information from the Municipal Environment Department, the county has a coverage of 90% of the collection system of solid waste, carried out by a truck collector acquired in the year 2012 and a bucket, in which the final disposal of this waste is in open dump, this without any previous treatment, the county does not have selective collection and the management model used is of direct public administration. In relation to the public cleaning it was verified that the service is not charged and the quality of this cleaning service is monitored by means of rounds with motorcycles and also by denunciations of the population.

However, when we talk about coverage of the waste collection system, the Brazilian Institute of [13], contradicts the information provided by the municipal environment secretary stating that in Jutaí the coverage of this service is 11.98% in relation to households, that is, 379 households, the others use their waste as shown in figure 5.

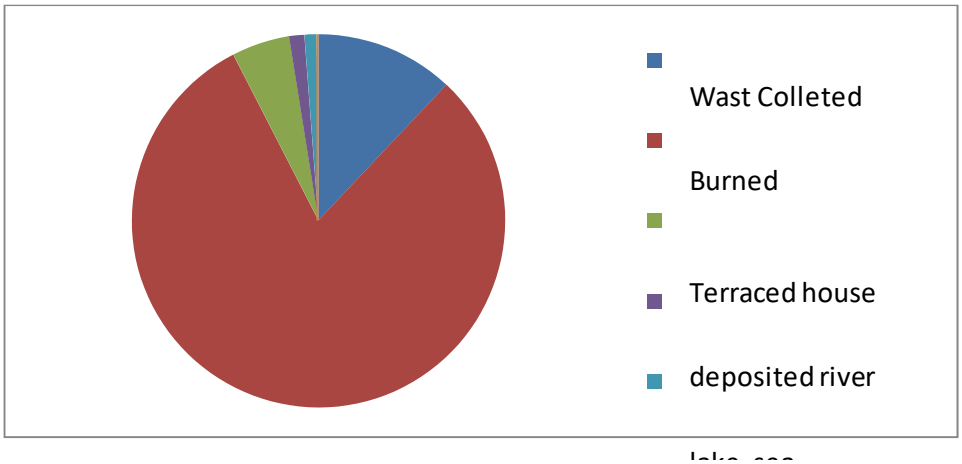

Fig.5: Graph: Destination of Waste.

Source: IBGE, (2010).

Faced with this, we can see a great deficiency in urban cleaning services, the curious thing to note is that there is no collection of values for this service, the same happens with the water supply system, which makes us rethink about the municipal administration model, since the collection of taxes, in a fair way is necessary in some cases, so that there is implantation and maintenance of these types of services that imply directly in the social welfare. On the other hand, it is inferred that as the city has chosen not to charge these services, which at least makes them available to the population.

The current condition of the final disposal of the waste in the county, which is in the open dump (figure 6), can not be underscored. In this dump operated by the Municipal Government, all types of which represent a high risk for both the environment and the population.

Fig.6: Open dump in the county.

Source: Municipal Environment Secretary (2016).

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When waste is improperly disposed of in landfills, for example, sanitary and environmental problems are unavoidable, because these sites become suitable for vectors of various diseases, this type of situation is also responsible for pollution of the air, caused by the burning of residues, soil and both surface and underground water contaminated mainly by manure, so that the more adequate and efficient the final disposal of waste, the lower the impacts on the health of the population and the environment [9].

Within this context, it was observed that in the area of Health the county presents a negative factor in relation to the Information System on Agravos, which is a system that stores information on the number of cases of diseases and deaths occurred in the county and administered by the Municipal Health Department, which only started to be fed in 2014, regarding the cases of diarrhea the system indicated the number of 3,375 cases and only 02 cases of deaths registered in the year 2014, already in 2015 was possible to note an increase of 35.64%, that is, 5,244 case numbers and 03 recorded deaths, which leads us to inquire about the quality of the water offered to the population, since this disease is waterborne.

Some diseases are transmitted by insects, called vectors that relate to water, as species that transmit filariasis (etiological agent Wuchereriabancroftie vector Culexquinquefasciatus), malaria (etiological agent Plasmodium spp. And vector Anopheles spp.), Yellow fever (etiological agent Flavivirus e Aedes aegypti vector and Haemagogus genus), leishmaniasis (etiological agent Leishmania spp. and Lutzomyialongipalpis vector), among other diseases.

The Health Surveillance Foundation registered in the county between 2010 and 2015 a total of 624 cases of filariasis, which in Brazil is known as elephantiasis, is a parasitic disease, caused by three species of nematode worms, which affects only the and is not contagious.

Jutaí presented between the years 2010 to 2015 the number of 6,837 cases of malaria, among which 5,719 are of the species *Plasmodium vivax*, which in turn is more frequent and the only one capable of surviving long winters, 1,093 is of the species *Plasmodium falciparun* that is is a species associated with more severe forms and finally there may be the possibility of transmission of these two species at the same time *P. vivax P. falciparun* which is rare, which sum a total of 25 cases, as we can see in figure 7.

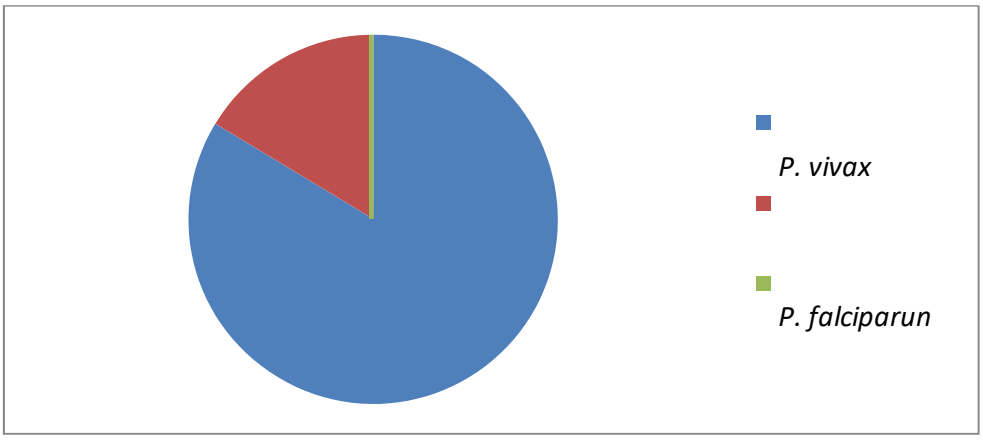

Fig.7: Graph: Number of malaria cases in the county of Jutaí-AM.

Source: IBGE, (2010).

According to the health department of the municipality in the last 6 years no case of yellow fever and only 4 cases of leishmaniasis were found. It is important to note that none of the health-oriented agencies knew how to report any deaths in the last six years due to insect-borne diseases.

The mosquito Aedes Aegypti has been the focus of research, according to [5], one of the main reasons for the proliferation of this mosquito. is the lack of investments in basic sanitation. However, according to the Health Surveillance Foundation, the county of Jutaí does not currently have this transmission vector, which generates a relief for the Jutaian population, since this disease has caused dread in the population of numerous Brazilian cities.

4.3 PROPOSAL OF ENVIRONMENTAL EDUCATION PROJECT FOR THE COUNTY OF JUTAÍ

4.3.1 PROPOSAL SUMMARY

Environmental education is concerned with educating citizens who are aware and concerned about the

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environment and the problems that affect them, in order to bring the population closer to the environmental reality so that they realize that the health of the environment is the responsibility of all. The environmental education project proposal of the present research is aimed at the formal and informal education of the county of Jutaí, where it contemplates the school, labor and community, having support to the current conservationist and environmental management.

4.3.2 PURPOSE OF THE PROJECT PROPOSAL

To suggest to the public administration a possible implementation of the Environmental Education project so that it can sensitize the population in relation to the importance of Environmental Sanitation and how the behavior change can help in the quality of life and in the maintenance of this sanitation system.

4.3.3 METHODOLOGY

The methodological approach will be based on the Proposal for Participation-Action for Knowledge Building (PROPAAC) [15], which consists of a matrix methodology that leads to the application, elaboration, analysis, reconstruction, based on a dynamics of construction, in order to obtain a critical and comprehensive understanding of environmental systems.

4.3.4 PROPOSALS FOR THE APPLICATION OF PROPAAC

The Propaac methodology can be applied in a training module of Environmental Education multipliers, consisting of a process of collective elaboration and re-elaboration of six matrices.

Matrix 1- Identification of socio-environmental problems. This matrix makes it possible to analyze and diagnose problematic environmental situations at the global, national, regional and local levels.

Matrix 2 - Potentialities of the environment and sustainable development. Identification of environmental potential at different levels.

Matrix 3 - Matrix of establishment of the interrelations of the problems identified.

Matrix 4 - Selection of problems and possible solutions. Evaluation of defined solution strategies

Matrix 5 - Curriculum Matrix, to identify community or school Environmental Education activities to help solve problems.

Matrix 6 - Curriculum Matrix for educational and methodological planning to implement Environmental Education activities to be carried out.

V. RESULTS TO BE ACHIEVED

It is hoped that this proposal will create subsidies to aggregate knowledge, ethical values, strengthen the relationship between education and reality, and promote the adoption of compatible ways of life with the conservation, preservation, prevention and minimization of environmental problems in the county of JUTAÍ.

VI. CONCLUSION

It was concluded that there is a need for efficient implamentation of environmental sanitation services in the county under study, in order to promote monitoring and continuity, especially in public policies that can contemplate this type of service independent of the current government. it is also necessary to invest in environmental education programs so that the population is aware of the problems involved in the county.

in this way, the quest for the health of the environment must be continuous, so that society can not be excluded from its responsibilities towards the environment, since such a process is substantial to build sustainability and improvements in public health of the population. municipality of JUTAÍ.

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The Impact that Fringe Benefits have on Job Satisfaction and Employee Engagement at Sinapi Aba Savings and Loans Limited (SASL)

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Abstract— *The study investigates the impact that fringe benefits have on job satisfaction and employee engagement at Sinapi Aba Savings and Loans Limited (SASL).Specifically, the study was to determine the impact of fringe benefits on employee engagement, to determine the impact of fringe benefits on job satisfaction and to gain better knowledge of the structuring of remuneration packages. The sample consisted of ten (10) branches of Sinapi Aba Savings and Loans Limited (SASL) representing 20.83% of the research branches. 300 questionnaires were distributed, 270 questionnaires were filled and returned for analysis which represents 90% of response rate of the sampled research population. The study employed descriptive statistics method for presenting and summarizing bio-data. The researcher also analysed collected data using Statistical Program for Social Sciences (SPSS) version 25. Statistical instrument used for the research analysis were inferential statistics, specifically multiple regression.*

The study showed that fringe benefits significantly influence Employees Engagement (EE) and Job Satisfaction (JS) at Sinapi Aba Savings and Loans Limited (SASL). The findings indicated that, among the four indicators of fringe benefits used as independent variables (Medical aid contribution, Accommodation allowance and Educational assistance) were statistically significant in predicting employee's engagement at (SASL). The study also indicated that, (Medical aid contribution, Accommodation allowance and Vehicle allowance) were statistically significant in predicting job satisfaction at (SASL). This study then recommend that management should add these indicators of fringe benefits in their employee's compensation plan in order to retain their loyal employees and increase organisation's productivity.

Keywords— employee engagement, fringe benefits, job satisfaction, remuneration.

I. INTRODUCTION

Every organization aim is to meet its objectives, one of the ways in which organizations can achieve their goals is when their employees are satisfied and engaged at work place. But the question is, how will organizational human resource department strive to ensure that their employees are satisfied and engaged at work place? Companies have not yet grasped that information from lower levels can be sought on how the employees feel about the leaders, the working environment, their benefits and developments, their feelings about coming to work and whether they love their job and are willing to go an extra mile to see their companies grow which in effect will keep them a step ahead of their competitors. Milkovitch and Newman (2004) believe there still some debate over fringe benefits on whether they facilitate in employee productivity leading to organizational performance and do benefits impact on an organization's ability to attract, retain and motivate employees leading to productivity and improved organizations' performance.

Companies tend to expect maximum employee productivity after recruiting an employee. The problem arises when the employees, at a certain point in time start looking for other opportunities and their job satisfaction and engagement start to depreciate therefore, it is useful for management of an organisation of which Sinapi Aba Savings and Loans Limited (SASL) is no exception, to understand which job characteristics and provisions increase job satisfaction and employee's engagement at the work place. This paper thus seeks to investigate the impact of the fringe benefits on job satisfaction and

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employee engagement. Specifically, the study was to determine the impact of fringe benefits on employee engagement, to determine the impact of fringe benefits on job satisfaction and to gain better knowledge of the structuring of remuneration packages. The study aims to answer the following research questions: What is the impact of fringe benefits on employee engagement? How does fringe benefits impact job satisfaction? What is the remuneration packages structure? The research will help the managers of an organisation to find answers to the fundamental question of why employees stay and what would cause them to leave and to help the organisations formulate appropriate retention policies and strategies to enhance employee engagement and job satisfaction in the company.

II. LITERATURE REVIEW

2.1 Fringe Benefits

Bratton and Gold (2009) define fringe benefit as that part of the total reward package provided to employees in addition to base or performance pay. In the views of Mathis and Jackson (2003), fringe benefits are forms of indirect compensation given to an employee or group of employees as a part of organizational membership.Fringe benefits, or that part of the total compensation package other than pay for time worked provided to employees in whole or in part by employer payments, play a major role in the structuring of compensation packages (Williams, 1995:1097). According toBernardin (2007) fringe benefits focus on maintaining (or improving) the quality of life for employees and providing a level of protection and financial security for workers and for their family members. Like base pay plans, the major objective for most organizational fringe compensation programs is to attract, retain and motivate qualified, competent employees. Mathis and Jackson (2003) believe that an employer that provides a more attractive benefits package often enjoys an advantage over other employers in hiring and retaining qualified employees when the competing firms offered similar base pay.

2.2 Job Satisfaction (JS)

Employees are the key resources in every organization through which all the other objectives of the organisation are achieved. Hospital staffs are the employees of the hospital and their job satisfaction promotes good health care. Employees will demonstrate pleasurable positive attitudes when they are satisfied with their job. Millan, Hessels, Thurik and Aguado (2013).

Spector (1985) suggested that job satisfaction is influenced by both intrinsic and extrinsic needs. Therefore, the level of job satisfaction in both organizations is dependent on the linking of individual needs and the rewards offered by the organizations to satisfy those needs. (Spector, 1985) Job Satisfaction Survey was designed to measure job satisfaction based on nine facets of employee attitudes, includingpay, promotion, supervision, fringe benefits, contingent rewards, operating procedures, co-workers, nature of work, and communication.

According to Simatwa (2011) job satisfaction means a function, which is positively related to the degree to which one's personal needs are fulfilled in the job situation. Kuria (2011) however argues that employees are the most satisfied and highly productive when their job offers them security from economic strain, recognition of their effort clean policy of grievances, opportunity to contribute ideas and suggestions, participation in decision making and managing the affairs, clean definitions of duties and responsibilities and opportunities for promotion, fringe benefits, sound payment structure, incentive plans and profit sharing activities, health and safety measures, social security, compensation, communication, communication system and finally, atmosphere of mutual trust respect. In the view of Simatwa, (2011) job satisfaction means pleasurable emotional state of feeling that results from performance of work.According to Davis (1992), the factors that have an impact on job satisfaction are: the structure of rewards offered, surroundings of workplace and family responsibilities of an employee.

2.3 Employee engagements (EE)

Schaufeli et al. (2002), defined engagement as a persistent and positive affective – motivational state of fulfilment in employees, characterized by vigour, dedication and absorption. According to Kahn (1990) when people are engaged, they tend to express themselves physically, cognitively and emotionally during role performances.

Kahn the founder of the employee engagement movement (as cited in Bedarkar & Pandita, 2014; Kataria, Rastogi, & Garg, 2013) described engagement as the harnessing of organization members' selves to their work roles: in engagement, people employ and express themselves physically, cognitively, emotionally, and mentally during task performance (Schaufeli, 2012).

Charith (2015) believes that employee engagement is the key to human capital management because it focuses on managing employees to produce for the organization rather than focusing on what the

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organization does for the employees. Schneider et al. (2009) asserts that employee engagement is different from employee satisfaction with the latter connoting satiation and the former connoting energy. An engaged employee is aware of business context, and works with colleagues to improve performance within the job for the benefit of the organization. They added that, the organization must work to develop and nurture engagement, which requires a two-way relationship between employer and employee. Therefore, employee engagement will be the barometer that determines the association of a person with the organization as asserted by Vazirani (2007).

2.4 GapAnalysis of impact of fringe benefits on employee's engagement and job satisfaction

Many researches have been made recently on the impact of fringe benefits on employee engagement and job satisfaction. Over the past four decades, economists have given job satisfaction and engagement increasing attention. Job satisfaction is negatively related to job turnover (Freeman, 1978, McEvoy and Cascio, 1985, Akerlof et al., 1988, Weiss, 1984), absenteeism (Clegg, 1983), and positively related to productivity (Mangione and Quinn, 1975). Therefore, it is useful to understand which job characteristics and provisions increase job satisfaction and employee engagement. Fringe benefits have merely acted as controls in most studies and not as the primary subject of scrutiny. Indeed, more than one or two measures of fringe benefits are rarely found as independent variables in job satisfaction and employee engagement studies. Rather, pensions often act as the predominant proxy for fringe benefit provision within the job satisfaction and employee engagement literature and consequently the estimated impact of fringe benefits on job satisfaction and engagement.Artz (2008) uses the Working in Britain 2000 dataset and finds that pensions have no significant impact on job satisfaction.Donohue and Heywood (2004) find a similar result in the tenth wave of the National Longitudinal Survey (NLS) regarding employer-provided retirement plans. A. STEYN (2010) also finds that fringe benefits showed a low practically significant with employee engagement.

In another study, Chukwudumebi and Kifordu 2018) concluded that fringe benefits play a vital role in the level of employees" morale and productivity of companies and there is an association between fringe benefits and welfare matters. These researchers (Artz (2008) andDonohue and Heywood (2004) studies analysed only pensions as part of fringe benefits impact on employee's job satisfaction. Again, the study by A. STEYN (2010) and Chukkudumebi and Kifordu (2018) also did not indicate which variable of fringe benefits have low practical significance with employee engagement and which variable of fringe benefits also play a vital role in the level of employee's morale and productivity of companies respectively. Meanwhile, fringe benefits include several variables. Through this research, an effort has been made to analyse different variables of fringe benefits impact on job satisfaction and employee'sengagement. This research has been made for the Sinapi Aba Savings and Loans Limited (SASL) within Ghana and has analysed which variable of the fringe benefits among the four(medical aid contribution, accommodation allowance, vehicle allowance and educational assistance)appears to have an impact on job satisfaction and employee's engagement and should be made the part of employee's compensation plan in order to attract and retain employees in the organisation.

III. METHODOLOGY

According to the research objectives a descriptive research design was adopted and structured questionnaire was developed for data collection. According to Mugenda & Mugenda (2003), descriptive survey design helps a researcher to gather, summarize, present and interpret information for the purpose of clarification. The researcher has used both the primary and the secondary data for the purpose of this study. Secondary data were collected from available books, publications, research studies, articles and websites. The studyemployedsimple random sampling to ensure that all employees stand equal chance of being selected to avoid sample bias and ensure that theresults are reliable enough to be generalized. The sample consisted of ten (10) branches of Sinapi Aba Savings and Loans Limited (SASL) representing 20.83% of the research branches. 300 questionnaires were distributed, 270 questionnaires were filled and returned for analysis which represents 90% of response rate of the sampled research population. Items in the questionnaire were measured using a five-point Likert Scale, with 1= strongly disagree 2= disagree 3= uncertain 4= agree and 5 = strongly agree.

The researcher analysed collected data using Statistical Program for Social Sciences (SPSS) version 25. Descriptive statistics such as mean, standard deviations, percentages and frequency distributions was used to generate meaning from the data in relation to the research objective. Statistical instrument used to test the relationship between fringe benefits (medical aid contribution, accommodation allowance, vehicle allowance and educational assistance) and job satisfaction as well as employee engagement were inferential statistics, specifically multiple regression analysis.

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3.1. Conceptual Framework

This research showed the impact of fringe benefits variables on job satisfaction and employee engagement which can be gauged through various variables used as independent variables in this research: Medical aid contribution, accommodation allowance, vehicle allowance, educational assistance and as well as remuneration whereby employee engagement and job satisfaction were treated as the dependent variables for the research. A typical conceptual framework has been developed which is the proposed theoretical framework to test the impact of fringe benefits on employee engagement (EE) and job satisfaction (JS).(Please see Fig. 1 below) .

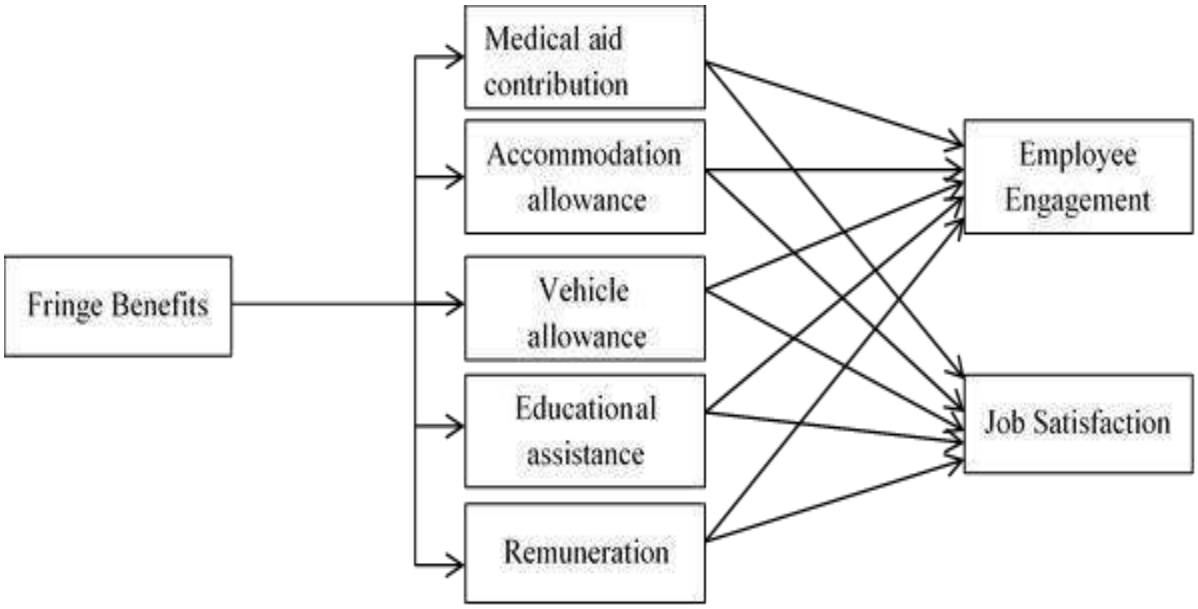

Fig. 1. Proposed theoretical framework to test the impact of fringe benefits on job satisfaction (JS) and employee engagement (EE).

3.2 Variables

3.2.2 Dependent Variables

Employees Engagement: Employee engagement is the key to human capital management because it focuses on managing employees to produce for the organisation rather than focusing on what the organisation does for the employees.

Job Satisfaction: Job satisfaction refers to the level of fulfilment employees experience from their occupations and associations.

3.2.3 Independent Variables

Medical Aid Contribution: This includes the contribution that the employer pays on behalf of the employee for the medical aid cover of the employee as well as his immediate family members that are also covered by this medical aid cover.

Accommodation Allowance: This includes the cash component that the employee receives for the purpose of contributing to the rental of suitable accommodation, or the contribution to paying for his own accommodation.

Vehicle Allowance: This includes the benefit to the employee of a cash component in his salary for the purpose of buying and maintaining a vehicle suitable for performing his duties, or the use of a company vehicle that would assist him in performing his duties, or the use of a pool vehicle that would assist him in performing his duties.

Educational Assistance: Educational assistance is one of the few fringe benefits giving by an employer to assist employee to upgrade himself or assist an immediate family member of an employee, which is not subject to income tax, payroll taxes or unemployment taxes.

Remuneration: Remuneration is any type of compensation or payment that an individual or employee receives as payment for their services or the work that they do for an organization or company. It includes whatever base salary an employee receives, along with other forms of payment that accrue during the course of their work, which includes expense account funds, bonuses, and stock options.

3.2.4 The Total Reward Model

In the view of Armstrong (2006) total reward describes a reward strategy that brings components such as learning and development together with aspects of the work environment, into the benefits package. In the total reward system, both tangible and intangible rewards are

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considered valuable. Tangible rewards arise from transactions between the employer and employee and include rewards such as pay, personal bonuses and other benefits. Intangible rewards have to do with learning, development and work experience. Examples of these types of rewards are opportunity to develop, recognition from the employer and colleagues, personal achievement and social life. The aim of total reward is to maximize the positive impact that a wide range of rewards can have on motivation, job engagement and organizational commitments. The components of the total reward can be described**(please see fig.2 below).**

Fig. 2 total reward

3.2.5 Hypothesis Testing for the Study

Fringe Benefits of the study ((Medical aid contribution, accommodation allowance, vehicle allowance, and educational assistance).

H1a: Fringe benefits significantly influence Employee Engagement (EE).

H1b: Fringe benefits significantly influence Job Satisfaction (JS).

H2a: Remuneration significantly influences Employee Engagement (EE).

H2b: Remuneration significantly influences Job Satisfaction (JS).

H3: Job satisfaction significantly influences Employee Engagement (EE).

Validity and Reliability

5.1 Validity

Validity estimates how accurately the data obtained in the study represents a given variable or construct in the study (Mugenda, 2008). The questionnaire was given to my supervisor to seek her opinion about the adequacy and representativeness of the instrument to ensure it covers all the variables being measured as a way of eliminating content validity. The validity of the questionnaire was also gauged through a pilot study which indicated that the research instrument aimed to gauge what it entailed.

5.2 Reliability

In order to check reliability of the results, the study used Cronbach's alpha methodology, which is based on internal consistency. This test was performed to test for consistency in responses given by respondents. A Cronbach's alpha coefficient value of greater than 0.7 indicates an internal consistency of the answering pattern of the participants indicates reliability (Nunnally, 1978). Cronbach's alpha coefficient estimates the reliability by determining the internal consistency within the test (Nunnally, 1978). The table 1 below shows the reliability of α=0.835. This illustrates that all the questions used in the study were reliable as their reliability value exceeded the prescribed threshold of 0.7.

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Table 1 Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.835	.844	39

IV. RESULTS AND DISCUSIONS

Frequency Distribution and Descriptive Statistics of the Respondents, Employee Engagement, Job Satisfaction and Fringe Benefits and Remuneration.

5.1 Respondents Profile

In this study, the researcher distributed 300 questionnaires and only 270 were filled and returned. This represents a response rate of 90 %. According to Field (2013) the statistically significant response rate for a study should be at least 50% therefore the threshold requirement condition was met. The findings revealed that 49.6% of the respondents were males whiles 50.4% were females. This shows that females dominated the work force at the firm. The study revealed that out of the 270 respondents who answered the questionnaire, majority of 80.4% of the employees were between 20 – 30 years, 16.7% were between 31 – 40 years and 3.0% were between 41 – 50 years. These results indicated how youthful the workforce of the institution was.

It was also found out that 67.0% of the employees were Single whiles 32.6% were Married and 0.4% were Divorced. Among the 270 employees who responded in the research, 28.1% have WASSCE/SSCE certificate, a majority of 65.9% have First Degrees and 5.9% have Masters Degrees. The research also established that 7.4% of the employees had worked for Less than a year, 46.7% of them had worked from 1-3 years, 35.6% also worked from 4-6 years whiles 7.4% had worked for 7-9 years and only 3.0% worked for 10 years and above.On the job role the study also found out that Clerical staff constituted 17.4% of the employees, Supervisory staff were 5.2%, with Managerial staff being 9.3%. The majority were the Mobile Bankers who constituted 66.3% and 0.4 Cleaners. However, 1.5% did not respond to this question.The study also found out that 77.4% of the employees were full time workers of the organisation whiles 22.6% were Contract workers.From the survey conducted, it has been blished that 27.0% of the staff earn a monthly salary below GH¢ 500, a majority of 56.7% earn between GH¢ 501 – GH¢ 1000. Again, the study found that 7.0% were earning between GH¢ 1001 – GH¢ 1500 whiles 6.7% between GH¢ 1501 – GH¢ 2000 and only 2.6% earn above GH¢ 2000 monthly.

5.2 Employee Engagement. (Please see appendix A Table 2)

The study sought to determine the level at which respondents agreed or disagreed with the statements relating to Employee Engagement in the organization. The findings showed that a majority of about 63.4% of the respondents were satisfied working for the organization. Even though a higher number of 67.6% of them were uncertain of their plan on working for the organization a year from now, 62.2% of them were proud that they were working for the organization. A majority of 60.3% of the respondents agreed they would recommend to a friend that he or she come work for the organization. 58.0% of them felt that there is full utilization of their skills and abilities in their workplace. A lager number of about 85.9% agree to seeing a link between their work and the objectives of the organization. More than half of the respondents (59.2%) agreed they are being encouraged to innovate in a work. 79.8%also agreed there is quality of relationships with co-workers in the organisation whiles 84.1% agreed they feel trusted and respected. Interestingly on the confidence in the organization's future, 30.5% of the respondents were uncertain while 46.9% of them agreed and 19.5% strongly agreed. 63.4% agree to seeing a promising future for the employees of the company. On the confidence in the organization's senior leaders, 66.4% of the respondents indicated they had confidence in them. 83.8% of the staff used in the study agreed there are efforts that increase overall satisfaction in the organisation and 88.3% agreed managers who treat employees with respect and dignity.

5.3Job Satisfaction. (Please see appendix A Table 3).

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The study put together respondents' agreements or disagreements on statements about job satisfaction at their workplace. From the findings 61.9% of the respondents agreed to the statement 'I feel very positive and favourable about my job.' However, to the statement 'As soon as I can find a better job, I'll leave.' 41.9% agreed to it whiles 32.8%strongly agreed, 13.6% were uncertain and 11.3% disagreed to it. 60.4% of the respondents said they agree with the statement 'I am generally satisfied with the kind of work I do on this job. The study also found that 8.0% of the respondents strongly disagreed to the statement that they frequently think of quitting their jobs. 46.2% disagreed whiles 9.5% were uncertain with 32.2% agreeing and 4.2% strongly agreeing to it.

Most respondents (64.5%) agreed that they have sense of worthwhile accomplishment in their work with 17.7% strongly agreed and another 17.7% being uncertain. On the statement 'I had a good idea of what this position entailed before I was hired', 20.8% of the respondent strongly disagreed with it with 37.7% disagreed. 0.8% were uncertain while 33.2% agreed and 7.5% strongly agreed. 64.5% of the respondent also agreed that their positions contribute significantly to the pressure and anxiety in their personal lives with 10.9% strongly agreed and 18.9% disagreed. Whiles 63.4% agree that their job that they are doing makes them happy, 30.6% of them were uncertain whether it makes them happy or not.An overwhelming majority of 90.9% agreed that they receive adequate support from their Line Managers however 89.6% said they agreed that they have confidence in the leadership of their Line Managers.

5.4 Fringe Benefits and Remuneration. (Please see appendix A Table 4).

The study put together respondents 'level of disagreements or agreements' on statements about employee fringe benefits and remuneration packages. A very large number of the respondents would prefer to have a medical aid contribution by the employer. In fact, 51.0% of them said they agreed and 47.9% strongly agreed.On the organisation's assistance with a monthly allowance to buy or rent accommodation, there was a sharp division among respondents. 38.2% of them disagreed strongly, 15.8% disagreed. Only 1.2% were uncertain with 40.5% who said they agreed and 4.2% strongly agreed. 81.1% of the respondents said they would prefer to receive an allowance from the organisation to purchase their own vehicle. 50.2% of them also said they strongly disagree the organisation provides them with accommodation whiles 27.0% disagreed and only 12.0% agreed.45.9% of the employees disagreed that, they feel that for the amount of work they do, the pay is sufficient whiles 33.6% were uncertain and 12.7% agreed. On the statement, "The organisation assists me and my immediate family with education expenses", 26.3% of the respondents strongly agreed whiles 56.0% disagreed and 8.1% said they were uncertain with another 8.1% who said they agree.

Out of the 270 respondents 15.8% strongly agreed they would prefer to use a vehicle supplied by the organisation, 42.5% disagreed with 3.5% uncertain and 37.5% agreed.52.1% of the employees strongly disagreed the organisation provides them with the opportunity for in-house education, 27.8% disagreed and only 18.9% agreed.An overwhelming 91.5% of the staff that took part in the study agreed they prefer the company to reimburse all their medical expenses.68.7% said they disagreed with the statement 'I am satisfied with my remuneration package'. 9.7% were uncertain and 16.2% agreed. 85.5% of therespondents also agreed that it is important for them that the organisation assists them to give education to their immediate family members.There was a sharp division among respondents how important it is for them that the organisation assists them with a vehicle to perform their duties 32.7% strongly disagreed with 26.4% disagreed and 33.1% agreed.80.3% of the respondents agreed it is important for them to get assistance from the organisation to buy or rent accommodation. 58.0% of them disagreed that their remuneration package compares well to others in this field whiles 31.2% agreed. A majority of 86.6% also agreed it is important to them that the organisation assists them with medical expenses.

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Table 5: Descriptive Statistics

Variables	N	Minimum	Maximum	Mean		Std. Deviation
Section B (EE)	270	1.00	5.00	3.7655		.43876
Section C (JS)	270	1.00	5.00	3.6358		.20262
(Medical aid contribution) Section D1	270	1.00	5.00	4.1202		.40824
Accommodation Allowance) Section D2	270	1.00	5.00	2.7868		.76552
(Vehicle to Perform Duty) Section D3	270	1.00	5.00	3.0478		.84402
(Educational Assistance) Section D4	270	1.00	5.00	2.5788		.67507
Remuneration (Section D5)	270	1.00	5.00	2.5129		.72451.

The population of the survey has responded 1 to 5 (Minimum 1 and Maximum is 5). The respondents have their responses, some of them agree, some disagree and some are neither agree or disagree regarding various questions asked from them in the questionnaire. The findings provide us the following information: With respect to employee engagement (EE) the Mean is 3.7655 with .43876 S.D. The Mean for job satisfaction (JS) is 3.6358 with S.D = .20262. For Medical Aid the Mean value is 4.1202 and S.D = .40824. Accommodation allowance has the Mean of 2.7868 with its S.D is .76552. Vehicle to perform duty shows the Mean of 3.0478 and S.D = .84402. Educational Assistance shows the Mean of 2.5788 and its S.D = .67507. And finally, the response level Mean for Remuneration is 2.5129 with S.D = .72451.

V. REGRESSION ANALYSIS OF EMPLOYEE ENGAGEMENT AND JOB SATISFACTION

To further analyse the impact of fringe benefits on employee engagement and job satisfaction, Multiple regression analysis was employed.

6.1 The results of the regression analysis of the fringe benefits impacts on employee engagement (EE) are shown in Table 6 (Please see appendix A).

The regression analysis revealed that Medical aidas a fringe benefit has a statistically positive significant relationship with employee engagement. Medical aid beta coefficient, (β = .301, $p < 0.05$). This means that if the company provides medical aid insurance for the employees it would increase employee's engagement level by 30%. Accommodation Beta coefficient (β= .249, $p < 0.05$). Which indicates that if the organisation provides allowance for employees to rent their own accommodation or provides accommodation for employees would positively increase employee's engagement by 24.9%. Vehicle to perform duties Beta coefficient (β = -.321, $p < 0.05$).The p-vale indicated significant relationship between Vehicle to perform duties and employee's engagement but indicated negative beta coefficient. EducationalAssistanceas a fringe benefitsdepicted statistically positive relationship with employee engagement. Educational AssistanceBeta coefficient (β = .313, $p < 0.05$). This means that if the company provides educational assistance for employees at (SASL) would increase employee's engagement by 31.3%.

The findings indicated that, among the four independent variables of fringe benefits used for the studyonly three (Medical aid contribution, Accommodation allowance and Educational assistance) were statistically significant in predicting employee's engagement at (SASL). However, Vehicle allowance (β = -.321) was not statistically significant in predicting employee's engagement.

6.2 The results of the regression analysis of the fringe benefits impacts on the job satisfaction (JS) are shown in the table 7 (Please see Appendix A).

The regression analysis revealed that Medical aidas a fringe benefit has a statistically positive significant relationship with Job Satisfaction (JS). Medical aid beta coefficient (β=.167, $p < 0.05$). This indicates that if the company provides medical aid insurance for the employees at (SASL)would increasetheir job satisfaction by 16.7%. Accommodation beta coefficient (β= .225, $p < 0.05$), the analysis showed a statistically positive significant impact on job satisfaction. This depicted that if the company provides their employees with accommodation would increase job satisfaction by 22.5%. Another variable that had statistically positive significant was the Vehicle to perform duties. Vehicle beta coefficient (β= .065, $p < 0.05$). This means that if the organisation provides vehicle to perform duties or giving allowance to employees to purchase their own Car would increase employee's job satisfaction by 60.5%. With

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Educational assistance the regression analysis showed a statistically negative relationship with job satisfaction. Educational assistance beta coefficient (β= -.031, p < 0.05).

The p-vale indicated significant relationship between educational assistance and job satisfaction but indicated negative beta coefficient. The findings indicated that, among the four independent variables of fringe benefits used for the study only three (Medical aid contribution, Accommodation allowance and Vehicle allowance) were statistically significant in predicting job satisfaction at (SASL). However, Educational assistance (β = -.031) was not statistically significant in predicting job satisfaction.

6.3 Remuneration impacts on Employee Engagement (EE):The regression analysis results revealed that remuneration has a positive relationship with employee engagement. The beta coefficient, (β= .493, p<0.05). This can indicate that the level of employee engagement an employee experiences in the organization is influenced by his remuneration package.

6.4 Remuneration impacts on Job Satisfaction (JS):The regression analysis results revealed that remuneration has a statistically significant influence on job satisfaction. However, has a negative relationship with job satisfaction. The beta coefficient, (β= -.032, p<0.05). This can indicate that the level of job satisfaction an employee experiences in the organization is influenced by his remuneration package however, it can also have a negative impact on job satisfaction.

6.5 Job Satisfaction (JS) impact on Employee Engagement (EE): JobSatisfaction and Engagement: P-value = 0.54, indicating a highly important relationship. Thus, a high level of job satisfaction will imply a high level of engagement and vice versa.

VI. HYPOTHESIS TESTING

Regression analysis was employed for testing the hypothesis for this study.

H1a: Fringe benefits significantly influence Employee Engagement (EE).

H1b: Fringe benefits significantly influence Job Satisfaction (JS)

The current study for fringe benefits impact on Employee Engagement (EE) and Job Satisfaction (JS)shown that fringe benefits significantly influence Employees Engagement (EE) and Job Satisfaction (JS). This can indicate that the level of employee engagement and job satisfaction of an employee is dependent on the fringe benefits an employee receives from the organization. Thus, Hypothesis 1a and 1b, which together state that fringe benefits significantly influence employee engagement and job satisfaction, are accepted.

H2a: Remuneration significantly influences Employee Engagement (EE).

H2b: Remuneration significantly influences Job Satisfaction (JS).

The regression analysis depicted that remuneration significantly influences Employees Engagement (EE) and Job Satisfaction (JS). This can indicate that the level of employee engagement and job satisfaction of an employee is dependent on the kind of remuneration an employee receives from the organization. Thus, Hypothesis 2a and 2b, which together state that remuneration significantly influences employee engagement and job satisfaction, are accepted.

H3: Job Satisfaction significantly influences Employee Engagement (EE).

The regression analysis for Job Satisfaction (JS) impact on Employee Engagement (EE)depicted that Job Satisfaction significantly influences Employees Engagement (EE). Thus, a high level of job satisfaction will imply a high level of engagement and vice versa. Thus, Hypothesis 3, which states that Job Satisfaction significantly influences employee engagement, is accepted.

Limitations & Direction for Future Research

This study is limited only to the employees at Sinapi Aba Savings and Loans Limited (SASL). Consequently, the conclusion may not be the same as other companies.In this study only fringe benefits variables as part of total compensation packages were discussed whereas there is a long list of other variables that can also be study. The structure of remuneration packages is confidential and therefore employees were hesitant to answer questions regarding fringe benefits and remuneration.Although it seems to be a reasonable conclusion to say that the results of this study serve to provide a considerably more thorough understanding of the fringe benefits impact on job satisfaction and employee's engagementat Sinapi Aba Savings and Loans Limited (SASL) of Ghana and underlying indicators of fringe benefits that significantly influence job satisfaction and employee's engagement, further empirical research needs to be carried outwithin other sectors, like public sector institutions in Ghana since the Ghanaian government is the single largest employer to obtain a more comprehensive picture of this topic.

VII. CONCLUSION & RECOMMENDATION

The study investigates the impact that fringe benefits have on job satisfaction and employee

engagement at Sinapi Aba Savings and Loans Limited (SASL). The study found out that fringe benefits significantly influence job satisfaction and employee's engagement at (SASL). This depicts that employees at (SASL) experience a higher level of motivation from their fringe benefits. Therefore, this study then recommend that management should add these indicators of fringe benefits in their employee's compensation plan in order to retain their loyal employees and increase organisations productivity in the long -run. Although some of these fringe benefits are provided, much still need to be done to attract and retain their loyal employees in this competitive business environment.Employers should also improve the remuneration packages of their employees so they can adequately meet the needs of their families.

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Table .2 Frequency Distribution for Employee Engagement (EE).

	Strongly disagree		Disagree		Uncertain		Agree		Strongly agree		Mean	Std. Deviation
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %		
1. Satisfied working for this organization	3	1.1%	8	3.1%	58	22.1%	166	63.4%	27	10.3%	3.79	.711
2. Plan on working for this organization a year from now	8	3.1%	13	5.0%	175	67.6%	49	18.9%	14	5.4%	3.19	.740
3. Proud that I'm working for this organization	8	3.1%	45	17.2%	7	2.7%	163	62.2%	39	14.9%	3.69	1.021
4. Would recommend to a friend that he or she come work for this organization	0	0.0%	3	1.1%	59	22.5%	158	60.3%	42	16.0%	3.91	.652
5. Feel that there is full utilization of my skill and abilities	0	0.0%	38	14.5%	61	23.3%	152	58.0%	11	4.2%	3.52	.791
6. See a link between my work and the objectives of the organization	3	1.1%	0	0.0%	12	4.6%	225	85.9%	22	8.4%	4.00	.483
7. Being encouraged to innovate	3	1.1%	88	33.6%	8	3.1%	155	59.2%	8	3.1%	3.29	1.006
8. There is quality of relationships with co-workers	5	1.9%	0	0.0%	12	4.6%	209	79.8%	36	13.7%	4.03	.596
9. Feel trusted and respected	3	1.2%	15	6.0%	0	0.0%	211	84.1%	22	8.8%	3.93	.657

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10. Confidence in the organization's future	8	3.1%	0	0.0%	80	30.5%	123	46.9%	51	19.5%	3.80	.858
11. See a promising future for the employees	0	0.0%	8	3.1%	51	19.5%	166	63.4%	37	14.1%	3.89	.668
12. Confidence in the organization's senior leaders	9	3.4%	0	0.0%	46	17.4%	176	66.4%	34	12.8%	3.85	.767
13. There are efforts that increase overall satisfaction	0	0.0%	8	3.0%	28	10.6%	222	83.8%	7	2.6%	3.86	.484
14. A manager who treats employees with respect and dignity	0	0.0%	8	3.0%	6	2.3%	234	88.3%	17	6.4%	3.98	.456

Table .3 Frequency Distribution for Job Satisfaction (JS).

	Strongly disagree		Disagree		Uncertain		Agree		Strongly agree		Mean	Std. Deviation
	Count	Row Valid N %	Count	Row Valid N %	Count			Row Valid N %	Count	Row Valid N %		
1. I feel very positive and favourable about my job.	0	0.0%	8	3.0%	84	31.7%	164	61.9%	9	3.4%	3.66	.596
2. As soon as I can find a better job, I'll leave.	1	0.4%	30	11.3%	36	13.6%	111	41.9%	87	32.8%	3.95	.976
3. I am generally satisfied with the kind of work I do on this job.	0	0.0%	11	4.2%	84	31.7%	160	60.4%	10	3.8%	3.64	.625
4. I frequently think of quitting this job.	21	8.0%	122	46.2%	25	9.5%	85	32.2%	11	4.2%	2.78	1.108
5. I have sense of worthwhile accomplishment in my work.	0	0.0%	0	0.0%	47	17.7%	171	64.5%	47	17.7%	4.00	.597
6. I had a good idea of what this position entailed before I was hired	55	20.8%	100	37.7%	2	0.8%	88	33.2%	20	7.5%	2.69	1.324
7. This position contributes significantly to the pressure and anxiety in my personal life	0	0.0%	50	18.9%	15	5.7%	171	64.5%	29	10.9%	3.68	.905
8. The job that I am doing makes me happy	0	0.0%	3	1.1%	81	30.6%	168	63.4%	13	4.9%	3.72	.569
9. I receive adequate support from my Line Manager	1	0.4%	0	0.0%	3	1.2%	229	90.9%	19	7.5%	4.05	.348
10. I have confidence in the leadership of my Line Manager	0	0.0%	2	0.8%	12	4.6%	232	89.6%	13	5.0%	3.99	.357

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Table .4 Frequency Distribution for Fringe Benefits and Remuneration

	Strongly disagree		Disagree		Uncertain		Agree		Strongly agree		Mean	Std. Deviation
	Count	Row Valid N %	Count	Row Valid N %	Count	Row Valid N %	Count	Row Valid N %	Count	Row Valid N %		
1. I would prefer to have a medical aid contribution by the employer	0	0.0%	0	0.0%	3	1.2%	132	51.0 %	124	47.9 %	4.47	.523
2. The organisation assists me with a monthly allowance to buy or rent accommodation	99	38.2 %	41	15.8 %	3	1.2%	105	40.5 %	11	4.2%	2.57	1.443
3. I would prefer to receive an allowance from the organisation to purchase my own vehicle	0	0.0%	19	7.3%	6	2.3%	210	81.1 %	24	9.3%	3.92	.636
4. The organisation provides me with accommodation	130	50.2 %	70	27.0 %	25	9.7%	31	12.0 %	3	1.2%	1.87	1.081
5. I feel that for the amount of work I do, the pay is sufficient	20	7.7%	119	45.9 %	87	33.6 %	33	12.7 %	0	0.0%	2.51	.813
6. The organisation assists me and my immediate family with education expenses	68	26.3 %	145	56.0 %	21	8.1%	21	8.1%	4	1.5%	2.03	.900
7. I would	41	15.8	110	42.5	9	3.5%	97	37.5	2	0.8%	2.65	1.160

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	prefer to use a vehicle supplied by the organisation		%		%				%				
8.	The organisation provides us with the opportunity for in-house education	135	52.1 %	72	27.8 %	2	0.8%	49	18.9 %	1	0.4%	1.88	1.145
9.	I prefer the company to reimburse all my medical expenses	8	3.1%	0	0.0%	1	0.4%	237	91.5 %	13	5.0%	3.95	.575
10.	I am satisfied with my remuneration package	14	5.4%	178	68.7 %	25	9.7%	42	16.2 %	0	0.0%	2.37	.817
11.	It is important for me that the organisation assists me to give education to my immediate family	8	3.0%	11	4.1%	6	2.2%	230	85.5 %	14	5.2%	3.86	.698
12.	It is important to me that the organisation assists me with a vehicle to perform my duties	88	32.7 %	71	26.4 %	3	1.1%	89	33.1 %	18	6.7%	2.55	1.405
13.	It is important for me to get assistance from the	0	0.0%	31	11.5 %	2	0.7%	216	80.3 %	20	7.4%	3.84	.720

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	organisation to buy or rent accommodation											
14.	My remuneration package compares well to others in this field	8	3.0%	156	58.0 %	21	7.8%	84	31.2 %	0	0.0%	2.67	.953
15.	It is important to me that the organisation assists me with medical expenses	8	3.0%	6	2.2%	0	0.0%	233	86.6 %	22	8.2%	3.95	.661

Table 6. The results of the regression analysis of the fringe benefits impacts on employee engagement (EE)

Model	***Coefficient***	***Std. Error***	***t-stat.***	***Prob.***
CONS.	*2.335*	*.286*	*8.159*	*.000*
MEDICAL AID (SECTION D1)	*.301*	*.077*	*3.906*	*.000*
ACCOMMODATION ALLOWANCE (SECTION D2)	*.249*	*.046*	*5.377*	*.000*
VEHICLE ALLOWANCE (SECTION D3)	*-.321*	*.032*	*-10.042*	*.000*
EDUCATIONAL ASSISTANCE (SECTION D4)	*.313*	*.068*	*4.613*	*.000*
GENDER				
MALE	*Reference*			
FEMALE	*.062*	*.043*	*1.428*	*.154*
AGE RANGE				
20-30	*Reference*			
31-40	*.143*	*.055*	*2.589*	*.010*
41-50	*-1.047*	*.131*	*-7.975*	*.000*
MARITAL STATUS				
SINGLE	*Reference*			
MARRIED	*.183*	*.045*	*4.063*	*.000*
DIVORCED	*-1.028*	*.251*	*-4.094*	*.000*
EDUCATIONAL LEVEL				
WASSCE/SSCE	*Reference*			
BACHELOR DEGREE	*-.540*	*.056*	*-9.609*	*.000*
MASTERS DEGREE	*.105*	*.119*	*.881*	*.379*
EMPLOYEE STATUS				
FULL-TIME	*Reference*			
CONTRACT	*-.299*	*.062*	*-4.851*	*.000*
R^2	*0.747*	R^2adj	*0.735*	*P>F = 0.000*
N	*270*	*F*	*60.305*	

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Table 7. The results of the regression analysis of the fringe benefits impacts on job satisfaction (JS).

Model	*Coefficient*	*Std. Error*	*t-stat.*	*Prob.*
CONS.	*2.985*	*.202*	*14.789*	*.000*
MEDICAL AID (SECTION D1)	*.167*	*.055*	*3.025*	*.003*
ACCOMMODATION ALLOWANCE (SECTION D2)	*.225*	*.042*	*5.423*	*.000*
VEHICLE ALLOWANCE (SECTION D3)	*.065*	*.032*	*2.047*	*.042*
EDUCATIONAL ASSISTANCE (SECTION D4)	*-.301*	*.047*	*-6.378*	*.000*
GENDER				
MALE	*REFERENCE*		*-.157*	
FEMALE	*-.005*	*.030*		*.875*
AGE RANGE	*reference*			
20-30	*.141*	*.040*	*3.543*	*.000*
31-40	*.335*	*.086*	*3.897*	*.000*
41-50				
MARITAL STATUS	*reference*			
SINGLE	*-.063*	*.029*		*.031*
MARRIED	*.259*	*.155*	*-2.167*	*.095*
DIVORCED			*1.675*	
EDUCATIONAL LEVEL				
WASSCE/SSCE	*reference*			
BACHELOR DEGREE	*-.136*	*.045*	*-3.031*	*.003*
MASTERS DEGREE	*-.112*	*.078*	*-1.424*	*.156*
EMPLOYEE STATUS				
FULL-TIME	*reference*			
CONTRACT	*.050*	*.048*	*1.033*	*.303*
R^2	*0.541*	R^2adj	*0.517*	*P>F = 0.000*
N	*270*	*F*	*22.197*	

APPENDIX B
QUESTIONNAIRE

I am a Master of Enterprise Management student of the College of Economics and Management of Taiyuan University of Technology, China. As part of the programme, I am required to write an article titled "**the impact of fringe benefits on job satisfaction and employee engagement at Sinapi Aba Savings and Loans Limited (SASL)**". You are kindly asked to fill in the following questionnaire. I assure you that, the data collected will be used for academic purposes only and with outmos t confidentiality.

A. RESPONDENT PROFILE (please tick where applicable)

1. Sex: Male [ ] Female [ ]
2. Age: 20 – 30 [ ] 31– 40 [ ] 41 – 50 [ ] 51– 60 [ ] 60 and above [ ]
3. Marital status: Single [ ] Married [ ] Divorced [ ] Widowed [ ]
4. Educational Level: WASSCE/SSCE [ ] First Degree [ ] Masters [ ] Doctorate [ ] PhD [ ]
5. How long have you been working at the company? Less than a year [ ]
   1-3 years [ ] 4-6 years [ ] 7-9 years [ ] 10 years and above [ ]
6. What is your job role? Clerical [ ] Supervisory [ ] Managerial [ ]
   Other (please specify) ……
7. What type of employment contract do you have?
   Full time [ ] Part-time [ ] Contract [ ]
8. What is the range of your salary?
   Below GH¢ 500 [ ] GH¢ 501-1000 [ ] GH¢ 1001 – 1500 [ ]
   GH¢ 1501 - 2000 [ ] Above GH¢ 2000 [ ]

https://dx.doi.org/10.22161/ijaers.6763 *ISSN: 2349-6495(P) | 2456-1908(O)*

B. EMPLOYEE ENGAGEMENT

9. Satisfied working for this organization

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

10. Plan on working for this organization a year from now

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

11. Proud that I'm working for this organization

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

12. Would recommend to a friend that he or she come work for this organization

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

13. Feel that there is full utilization of my skill and abilities

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

14. See a link between my work and the objectives of the organization

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

15. Being encouraged to innovate

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

16. There is quality of relationships with co-workers

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

17. Feel trusted and respected

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

18. Confidence in the organization's future

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

19. See a promising future for the employees

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

20. Confidence in the organization's senior leaders

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

21. There are efforts that increase overall satisfaction

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

22. A manager who treats employees with respect and dignity

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

C. FRINGE BENEFIT IMPACT ON JOB SATISFACTION

23. I feel very positive and favourable about my job.

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

24. As soon as I can find a better job, I'll leave.

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

25. I am generally satisfied with the kind of work I do on this job.

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

26. I frequently think of quitting this job.

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

27. I have sense of worthwhile accomplishment in my work.

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

28. I had a good idea of what this position entailed before I was hired

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

29. This position contributes significantly to the pressure and anxiety in my personal life

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

30. The job that I am doing makes me happy

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

31. I receive adequate support from my Line Manager

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

32. I have confidence in the leadership of my Line Manager

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

https://dx.doi.org/10.22161/ijaers.6763 *ISSN: 2349-6495(P) | 2456-1908(O)*

D. FRINGE BENEFITS AND REMUNERATION PACKAGES STRUCTURE

33. I would prefer to have a medical aid contribution by the employer

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

34. The organisation assists me with a monthly allowance to buy or rent accommodation

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

35. I would prefer to receive an allowance from the organisation to purchase my own vehicle

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

36. The organisation provides me with accommodation

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

37. I feel that for the amount of work I do, the pay is sufficient

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

38. The organisation assists me and my immediate family with education expenses

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

39. I would prefer to use a vehicle supplied by the organisation

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

40. The organisation provides us with the opportunity for in-house education

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

41. I prefer the company to reimburse all my medical expenses

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

42. I am satisfied with my remuneration package

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

43. It is important for me that the organisation assists me to give education to my immediate family

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

44. It is important to me that the organisation assists me with a vehicle to perform my duties

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

45. It is important for me to get assistance from the organisation to buy or rent accommodation

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

46. My remuneration package compares well to others in this field

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

47. It is important to me that the organisation assists me with medical expenses

Strongly disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly agree [ ]

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Evaluating the Impact of HCL Atmospheric Dispersion caused by an Aborted Rocket Launch in different Stability Conditions

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Abstract *— An aborted rocket launch may occur because of explosions during pre-launch operations or launch performance, which generates a huge cloud near ground level comprising hot buoyant exhaust products. This action occur within a few minutes, and populated areas near the launch centre may be exposed to high levels of hazardous pollutant concentrations within a short time scale — from minutes to a couple of hours. Although aborted rocket launch events do not occur frequently, the occurrence rate has increased in the past few years, making it mandatory to perform short and long-range assessments to evaluate the impact of such operations on the air quality of a region. In this work, we use a modern approach based on the Model for Simulating the Rocket Exhaust Dispersion (MSRED) and its modelling system to report the simulated impact of a hydrogen chloride (HCl) exhaust cloud, formed during a hypothetical aborted rocket launch, on the atmosphere near the earth's surface at the Alcantara Launch Center, Brazil's space-port. The results show that when a launch occurs under stable atmospheric conditions, the HCl concentrations near the ground can reach levels that are extremely hazardous to human health.*

Keywords— aborted rocket launch, CMAQ, HCl dispersion, MSRED, rocket exhaust cloud.

I. INTRODUCTION

Rocket launches generate gas emissions produced from burning fuels that are re-leased into the atmosphere and transported and dispersed by the wind. Thus, before the launch, it is crucial to analyse the potential trajectory of these gases. Several models are presented in the literature, as in Denison et al. [1], Brady et al. [2], Bennett et al. [3], Bernhardt et al. [4], Koch et al. [5], Voigt et al. [6], and Bauer et al. [7], which deal with the impact that rocket exhaust pollutants cause in the stratosphere without focusing on the impact they cause in the region of the atmospheric boundary layer (ABL), notably at the time of the rocket launch and thereafter. This is due to the strong interest in evaluating the impact that these pollutants cause in the ozone layer where a large amount of hydrogen chloride (HCl) and alumina (Al_2O_3) is emitted during the burning of the propellant. Particles of Al_2O_3 can provide a heterogeneous HCl conversion surface to other chlorinated compounds, which in turn play an important role in depleting the ozone layer [8].

Likewise, it is important to study the impact caused in the lower troposphere, mainly owing to the problem of air quality. To solve this problem, some approaches use computational fluid dynamics (CFD) techniques for modelling the formation of the exhaust plume; however, the computational cost of this methodology is very high, which pre-vents its use in the operating environment [5,7]. Other researchers use an approach based on Lagrangian models [9,10,11,12] to model toxic gases, whereas others use Gaussian approaches. Some of these models include the Rocket Exhaust Effluent Diffusion Model (REEDM) [13], which was operationally employed by the National Aeronautics and Space Administration (NASA) to evaluate the impact of rocket exhaust clouds. It was recognized that the REEDM model does not adequately represent cases with greater atmospheric turbulence, because it uses a unique turbulence scheme to simulate the dispersion in the launch centre region and its environment [14]. In addition, Anderson and McCaleb [15] present a study which concluded that the REEDM model is deficient for cases of aborted launches caused by explosions, when the results are compared with the CALPUFF model which obtained better solutions in these types of situations. Further-more, it is important to stress that this model is not available to the scientific community for use and

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evaluation of its performance and accuracy. The Open Burn/Open Detonation Dispersion Model (OBODM) [16] does not focus on modelling the impact of the rocket exhaust cloud. Instead, it was designed to assess the impact of open-air explosions using the mechanism in the REEDM as a basis.

The Stratified Atmosphere Rocket Release Impact Model (SARRIM) [17] is employed by the France's space agency to evaluate the environmental impact of rocket effluent emissions at the Kourou spaceport in French Guiana; however, like REEDM, this model is not available for use by the scientific community.

The Plume Tracker [18] software package seeks to simulate the elevation, transport, stabilisation, and subsequent deposition and precipitation of particles from the ground cloud generated by rocket launches. Its focus is basically modelling the plume motion process starting at 6,000 ft above sea level, from cloud ascent and stabilisation to pre-collecting particulate matter, without concerns about cloud formation from an actual rocket launch, and the concentration of gaseous pollutants and the involved chemical reactions; therefore, it is not fully suitable for modelling the dispersion of toxic rocket gases, which is the focus of this work.

Developed by Moreira et al. [19] for use by the Institute of Aeronautics and Space ('Instituto de Aeronáutica e Espaço', in Portuguese) at the Alcantara Launch Center (ALC), the Modelo Simulador da Dispersão de Efluentes de Foguetes (MSDEF, in Portuguese) was designed to calculate peak concentrations with dry and wet depositions. Advances in the field were made by the work of Nascimento et al. [20] that presented the first effort to represent exhaust clouds from rocket launches using the Community Multi-Scale Air Quality (CMAQ) modelling system for the ALC region. Recently, Nascimento et al. [21] presented a new model called the Model for Simulating the Rocket Exhaust Dispersion (MSRED), emphasising its ability to simulate the formation, rise, stabilisation, expansion, and dispersion of rocket exhaust clouds for short-range assessment. This model is based on a semi-analytical three-dimensional solution of the advection-diffusion equation utilising a modern parameterisation of the atmospheric turbulence, which uses meteorological input from the Weather Research and Forecasting (WRF) model [22]. For long-range and chemical transport assessment, this model couples with the CMAQ model [23] by generating a ready-to-use initial conditions file to be input to CMAQ. Thus, the MSRED system represents state-of-the-art in the atmospheric modelling field for this unique type of air quality problem. Furthermore, Nascimento et al. [21] presented the study and simulation of the meteorology, dispersion, and chemical transport of rocket exhaust pollutants in the region of the ALC, Maranhão state, Brazil, by employing this hybrid system to assess the impact of normal launches on the atmosphere. Recently, Nascimento et al. [24] conducted an evaluation of the MSRED model application for the blast event of the SpaceX Falcon 9 rocket launch test on September 1, 2016 at the Cape Canaveral Air Force Station.

In this study, we considered an aborted case at the ALC to analyse the impact of the HCl compound, selected because of its hazardousness when released in ambient air. HCl can be perceived at low concentrations of approximately 0.8 ppm [25] and is corrosive to the skin and mucous membranes (such as the eyes). Acute exposure in a short period of time can cause coughing, hoarseness, inflammation and ulceration of the respiratory tract, chest pain, and pulmonary damage [26,27]. Previous studies about HCl dispersion in the atmosphere have focused on the chemical composition of the ground cloud and, more importantly, the arrangement of tons of HCl produced in approximately the first 10 s after the launch [28]. It was concluded that the ground cloud rises owing to thermal thrust, stabilises according to atmospheric conditions, is carried by the wind, and finally undergoes decay caused by entrainment of dry air and natural diffusion. This is a simplification of a complex process that inspires study and is a field quite open to research.

Accordingly, this work aims to provide a background for the simulation of aborted rocket launches considering HCl atmospheric dispersion. Hence, this work is divided into the following sections: Section II presents the methodology and Section III discusses the results. The conclusions are presented in Section IV.

II. METHODOLOGY

The modelling domain was defined in the WRF model using five domains wherein each domain's horizontal resolution was 8.1 km, 2.7 km, 900 m, 300 m, and 100 m, respectively, and 70 vertical levels in an episode ranging from March 18, 2013 to March 22, 2013. The case was simulated considering a hypothetical aborted launch of the satellite launch vehicle (VLS, 'Veículo Lançador de Satélites', in Portuguese) for different atmospheric conditions — unstable, stable, and neutral. The emission rate and effective heat of the propellant for an aborted launch are 1.36 x 105 g/s and 103 cal/g, respectively [21].

The constituents of the exhaust cloud are fractions of the total weight of the products released in the firing of

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the propellant. They are used to determine the emission rate of each contaminant in each cloud partition, multiplied by the release rate defined by the operator. The MSRED model is capable of simultaneously processing the contaminants that come from the burning propellant. The constituent compounds that impact air quality are carbon dioxide (CO_2), carbon monoxide (CO), HCl, and Al_2O_3. The first three are the main gases, and the last is a particulate material.

For an aborted launch case, MSRED considers that the exhaust cloud, after its formation, rise, growth, and stabilisation, has a cylindrical shape. The cloud is then divided into n partitions, where n is the number of vertical levels that the cloud intercepts, which are the same vertical levels configured in the WRF modelling. Each partition is treated as an independent source, and the MSRED computes the concentration at a receptor by calculating the contribution of each source in that receptor. More information about the details of the mathematical and computational modelling developed in MSRED can be found in Nascimento et al. [21]. As no contaminant concentration data are available to perform quantitative analysis of the results, a qualitative analysis was performed to evaluate how the modelling system simulates each event.

2.1. Short description of the model

The solution to the three-dimensional advection-diffusion equation obtained for a vertically inhomogeneous ABL is described in Nascimento et al. [21]. The solution is semi-analytical, as no approximation is given throughout the derivation process, with the exception of the stepwise approximation of the eddy diffusivities and longitudinal wind speed, and the numerical Laplace inversion of the transformed concentration. Some de-tails regarding the computational strategy developed in the model that were not presented in previous articles are now described in Section 2.2.

2.2. Computational strategy for parallel processing

The MSRED is designed to enable the use of high-performance computing during its execution in addition to the traditional serial approach. The chosen strategy for balancing the computational effort was to divide the dataset according to the number of avail-able processors. The model verifies the number of processors available for its execution and divides the domain in the longitudinal direction — x-axis of the computational grid — in q equal parts, generating subdomains with dimensions (x/q, y, z). This strategy ensures consistency between the diverse variables that are calculated throughout the execution and the scalability of the model, because it guarantees that the amount of processing time is inversely proportional to the number of processors available for its execution, thereby avoiding race conditions and bottlenecks in the communication between processes and in the execution of the various calculations.

To develop this strategy, the distributed memory parallelism approach was chosen using the Message Passing Interface (MPI) paradigm which is widely used in high-performance computing, including the WRF and CMAQ models.

2.3. Representation of the rocket exhaust cloud

The representation of the source term is one of the main challenges in modelling the environmental impact caused by rocket exhaust effluents in the atmosphere, notably in the region of the ABL. According to Simmons [29], rocket exhaust plumes exhibit a characteristic structure. For the formation of the cloud (stabilisation time, format, stabilisation height, cloud division, etc.), the approach presented in the MSDEF model was followed; however, it included the addition of important improvements aiming at a better representation of the source term which will be described in the Section 2.3.1. The parameterisation of the turbulence was the same as in Nascimento et al. [21,24].

2.3.1. Rise of the exhaust cloud

Determining the exhaust cloud stabilisation height for normal releases and the plume generated for launch failures are important factors in calculating the concentration of pollutants because, in general, the maximum concentration calculated on the earth's sur-face is inversely proportional to the cube of the stabilisation height [13]. For the aborted or explosive launch case the best option is the continuous plume rise model.

The exhaust cloud, once stabilised, may exceed the height of the atmospheric boundary layer. In this case, two distinct regions are considered to calculate the concentration: first, delimited in the lower part by the terrestrial surface and in the upper part by the ABL; and second, extending from the ABL height to a maximum of 3,000 m. The pollutants are assumed not to penetrate the region above the second region (above 3,000 m) and below the first region (below the earth's surface). It is assumed that the gases coming from the second region do not penetrate at its base (or at the top of the ABL); how-ever, for particles, it is assumed that penetration always occurs.

2.3.1.1. Continuous cloud rise

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In the case of an aborted launch or a blast, the time for a continuous plume to reach the height z_k is given by Eq. (1) [13]:

$$t_k = s^{-0.5} \arccos\left[1-\left(\frac{su\gamma_x\gamma_y z_k^3}{3F_c}\right)\right], \quad (1)$$

where s is the stability parameter given by Eq. (2):

$$s = \frac{g}{\theta}\frac{\Delta\theta}{\Delta z} \quad (2)$$

where:
u: wind speed velocity
$\frac{\Delta\theta}{\Delta z}$: vertical gradient of potential virtual temperature (K/m)
$\Theta = 0.0098\ K/m$: dry adiabatic lapse rate
γ_x, γ_y, γ_z: coefficients of longitudinal, transverse, and vertical entanglement, respectively

In this work, the vertical gradient of potential virtual temperature will be obtained by a more accurate calculation that uses the meteorological variables provided by the meteorological model WRF [30]. The term F_c (m^4/s^2), which is the thermal thrust term of the continuous boom, is given by Eq. (3):

$$F_c = \frac{gHQ}{\pi\rho c_p T} \quad (3)$$

where:
g = 9.8 m/s^2: acceleration of gravity
H : effective heat contained in the fuel (J/g)
Q : emission rate (g/s)
T : ambient air temperature (K)
ρ : air density (g/m^3)
c_p: 1.004832 J/gK: specific heat of the air at constant pressure

Thus, the stabilisation height of the continuous boom z_c is given by Eq. (4):

$$z_c = \left(\frac{6F_c}{u\gamma_x\gamma_y s^{1/2}}\right)^{1/3} \quad (4)$$

The constants γ_x and γ_y assume the value of 0.5, respectively [13].

2.3.2. Dimensions of the cloud (source term)

The longitudinal r_x, transversal r_y, and vertical r_z radiuses of the cloud at the stabilisation time t_* are given by the Eq. (5):

$$\begin{cases} r_x = \gamma_x z_c \\ r_y = \gamma_y z_c \\ r_z = \gamma_z z_c \end{cases} \quad (5)$$

For the aborted launch case, it is assumed that the cloud is cylindrical in shape [13]. Thus, the radius of each cloud partition is simply the radius of the cylindrical cloud, given by Eq. (6):

$$r_c = \gamma_x z_c, \quad (6)$$

where γ_x = 0.5 [13].

III. RESULTS AND DISCUSSIONS

This section presents the results from modelling the dispersion and chemical transport of exhaust clouds from aborted rocket launches for different atmospheric stability conditions, using the MSRED model for short range evaluation and the CMAQ model for long range evaluation.

The meteorological information used for each scenario and its respective atmospheric stability condition is presented in Table 1 and refers to the location of ALC. The time reference is Greenwich Mean Time (GMT), and u_*, L, w_*, h, u_v, and u_d represent the friction velocity (m/s), Monin-Obukhov length (m), convective velocity (m/s), height of the ABL (m), wind speed (m/s), and wind direction (º) at the surface layer (~10 m), respectively.

Table 1. Meteorological information of each modelling scenario.

Atmospheric Condition	Date and time (GMT)	Local date and time (GMT-3)	u_*	L	w_*	h	u_v	u_d
Stable	03/18/2013 09:00 h	03/18/2016 06:00 h	0.4	100.0	0.0	874.8	3.5	74.0
Unstable	03/18/2013 16:00 h	03/18/2016 13:00 h	0.6	-30.3	2.5	773.5	2.9	62.8
Neutral	03/18/2013 22:00 h	03/18/2016 19:00 h	0.6	180.0	0.0	733.0	4.0	63.6

The ABL was discretised using the meteorological vertical layers defined in the WRF model. Fig. 1 presents the volume of each partition in relation to the total

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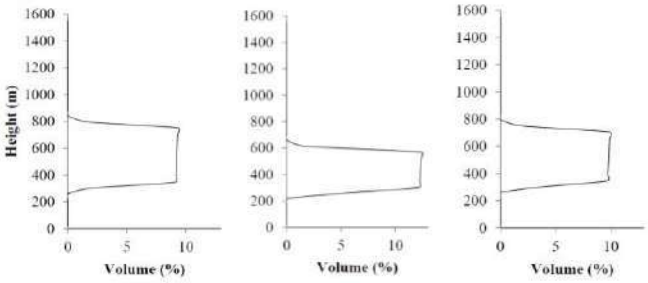
volume of the exhaust cloud for each scenario. As shown, the behaviour of the vertical distribution of the partitions is consistent with the mathematical modelling of exhaust cloud formation for aborted launch cases, and the cloud has a cylindrical shape.



(a) (b) (c)

Fig. 1: Percentage volume of each partition in relation to the total volume of the exhaust cloud for the aborted launch case and the (a) stable, (b) unstable, and (c) neutral atmospheric conditions.

The propellant used by VLS is primarily formed by CO, CO_2, HCl, and Al_2O_3 [21]. The following figures show scenarios of the modelling with MSRED and CMAQ for the HCl pollutant (March 18, 2013). The MSRED model simulated all the processes regarding the formation, rise, expansion, stabilisation, and dispersion of the exhaust cloud for the first hour, evaluating its short-range impact. Thereafter, it generated the mean concentration scenario of the first hour after the launch, which was then used as the initial conditions input for the CMAQ model for the long range modelling of the exhaust cloud's impact.

The time for the hypothetical aborted launch case with an unstable condition was at 16:00 GMT (13:00 local time). A scenario for the mean concentration of HCl at the sur-face level was generated with a 20-minute interval and is presented in Fig. 2.

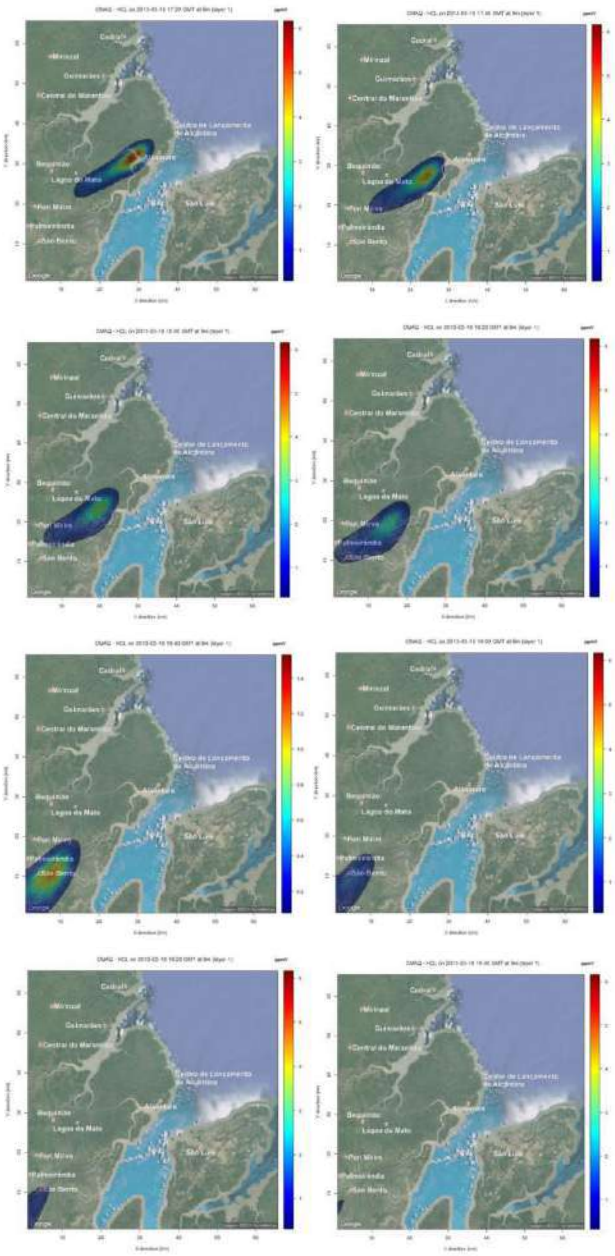


Fig.2. Scenario of the 20min average concentration for the HCl pollutant simulated by CMAQ using the initial conditions generated by MSRED, for a hypothetical aborted rocket launch case considering convective atmospheric condition.

At 17:20 GMT (first frame of Fig. 2), one can observe that the exhaust cloud travelled approximately 15 km from the launch pad, which is consistent with the surface wind speed (refer to Table 1). Each frame features the cities and villages near the CLA. As the time goes on, the HCl concentrations decrease below the concentrations at the beginning of the scenario. This occurs because of the physical and chemical processes that take place, leading to a decrease in the concentrations with the passing of time and as the plume travels along the domain.

https://dx.doi.org/10.22161/ijaers.6764 *ISSN: 2349-6495(P) | 2456-1908(O)*

The next scenario refers to the stable atmospheric condition for the aborted launch case, which is shown in Fig. 3.

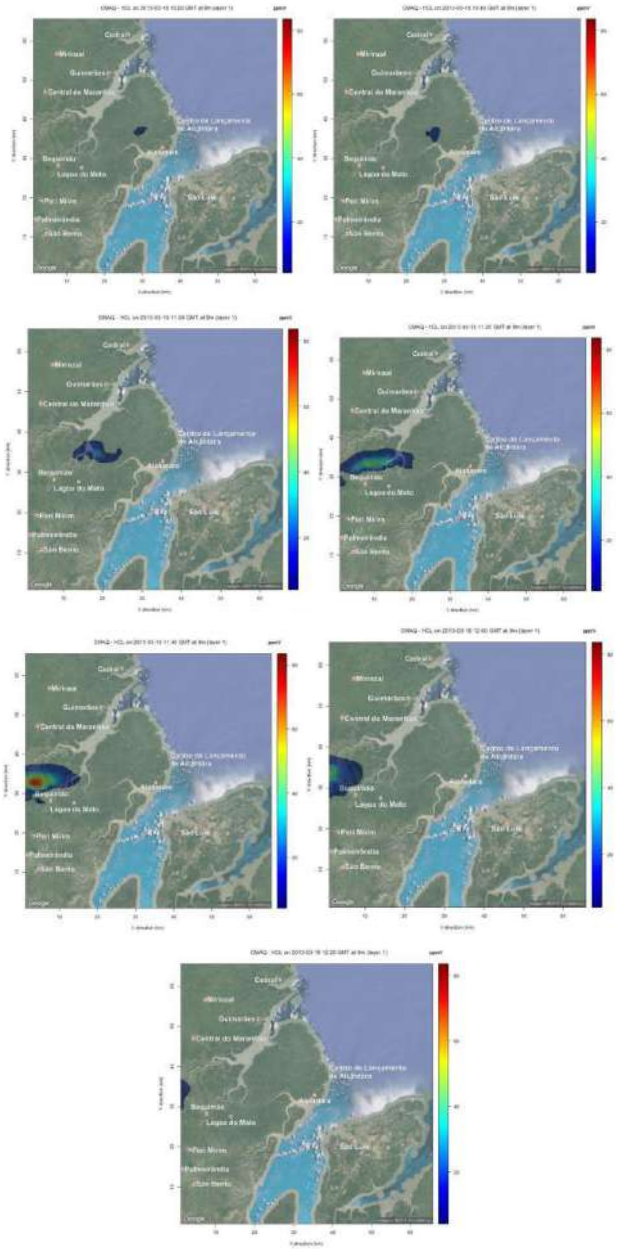


Fig.3. Mean 20 min concentration scenario for the pollutant HCL, modelled by the CMAQ for the aborted launch case with stable conditions, using the initial conditions generated by the MSRED model, from 10:20 until 12:20 GMT.

The concentrations in this scenario were the highest reported by the model for the aborted release case, and the presented concentration values had the potential to cause damage to human health or life. In this case, the cities most impacted by the exhaust cloud would be west of the CLA. It is important to note that higher concentrations occur at greater distances from the launch centre.

Finally, the modelling scenario with the CMAQ, using the initial conditions generated by the MSRED, will be presented for the long range evaluation of the impact of the rocket exhaust cloud on ambient air in the case of a hypothetical aborted launch in a neutral atmospheric condition. Fig. 4 below presents this scenario.

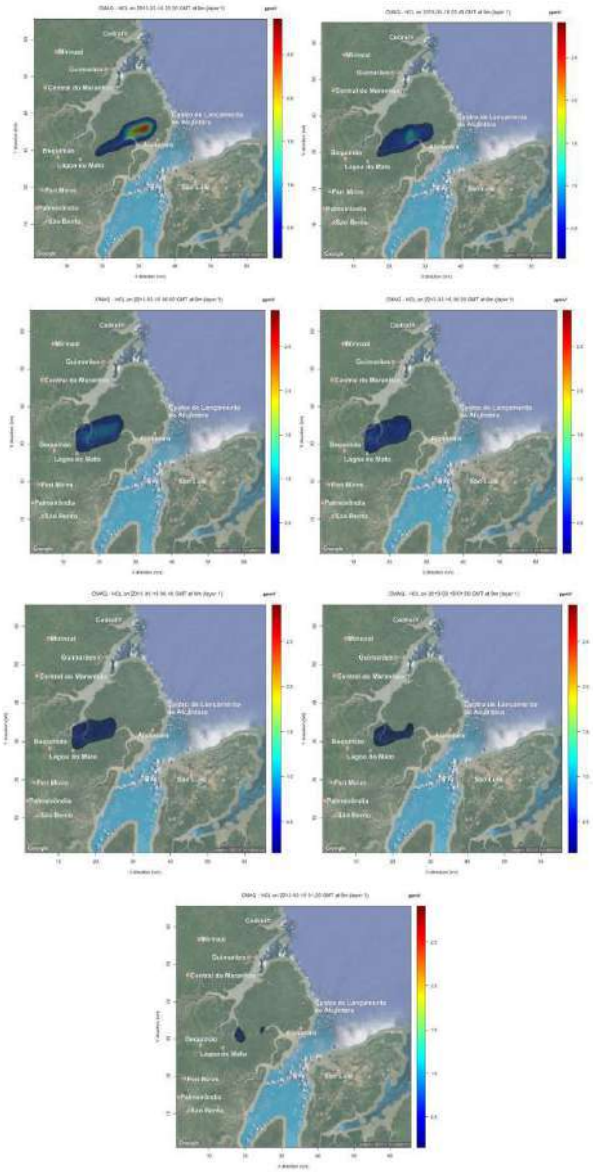


Fig.4. Mean 20 min concentration scenario for the pollutant HCL, modelled by the CMAQ for the aborted launch case with neutral conditions, using the initial conditions generated by the MSRED model, from 23:20 until 01:20 GMT.

It can be observed that the concentrations remained at lower levels than those presented in the stable condition scenario, although slightly higher than in the unstable

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case. In addition, for both the unstable and neutral cases, the highest concentrations occurred at distances closer to the launch centre. It should be noted that all simulations conducted under the different atmospheric conditions were for a hypothetical case that utilised a rocket carrying a much lower amount of fuel than a conventional rocket launched in other parts of the world; hence, the concentrations could be much larger than those found in this work.

3.1. Parallelism performance

The following figures present a graphical analysis of the performance of the computational parallelism mechanism that was designed and developed in MSRED. For this analysis, the processing time (in seconds) of the concentration calculation for each grid receiving point was measured based on the emission of an exhaust cloud partition using a varying number of processors. Fig. 5 presents a graphical analysis of the performance of the computational parallelism mechanism showing a reduction in processing time as the number of processors is increased. Fig. 6, however, presents the graphical analysis of the MSRED speedup. Speedup is a measure of performance which measures the ratio of sequential to parallel runtime:

$$S_p(n_p) = \frac{T_e(1)}{T_e(n_p)}, \tag{8}$$

where n_p is the number of processors, $S_p(n_p)$ is the speedup, and $T_e(n_p)$ is the model execution time for n_p processors. Performance tends to be ideal when speedup approaches n_p.

Another important measure is the efficiency E_p, which deals with the relationship between speedup and the number of processors:

$$E_p(n_p) = \frac{S_p(n_p)}{n_p} \tag{9}$$

In the case where speedup = n_p, the efficiency would have value of 1 (100%), meaning a greater efficiency value is optimal. Its chart is shown in Fig. 7.

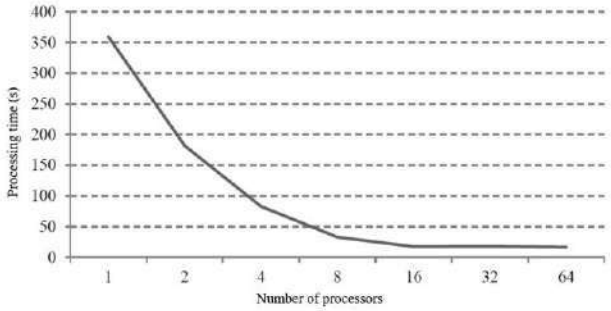

Fig.5. Percentage Reduction Graph of Processing Time.

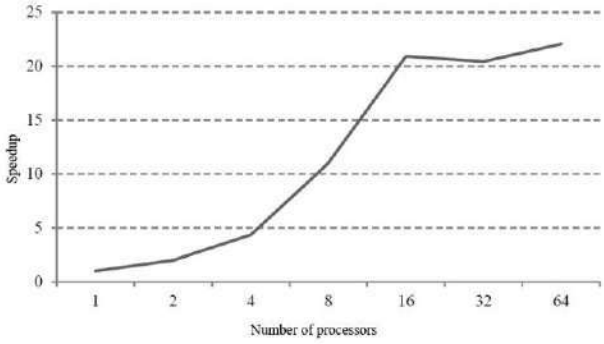

Fig.6. Speedup Chart.

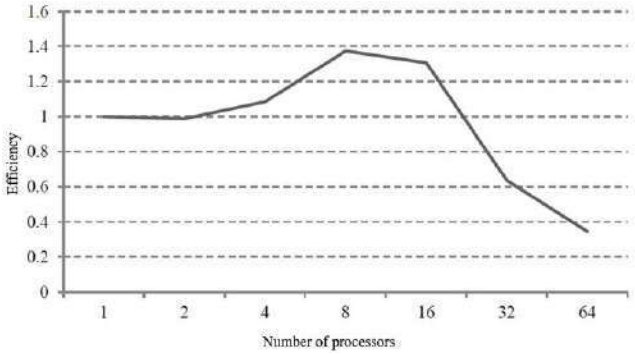

Fig.7. Efficiency Chart.

Table 2, in turn, presents the values of the processing time for each set of processors along with the percentage reduction, speedup, and efficiency. The tests were performed using 64-bit Intel Xeon 8-core computers, each with 2.133 GHz and 8 GB of RAM.

Table 2. Concentration processing time due to the issuance of an exhaust cloud partition for each processor set.

Number of processors	1	2	4	8	16	32	64
Processing time (s)	359.4	181.8	82.9	32.7	17.2	17.6	16.3
Reduction (%)	-	49.4	54.4	60.6	47.4	-2.3	7.4
Speedup	1	2.0	4.3	11.0	20.9	20.4	22.0
Efficiency	1	1.0	1.1	1.4	1.3	0.6	0.3

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In analysing the presented performance indicators, it can be observed that as the number of processors doubles, the processing time reduces by approximately one half, and in some cases by even more than a half, such that the processing time of the model is inversely proportional to the number of processors allocated for its execution. This shows the MSRED model's ability to be scalable, that is, to increase performance as more capacity is added. However, it is also observed that as the number of processors greatly increases, the reduction in processing time is negligible; hence, the processing time is stabilised at an approximately constant value. This occurs when there are more processors available for executing the model than grid subdivisions, in cases where the number of processors is greater or equal to the number of receptor points in the x direction, which is the basis of the division strategy for the computational parallelism of the MSRED model.

IV. SUMMARY AND CONCLUSIONS

This work presented a qualitative analysis of a hypothetical aborted/explosion of a VLS rocket launch in the CLA, Brazil, considering HCl compounds and the impact on the air environment for different atmospheric conditions. The concentrations in the stable scenario were the largest reported by the model for the aborted release case and presented concentration values with the potential to cause damage to health or human life.

This study highlighted the importance of simulating this type of event owing to the large amounts of hazardous pollutants that are emitted in a short time scale. Though an aborted launch is not a frequent event, it can severely impact the surrounding populated areas, potentially causing serious damage to public health. Aiming to fill a gap in the scientific community, Nascimento et al. [21] designed a hybrid, integrated, and modern modelling systemto address this issue. At its core is the MSRED model which was developed to accurately represent the exhaust cloud and the physical processes that are involved in the fast release, formation, rise, expansion, stabilisation, and dispersion of rocket exhaust gases for short-range evaluation, using meteorological input data from the WRF model, and to generate a concentration scenario based on the short-range scenario that is input to the CMAQ model to simulate the chemical transport for long-range assessment.

The results show the importance of utilising a modern, hybrid, and integrated model-ling system to assess the impact of rocket exhaust clouds on the environment by simulating the effects of aborted launch/explosion cases. This system is suitable for use in pre-launch planning activities, post-launch environmental analyses, emergency plans, test missions, and in decision making studies regarding the spatial allocation of monitoring networks.

Likewise, it is important to mention that this modelling system can be applied to any launch centre in the world because of its degree of generalisation and parameterisation, and it can also be used to evaluate explosions which have characteristics similar to aborted rocket launches.

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The Deleterious Impacts of Bariatric Surgery on Oral Health: A Review Article

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Abstract *— Obesity is one of the most urgent public health problems today due to the epidemic growth of this pathology. Elevated values in body mass index are associated with increased morbidity and mortality. Among the treatments for weight reduction is bariatric surgery, an invasive procedure that presents varied adverse effects. Among the consequences of surgery is the decline in oral health. Bariatric patients may present dental erosion, caries, periodontal diseases and hypersensitivity that negatively affect the quality of these individuals. In this way, through a review of the literature, this article brought together the scientific publications related to oral health damages after the bariatric surgery of Y de Roux, in order to explain the importance of dental follow-up of these patients.*

Keywords *— **Obesity. Bariatric surgery. Oral health. Gastric bypass. Y de Roux.***

I. INTRODUCTION

Obesity has become a worldwide epidemic because of its widely distributed prevalence[1]. According to the World Health Organization (WHO), 2/3 of the world's population are overweight[2]. In Brazil, the high rate of obesity has raised great concern, since half of Brazilians are overweight and of these, 1/5 are classified as obese, placing the country in fifth position in the world ranking of obesity[3].

During the twentieth century, in an attempt to contain obesity, there was the intervention of the pharmaceutical industry and the introduction of medicalization was started to treat this pathology[4]. Several drugs have been and are still being used, but the limited long-term efficacy, the various adverse effects and the rebound effect caused by the interruption of medication have caused their use to be questioned[5].

In 1954, researchers Kremen, Linner and Nelson developed the technique of disabsorptive surgery in dogs, removing part of the small intestine of these animals to promote weight loss[6].This was not the first surgical intervention to reduce obesity, historical accounts describe that the first surgical attempt for weight control was performed in the tenth century by the Jewish physician Hasdai Ibn Shaprut[7], but it was only after Kremen and co-workers that this procedure won notoriety and the number of operations for obesity has grown over the years.

Currently there are different surgical procedures for the containment of obesity[8]. Among the techniques are biliopancreatic deviation with duodenal key; vertical gastrectomy; vertical banded gastroplasty and the Roux-en-Y technique or gastric bypass.

The Roux-en-Y surgery causes a decrease in stomach and intestinal size, being denominated restrictive, by reduction in the gastric volume, and disabsortiva, because it causes the reduction in the absorption of the nutrients [9].This technique is considered the gold standard methodological due to its efficiency in reducing and maintaining body weight in the long term[10].

According to the Brazilian Society of Bariatric and Metabolic Surgery (SBCBM), in 2017 Brazil performed 105,600 bariatric surgeries. But according to SBCBM estimates, five million Brazilians would be able to perform the procedure due to the high numbers of obesity in the country.

As bariatric surgery is an invasive and sometimes irreversible procedure, initially only indicated for patients between 18-60 years old, with class III obesity (BMI $\geq$ 40 kg / m^2) or with class II obesity (BMI $\geq$ 35 kg / m^2) with comorbidities.But due to the problems caused by overweight, currently, adolescents between 16-18 years old and elderly can be submitted to the procedure provided they fall into one of the categories 11. Extension of surgery also occurred for diabetic patients with BMI $\geq$ 30 kg/m^2[12].

Gastric bypass is not only effective for weight loss, the benefits of surgery also include improved quality of life, reduced mortality and remission of obesity-related

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comorbidities such as diabetes[13], hypertension and cardiovascular diseases[14], depression [15]and apnea[16].

Surgery is recognized as an effective treatment for severe obesity, but this procedure may present adverse effects resulting from surgical intervention such as mnemonic and behavioral changes, decreases in immune defense responses, bone decalcification, nutritional deficiencies and decrease in oral health[17,18].

Thus, this literature review investigated the repercussions of Roux-en-Y bariatric surgery in the oral cavity.

II. MATERIAL AND METHODS:

For the selection of articles used in this narrative literature review, the following keywords were used: (Oral Health and Bariatric Surgery); (Gastric by-pass or Roux-en-Y and Oral Impact); (Gastric by-pass or Roux-en-Y and Oral Health) in the MEDLINE / PubMed (NLM), Science Direct, Lilacs) PubMed, Lilacs and Science Direct databases. After electronic searching, full articles were reviewed and the most appropriate ones were included in this article.

BARIATRIC SURGERY AND ORAL HEALTH:

The oral cavity is an anatomical-physiological component of the gastrointestinal tract, and when part of this system undergoes some alteration, oral health may be potentially impaired[19].

After bariatric surgery one of the most frequent adverse manifestations is gastroesophageal reflux and vomiting, leading to changes in pH in the oral cavity[20].This regurgitation of gastric juice causes acidification of the mouth, leading to a decrease in pH at critical values for enamel and dentin, promoting the dissolution of hydroxyapatite crystals[21]. This loss of tooth structure may lead to exposure of the dentinal tubules causing hypersensitivity[22].

Patients with frequent reflux and vomiting may have dental erosion as well as lesions on the oral mucosa[23]. This loss of tooth structure due to significant pH reductions may result in loss of pulp vitality.

Reduced pH values also contribute to the development of dental caries. The oral cavity is largely colonized by cariogenic bacteria that produce organic acids through the metabolism of carbohydrates and sugars from food intake[24].Reduced pH values also contribute to the development of dental caries. The oral cavity is largely colonized by cariogenic bacteria that produce organic acids through the metabolism of carbohydrates and sugars from food intake[25]. The bone fragility caused by hypovitaminosis may be reflected in the increased mobility of the teeth, which may lead to tooth loss. In addition, Wojcik et al. Demonstrated that caries may be a reflection of vitamin D deficiency, since increases in the concentrations of this micronutrient in the diet reduce the incidence of caries[26].

The generation of acids helps in the degradation of the organic and inorganic matrices of the tooth. Saliva plays a key role in pH buffering in the oral cavity, but acid attacks from the stomach contents favor tooth demineralization and salivary packing becomes inefficient in the face of continuous regurgitation, resulting in the onset of caries[23].

Another important factor that is associated with the increase of dental caries in bariatric patients is the acquisition of new eating habits after the surgical procedure. Due to stomach reduction, it is necessary to reeducate food with reduction of ingested volume and increase in the frequency of intake (10-8 meals / day)[24], consequently, it is indispensable that brushing happens after feeding so that plaque formation does not occur and caries development is possible[27]. How bariatric surgery was developed to cause a reduction in intestinal absorption. This dis-absorptive intervention may affect the nutritional status of the patient. Studies reveal that after surgery may occur deficiencies of vitamins D, B vitamins and vitamins A[28,29,30].

Deficiencies of vitamins B2, B3, B6 and B12 usually manifest in the oral cavity through stomatitis, glossitis and oral ulcers, causing pain and discomfort to the patient[31].

Vitamin A (retinol) is known for its role in oral health and declines in systemic vitamin A concentrations are reflected in oral health. Vitamin A plays an important role in the maintenance of oral mucosa, salivary glands and teeth. In animal models, vitamin A reductions have been shown to cause degeneration of the salivary gland and a significant increase of cavities [32].

Saliva plays a crucial role in maintaining oral health due to functions in the immune response through the presence of antimicrobial components and proteins that act in innate and adaptive defense, as well as in buffering capacity[33]. Reports of hyposalivation have been observed in patients submitted to the Roux-en-Y procedure and reduction of salivary flow directly impairs the remineralization of teeth and decreases oral health[34].

Changes in periodontal tissues are also observed in patients undergoing bariatric surgery[35]. Due to the inflammatory nature of obesity resulting from the secretion of adipokines [tumor necrosis factor alpha (TNF-α) and interleukin 6 (IL-6)] by adipose tissue[36], initially it was believed that the surgical procedure could

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improve the periodontal condition of obese patients. But research investigating the periodontal condition after the Roux-en-Y procedure demonstrates that there is an increase in gingival bleeding and periodontal disease in these patients. It is believed that the reasons for this decline in periodontal health are partly due to changes in the microbiota of the oral cavity and nutritional changes after surgery[35].

III. DISCUSSION

Obesity in recent years has shown a worldwide growth, and due to the lack of efficient methodologies for the reduction of body weight, there was agreement on the use of more aggressive methodologies. In this context, bariatric surgery has proved to be a therapeutic option capable of causing a dramatic and sustainable loss of body weight[37].

Although the evolution in the surgical methodology reduced the risks involved during the procedure, adverse effects caused by the gatroplasty procedure are still observed. Thus, there is agreement that bariatric surgery is considered an effective model for reducing body fat, however, it should be the last option for weight loss.

The oral cavity is a component of the digestive tract and is also subject to the negative consequences of surgery, but often the adverse effects on the dentition are ignored. The authors are unanimous in reporting the significant decline in oral health after the gastrectomy procedure[18,23,38].

Among the oral pathologies commonly found in patients submitted to the Roux-en-Y bariatric surgery, the prevalence of periodontitis, caries, dental erosion and dental hypersensitivity is evident, demonstrating that despite Roux-en-Y surgery, the quality of life of patients is improved due to the reduction of body weight and obesity-related comorbidities, with decreased oral health[18]. This decline in the oral condition is observed mainly in the first six months after the procedure, period of greatest weight loss.

It is believed that many of these undesirable results may be consequences of changes in eating habits with an increase in the frequency of intake, frequent regurgitations, as well as reduction of oral hygiene. In addition, knowing that obesity is a pathology that causes a chronic inflammatory state due to the secretion of proinflammatory cytokines by adipose tissue and oxidative stress, the maintenance of fat cells in the first months after the surgical intervention together with the caloric restriction due to the post-surgical diet may reflect on the general condition of the patient, decreasing oral health conditions[39].

The decline in oral health has a negative effect on the patient's life[40].According to the WHO, oral health-related quality of life has significant implications in the individual's different domains (social, environmental, functional), impacting on self-esteem, personal satisfaction with oral health, ability to feed[41].

In this way, health professionals should be warned about the decline in oral status in bariatric patients so that the necessary care. However, there are no reports of the presence of dental surgeons in the pre-surgical follow-up of this group of patients and the need for the insertion of the dentist in the multidisciplinary team of bariatric surgery is undeniable in order to dignify and treat possible previous oral pathologies, as well as to prevent or attenuate the effects caused by bariatric surgery.

IV. FINAL CONSIDERATIONS

Obesity has become a public health problem responsible for several comorbidities that result in decreased quality of life, in addition to reducing the longevity of the individual, and therefore must be tackled. Thus, bariatric surgery is an effective method for reducing body weight, however, the scientific community should be aware of the adverse effects caused by surgical intervention, including oral health impairments.

There is no consensus about the deleterious effects of bariatric surgery on oral health, however the damage is evident. Thus, this review highlights the need for follow-up of patients submitted to surgical procedures, and the importance of the insertion of the dentist in the team of bariatric surgery professionals, in order to control the harmful effects on the oral cavity caused by surgery.

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2D Microwave Imaging of the Breast Tissue: Forward Problem Technique

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Abstract *— Microwave imaging is the method that used to detect breast cancer. Previous research is done by inverse problem and forward problem solution, but the inverse problem is difficult to solve because there are many unknown constants. Thus in this paper, microwave imaging is solved by different way, i.e. using forward problem solution only with the aim to easier the imaging process without ignoring the resolution. So the malignant breast cancer is easier to detect and this technique can be used as an easy, safe, and cheap of early detection of the breast cancer. This process is done by illuminating normal and malignant breast tissue model using microwave at frequencies 5GHz, 10GHz, and 15GHz. Then the scattered field data are calculated by Method of Moment. The scattered field data is presented in 2D figure. The results show that normal and malignant breast tissue produce different scattered field patterns. The normal breast tissue tends to produce more curve pattern around object. This difference in patterns can be used as a reference to distinguish b etween normal and malignant breast tissue.*

Keywords *— **Dielectric Constant, Forward Problem, Method of Moment, Microwave Imaging.***

I. INTRODUCTION

Breast cancer is the most often cancer that affects women and causes many deaths. Early detection can improve treatment succes and safe patient from the deaths. Microwave imaging is the imaging method that has been developed for early detection of breast cancer, because microwave imaging do not ionize the breast tissue, lower cost, and do not use compression [1], [2].

Previous research about microwave imaging have been done by using Microwave Tomography (MWT) [3]–[5]. Microwave tomography technique consists of two process, inverse problem solution and forward problem solution. Forward problem solution calculates scattered field around breast object using Maxwell equation. While inverse problem estimates dielectric properties of the breast tissue from the measurable scattered field data produced by forward problem [6]. However the researchs about MWT technique do not develop faster[4], [7]. This is because the large dielectric contrast of biologist tissue so that generates the change of inverse problem solution, that is the appearance of complex permittivity function in the Maxwell equation thus becoming non linear equation [8]. Because there are many unknown constants, the inverse problem solution becomes more complicated [9], needs more time [10], and needs adquate computer [4]. Whereas the inverse problem solution is needed to produce accurate solution.

To solve this problem, we present the alternating solution of microwave imaging. i.e microwave imaging based on the scattering image that produced by forward problem solution. This microwave imaging technique is simpler than previous technique, because only using forward problem solution. Therefore the resulting images can not show the component that exist in the breast tissue, but only the scattered field around the breast object. Nevertheles, the result of forward problem solution still can be used to detect cancer in the breast tissue. This is due to the dielectric constant of the breast. The dielectric constant of the normal breast tissue and malignant breast tissue is different [10]–[12]. Malignant breast tissue has greater dielectric constant than normal breast tissue because malignant breast tissue contains more water [13]. The difference in the dielectric constant causes a difference in scattering patterns. The pattern of the scattered field can be used as a reference to distinguish between normal breast tissue and malignant breast tissue. So the microwave imaging with forward problem solution can be used as early detection method.

II. METHOD

In this section we describe tomography model, object model, and mathematical model. The tomography model used is shown in Fig. 1. We can see that antennas are located around object. Each antenna can swich as a transmitter or receiver antennas. If the first antenna as a transmitter antenna so the other antennas as a receiver antenna, this happens until the last antenna. The transmitter antenna illuminates object using microwave

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with frequencies 3 GHz, 9 GHz, and 15 GHz alternately and the scattered fields are observed at receiver antennas.

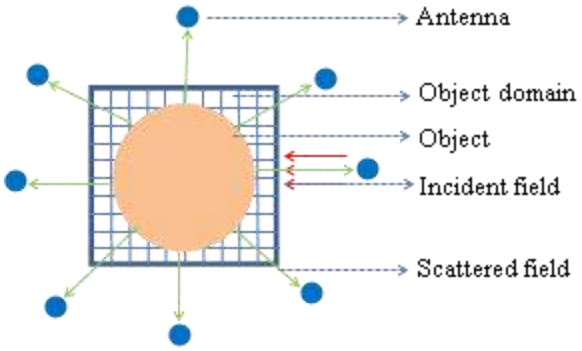

Fig.1: Tomography Model

Breast object is modeled by dielectric silinder with radius 3 cm. There are two objects, normal breast object and malignant breast object. Both of them are modeled by Cole-cole equation.

$$\varepsilon(\omega) = \varepsilon_\infty + \frac{\Delta\varepsilon}{1+(j\omega\tau)^{1-\alpha}} + \frac{\sigma}{j\omega\varepsilon_0} \quad (1)$$

$\varepsilon(\omega)$ is the dielectric constant that changed depend on angular frequency, ε_0 is relative dielectric constant of material, ε_∞ is infinite dielectric constant, $\Delta\varepsilon$ is the reduction between static dielectric constant and infinite dielectric constant $(\varepsilon_s - \varepsilon_\infty)$, α is expontial parameter, ω is angular frequency, τ is time constant, and σ is material conductivity. The Cole-cole parameters are shown in the Table 1.

Table 1. Cole-cole parameters [14]

Parameter	Normal	Malignant
ε_∞	3.00	8.00
$\Delta\varepsilon$	1.00	50.50
α	0.10	0.04
τ	20.00	10.50
σ	0.036	0.90

The mathematical model states the breast object model and electrical field in the mathematical equation. The imaging process can be stated in three equation, scattered field, incident field, and total field.

$$E^i(\vec{r}) = E^t(\vec{r}) - E^s(\vec{r}) \quad (2)$$

By using vector potential, Green function, and polarization current density principle, the equation 1 can be stated as

$$E^i(\acute{r}) = \frac{1}{jw(\varepsilon-\varepsilon_0)} J(r) - jk_0\eta_0 \iint_\Omega \frac{1}{4j} J(r') H_0^2(k_0\rho)\, dr' \quad (3)$$

The polarization current density in equation 3 is unknown, so the value must be determined first before determines the scattered field. Therefore we use Method of Moment (MoM) to solve this forward problem. MoM is more efficient that other numerical method, because MoM use Green function so the boundary condition can be fulfilled automatically [15]. By applying pulse basic function, the breast object is divided into N cell that have same size. So the polarization current density at each cell can be stated as

$$J(r) = \sum_{n'=1}^{N} J_{n'} P_{n'} \quad (4)$$

Where pulse basic function is

$$\begin{aligned} p_n &= 1 \rightarrow ((r) \in cell_n) \\ p_n &= 0 \rightarrow (elsewhere) \end{aligned} \quad (5)$$

By subtituting equation 4 into equation 3, we can states

$$\left[E_n^i\right] = \left[Z_{nn'}\right]\left[J_{n'}\right] \quad (6)$$

Where

$$\begin{aligned} \left[Z_{nn'}\right] &= \frac{\eta_0 \pi a_n}{2} J_1(k_0 a) H_0^{(2)}(k_0\rho) \rightarrow \rho > a(n \neq n') \\ \left[Z_{nn'}\right] &= \frac{\eta_0 \pi a_n}{2} H_1^{(2)}(k_0 a) \rightarrow \rho \leq a(n = n') \end{aligned} \quad (7)$$

Thus the polarization current density can be calculated. Based on the equation 3, the scattered field can be stated in

$$E^s(r) = jk_0\eta_0 \iint_\Omega \frac{1}{4j} J(r') H_0^{(2)}(k_0\rho)\, dr' \quad (8)$$

By subtituting equation the polarization current density to equation 8, the scattered field produced by each cell and each projection can be approximated as

$$\left[E_m^s\right]_t = \left[Z_{nn'}\right]\left[J_{n'}\right]_t \quad (9)$$

Thus the scattered field around breast object can be calculated and presented in 2D images.

III. RESULTS AND DISCUSSION

The scattered data around breast object is presented in 2D image. Where the magnitude of the scattered field is shown by color as seen in the legend besides. The dark red color shows the greatest magnitude of scattered field and the dark blue shows the smallest magnitude of scattered field. The results are shown in Fig. 2. If seen in general, the area that located at opposite transmitter has greater magnitude of scattered field than other area. This applies to normal and malignant breast tissue at frequencies 5GHz, 10GHz, and 15GHz. However, both of them has different scattered field patterns. At 5GHz, the different pattern between normal and malignant breast tissue is not so visible. But still there is a different pattern at area located in same side with transmitter antenna, where the malignant breast tissue has greater magnitude of scattered field than normal breast tissue as seen in

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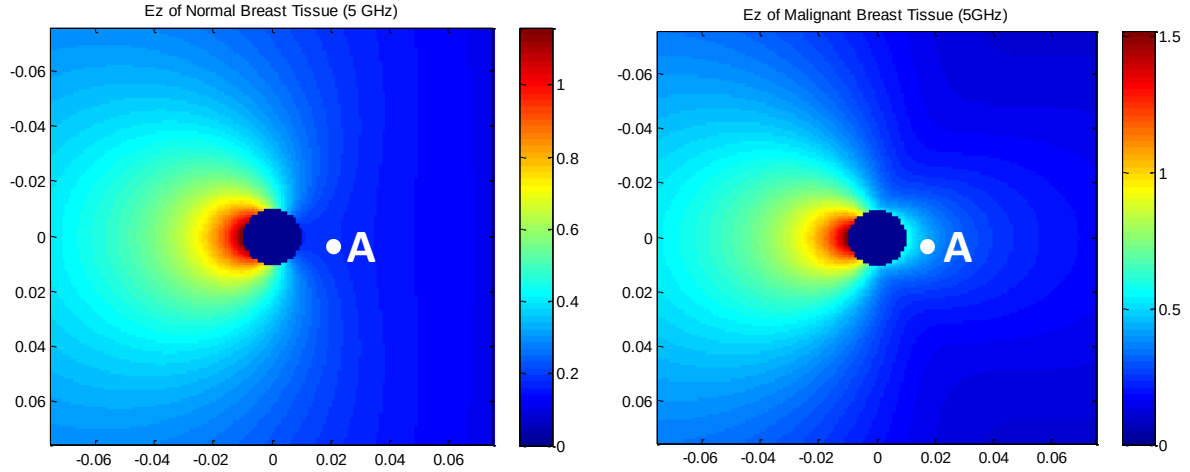
point A, where the normal breast tissue is shown by blue color and malignant breast tissue is shown by light blue color that forming a curve pattern.

At 10GHz the different pattern is clearly visible. Normal breast tissue produces four curve pattern around the normal breast tissue which resembles dark and bright patterns. But only curve pattern that located at opposite transmitter antenna has greatest magnitude of scattered field. While malignant breast tissue produce one elongated pattern at the area opposite the transmitter antenna and one curve pattern at the same side area with transmitter antenna. If seen in point B, we can see that normal breast tissue is shown in blue color, while the malignant breast tissue is shown in green color. This shows that malignant breast tissue produces greater magnitude of scattered field than normal breast tissue.

The different pattern of scattered field at 15GHz also clearly visible. Both of them has similar pattern with scattered field pattern at 10 GHz, but more complex. Normal breast cancer produce six curve pattern around breast object. While malignant breast tissue produce one oval pattern and two small curve pattern. Same with the image at 5GHz and 10 GHz before, malignant breast tissue also produces greater magnitude as seen in point C which is shown in light blue color. This results show that normal breast tissue tends to produce curve pattern around breast object and has smaller magnitude of scattered field than malignant breast tissue. The different pattern between normal and malignant is better observed at 10GHz and 15GHz. This result is due to the difraction process in the breast tissue. Which the cells in the breast tissue are considered as narrow slit. So when the microwave illuminates the breast tissue, the microwave is deflected and become the scattered field. When the frequency used is suitable with the slit, so the dark and bright pattern are produced. Thus the normal breast tissue at 10GHz and 15 GHz produce dark and bright pattern, while the malignant breast tissue does not.

The difference in dielectric constant causes a difference in scattering patterns. Malignant breast tissue has greater dielectric constant than normal breast tissue. When illuminated using microwave, the centroid of the positive and negative charge which is bound will shift from its initial position. Thus the atom are polarized with dipole moment and produces polarization current in the breast tissue. The polarization current density is influenced by dielectric constant and frequency of microwave. Thus the tissue with greater dielectric constant produces more polarization current density. The presence of the polarization current density in a dielectric tissue causes scattered field around it. The greater polarization current density the greater magnitude of scattered field produced. Suitable with equation 8, polarization current density is directly proportional with scattered field. Therefore the scattered field produced by malignant breast tissue has greater magnitude than normal breast tissue.

At different frequency of microwave, the pattern of scattered field is different, both normal and malignant breast tissue. The scattered field at 15 GHz has more complex pattern than scattered field at 10 GHz and 5 GHz. However, the magnitude of scattered field is smaller. It can be seen from the pattern of scattered field at opposite area with transmitter, which is shrinking more when the higher frequencies of microwave used (indicated by color around object). This is because frequency influences the dielectric constant of the breast tissue. Suitable with Cole-cole equation, the greater frequency used the smaller dielectric constant of the breast. So magnitude of the scattered field decreases.This is suitable with previous research by Winters *et al.* (2006).



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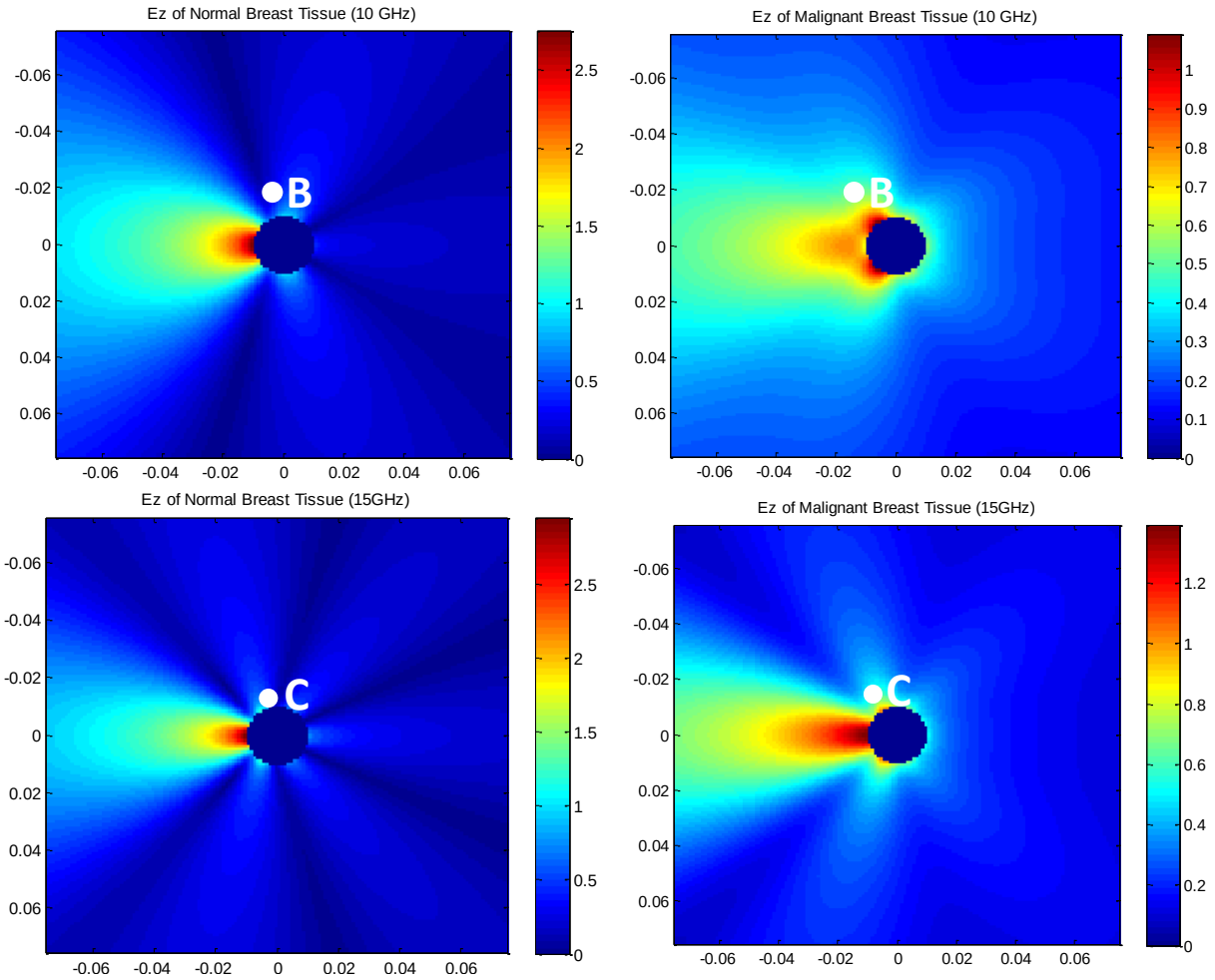

Fig. 2: Scattered field of normal and malignant breast tissue at 5GHz, 10GHz, and 15GHz

IV. CONCLUSION

We have been shown the microwave imaging using forward problem solution and MoM. Based on the result, we can see that the normal and malignant breast tissue produce different scattering patterns. Normal breast tissue tends to produces many curve patterns around the object and have smaller magnitude than malignant breast tissue. At 15 GHz, the difference of scattering patterns is seen clearly, so this frequency can be an effective frequency for breast imaging. Nevertheles this numerical algorithm can not be used to determine the position of tumor in the breast tissue, but this algorithm already can be used as an early detection of breast cancer, because this algorithm can distinguish between the pattern that produced by normal and malignant breast tissue. The further research can be done by considering the higher frequencies of microwave to know the most effective frequency to detect breast cancer.

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Using the INJET System in the EPS Injection Industry

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Abstract**—** *The aim of this research is to demonstrate the improvements and gains that the expanded polypropylene company (EPS) obtained with the use of the mes-idw injet system in the machines, to obtain levels of productivity compatible with the resources of the company. By analyzing the data and facts collected in the company's process flow, it was possible to identify improvement in the operations performed. The productive control has contributed to the company's productivity with excellence. According to the bibliography based on data collected in the company, it was possible to identify actions that are satisfactory. Based on the needs evidenced in the company and the necessary measures that were taken through the implementation of the INJET system, it is feasible the improvements that were applied, with which it increased the continuous production performance and the total quality of its products..*

Keywords**— Production management, monitoring system, quality, improvement tools.**

I. INTRODUCTION

Production management encompasses all processes related to production in a company that works with manufacturing, where the competitive environment is becoming more and more disputed, making it always a search for improvements in productive resources, with quality and the lowest possible cost.

There are several definitions for the term quality, which makes a definitive concept impossible for the idea of what it is. The truth is that it has come to stay, whether at work, at home, in the production of goods or in the provision of services, quality is present in all areas of our lives.

The thermo technique is a company focused on the production of solutions, integrated in the supply chain, producing the own raw material and products developed with the best performance in the market. It is considered a leader in the Brazilian packaging market for industrial products, and consolidates with ample growth and evolution, as the largest manufacturing industry of EPS-Styrofoam Expanded (Styrofoam) in South America.

The MES-IDW INJET (manufacturing execution system) system is a monitoring system that provides managers with information about each machine in the production process: a case study at the company Termotécnica da Amazônia Ltda.

The general objective of the research is to demonstrate what improvements and gains in the quality of the products and services that the company Termotécnica obtained with the use of the system in the production line. In order to contextualize, the specific objectives were created: to demonstrate the improvement of productivity and time that the organization obtained with the use of the system; verify the vulnerability of the system; to describe the efficiency of the machines that the company had with the implementation of the monitoring system.

Methodologically, this study adopted the type of field research within the production area, where the system is applied and developed based on the questionnaire done in all sectors that compose the company's portfolio.

The study is therefore justified if factory floor information is not handled properly, a number of problems can occur in production management, so the INJET system plays a key role within the company, it streamlines the process of data collection, emitting accurate reports on production design and machine shutdown reports, giving an extensive view throughout the productive process, thus aiding in decisions and the total quality of the products.

It has relevance for the companies, due to the fact that in the productive process that is the greater possibilities of losses and, also, the greater of gain. In this way, the evolution of the machine monitoring system is

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fundamental to promote the identification of these losses, as companies seek to excel in the market through productivity and quality, and using an efficient and innovative system to facilitate the data collection of the production. Society is the most benefited by this feature, because it increases the quality of products, reducing production time, thereby reducing waste and, consequently, the final price passed on to customers will be lower.

For the academics of quality and production management, it has relevance because they have gained knowledge, added values and a better understanding for a good strategy in the globalized and competitive market.

II. THEORETICAL REFERENCE

Will be presented in this item, the conceptual elements on industrial production, technology, INJET system, INJET architecture, Quality Management, Quality Tools, Management Systems and KAIZEN.

2.1 INDUSTRIAL PRODUCTION

What we know as industry, developed from the Industrial Revolution, which began in the eighteenth century in England. The bourgeoisie sought greater profit, lower cost and accelerated production, so it sought an alternative to improve the production of goods, because in the middle ages, the way of production was handmade [1].

In today's globalized world, companies seek to increase their competitiveness, either by reducing costs, improving the product or adding value to the customer's product, to differentiate themselves from the competition [2].

The revolution brought the production method more efficient, the products are produced quickly, with the help of machines, thus, prices became more affordable, but also with the evolution of machines came unemployment, because, with the use of machines , human labor was no longer necessary [3]. No organization survives unless it produces something that society needs, at the price it is willing to pay. Each organization defines its systemic model because it depends on the marketed product and the production capacity.

The assembly line and the standardization of the equipment used in the production gave rise to uniform products, unlike craft products which could hardly be reproduced equally [4].

Production within the factory requires a lot of technology and investment to be economically profitable, the traditional production line is subjected to a series of rationalization and optimization methods; study of time and methods to better seize the workforce. According to [5], abundant capital provided innovations, making the mechanization of manufacturing organizations result in increased production and cost reduction.

With these changes, it was necessary to create software to be able to manage production processes. According to [6], companies and professionals need continuous improvement, not to be stagnant or to be carried by the current of events to the past, because of the knowledge gap. These technological inventions have positive effects in the industries, because it is developed to aid in the decisions of the organizations and ends up becoming a competitive differential with the innovations.

2.2 INFORMATION TECHNOLOGY

Companies are turning to technologies, seeking to automate their production processes using these tools. A company without technology does not survive in the globalized world, where the search for cost reduction is constant.

The use of information technology as an organizational resource consists of its strategic use, which allows the organization to obtain a competitive advantage in relation to the competition, as well as the possibility of generating new business [7].

This system uses hardware, software, telecommunications networks, computerized data management techniques. The information age and the potential of new technologies is undeniable, however, this potential can be used positively or negatively, new technologies are of utmost importance for the survival of organizations, information technology has positive effects in the business world , since it improves the strategic and functional level, enabling companies to improve planning processes and to interact with their environment in the most productive way and making them more competitive, but it is worth emphasizing that, for the productive process to be satisfactory, employees are trained and qualified to meet the demand for information contained [8].

According to [9], many professionals, regardless of their field of activity, use the information system as a wild term, that is, it has an almost total coverage when it comes to technological solutions. The current scenario, where it is increasingly competitive, leads companies to invest in innovative programs for cost reductions, quality improvements, greater attention to consumer needs, and increasing use of information systems and technology.

A management information system is an integrated man / machine system, which provides information to support the operations, management and decision-making functions of an organization [10].

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Success and differentiation are always obtained by companies when they use the information system. System professionals are not only required to provide organizations with good software, databases and information exchange networks, it is necessary for them to know the business of the company, with a broad view of the business, main competitors and the market of the activity, only so it can develop solutions that contribute to the achievement of effective and sustainable competitive advantages.

According to [10], technological innovations and review of organizational structures will lead to the discovery of new opportunities. The path offered to organizations and people by the use of computational resources, have been very promising according to processes and communication more agile and of better quality. As the direct body of organizations becomes aware not only of the benefits of new technologies but also of risks, this system can play a much larger role than just supporting the development of new business and business processes, but also with concern about the consequences that these new technologies will add in the organizational environment.

2.3 INJET SYSTEM

The INJET system is an information tool that assists in the management of continuous improvement of the production process of machines [11]. This system is used and has been successful in management philosophies such as Lean Manufacturing with the use of Six Sigma techniques, all successful history monitored by the INJET System and registered in a database.

These new technologies have been of paramount importance to organizations, especially in the area of production.

According to [6], the companies with the greatest capacity for innovation are the most competitive, as they seek incessantly the differentiation of their products and services.

The technologies leverage levels of productivity within organizations, because these tools streamline the process and help decision making, the Injet is an indispensable tool in the production line, organizations that use this system have a differential in the level of productivity, this system is a resource with hardware and software devices that can be integrated with other organization information systems such as the Enterprise Resource Planning (ERP) system [12].

According to [13], before we implement a new process, we need to have an early idea of its possible results, either to confirm our expectations regarding the benefits sought or to identify possible side effects. The system itself does not bring capacity, that is, it provides awareness to the administrator, to the machine operator, where he can really act to improve. Where it understands and seeks more efficiency and results, this sense of achievement is the greatest gain for the organization and its employees.

The company must plan and choose carefully the purchase of software, allowing a fast and secure transaction between the management model in which it operates and what the software will provide to achieve the proposed objectives [14].

The INJET system is a tool that, well used, can bring several benefits to the productive and strategic process of a company, since there is a need to be a competitive and differentiated company in the market where it operates, thus, there is an opportunity to search solutions, where the INJET system proved to be highly adaptable to the structure of the organizations that adhered to this system, another point that was very favorable, it was the opportunity to perform a pilot with the system for later decision on its acquisition, as this system, besides reducing cost, it assists in the decision making of the organization in relation to productivity, besides making the more streamlined production line.

According to [12], with the availability of information, the flexibility in the use of available resources increases, knowing when and where they can be used, and with this, we gain competitive advantage. This system can verify the real effectiveness of the product, because it shows a different way of managing and managing the factory floor in a dynamic way, because this system has several reports that enables the continuous action where the product itself is self-marketing due to improvements and maximization of the results it offers.

2.4 INJET SYSTEM ARCHITECTURE

The INJET system needs four steps for data flow to work; the first is the data application of the machine, which is based on the use of programmable logistical controllers, it can be used automatically or manually; the second is a server that is based on the client and server architecture, this collection is in the system database; the third is a master computer, it manages the receipt of data, where all information will be analyzed and processed, and the fourth step is a maintenance terminal (TM), which are computers that work the corporate network, in that computer will be monitoring in real time and also the results of the reports already made [16].

For [17], the architecture based on the business of the electronic system is a worldwide trend. This system must be well accepted within organizations, because it raises the degree of productivity, companies that already use

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this system, have reaped the fruits with the increase in profitability.

Second Technology alone is not capable of making a business more dynamic, but it can make its business models more flexible, able to adapt to the constant changes in the market.

The INJET system offers a number of analytical reports and managements that help to define improvements in the production process, taking into account the performance of machines in product performance. This technology has come to aid in the continuous process of organizations, but to achieve a good performance, it is not enough to have an efficient system, but, people qualified to operate these machines.

The INJET system goes beyond monitoring the factory floor process. For [18] this processing generates accurate information that can be presented in the form of reports and graphs that facilitate the analysis and interpretation necessary for the immediate decision making. This system controls the production in real time, the data is processed at the same time that happens the productive process.

2.5 QUALITY IN INDUSTRIAL PROCESSES

Quality is the degree of utility expected or acquired of anything, verifiable through the form and constituent elements of the same and the result of its use [19].

Quality is conceptualized by processes and methodologies, applying rules and norms in a context with company policy [20]. The implementation of the rules controls how the processes available within the company are performed so that the achievement of the organization's objectives occurs.

Usually, quality is seen as an attribute of the product or service. Broadly speaking, it refers to anything done by people, such as electrical equipment, cars, hospital services, school-provided instruction, or someone else's work, in any department, company, or institution [21].

The quality itself is characterized by the production of something, from this concept, quality serves as a measurement parameter of products and services to the needs and requirements of the final customers. In the 21st century, the quality process accompanies every stage of manufacture.

The acronym TQM stands for Total Quality Management [22]. It is a managerial philosophy, a set of practices that emphasizes continuous improvement, seeking customer needs, long-term thinking, elimination of scrap and rework, worker involvement, teamwork, new process projects, benchmarking of known best work practices), analysis and problem solving by employees, outcome measures and close relationship with suppliers [23].

When talking about Total Quality Management or Total Quality Management (TQM), reference is made to quality in a broader way, that is, encompassing several economic sectors, such as industry, commerce and services. It is a set of coordinated activities aimed at directing and controlling an organization in relation to quality, including planning, control, quality assurance and improvement [24].

TQM is an effective system for integrating efforts to develop, maintain and improve the quality of an organization's various groups, enabling production and service to be brought to the lowest levels of operation and fully meet consumer satisfaction. The search for quality to meet the needs of customers is no longer a competitive differential, but an obligation for your business to survive in the market, therefore, the use of quality tools arises.

2.6 QUALITY TOOLS AND MANAGEMENT SYSTEMS

Using the techniques and tools of quality and management helps a company win the market and have loyal customers.

Quality tools come from knowledge and, although many of these tools are used based on the ideas and opinions of the employees, that is, the work team, they can be classified for their purpose [24].

There are several tools, however, let's talk about the best-known quality tools, are the flowchart, Ishikawa diagram, check sheet, histogram, Pareto diagram, dispensing diagram, control chart, brainstorming, benchmarking, 5W2H.

The 5S and PDCA management philosophy. Together, these tools are part of a specific group of elementary statistical methods [25].

Flowchart: This tool uses graphic symbols to represent the nature and flow of process steps [26].

Ishikawa diagram: known as cause and effect diagram, fishbone or graph, its function is to identify, classify into useful categories and show the possible causes of a problem or aspect related to quality [26].

The cause and effect diagram was developed in 1953 by Professor Kaoru Ishikawa of the University of Tokyo, derived from an explanation of the relationship between a problem or the undesirable effect of the effect of the process result and the possible causes of the problem.

Benefits: It is very visual and uses a very simple format, facilitates resolution of the problem, dividing it into units easier to manage and provides a very interesting global perspective, also helps to detect the root causes and possible reasons for the variation.].

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Check Sheet: Facilitates process monitoring, providing valuable information on the most frequent deviations and global errors. Data collection is carried out based on the formulation of questions such as: where, what, who and how [27].

Histogram: The most commonly used graph to show frequency distributions or how often each different value appears in a data set.

It is represented by a bar graph showing the distribution of the data. It can be considered as a snapshot of the data obtained from a process.

Pareto Diagram: The Pareto diagram shows in a bar graph which factors are most important based on the 80/20 rule which determines that 80% of the defects are concentrated in 20% of the processes [27].

Dispersion Diagram: It is used to study and identify the possible relationship between observed changes in two different sets of variables.

Letter of Control: It is a statistical tool that allows to differentiate the variations in the processes due to common causes and those that have their origin in others less normalized. This type of chart allows us to study how a process changes over time [25].

Brainstorming: means brainstorming and is a technique used to generate ideas within a group of people through interesting and creative solutions to solve the problem;

Benchmarking: A tool that compares the processes of a company with other successful companies. In the end, all ideas are analyzed [27].

5w2h: It is a tool used in the mapping and standardization of processes in the elaboration of action plans. We need to work out a framework and answer the questions: What? When? Because? At where? As? Who? How much?

Thus, this 5W2H model defines the action to be applied in the organization from the response of each of the questions made, using this tool, we can see the adequate solution of a problem, with the possibility of monitoring the execution of an action [28].].

5s: this management philosophy has five principles (Seiri, Seiton Seiso, Seiketsu, Shitsuke) - Sense of Use, Organization, Cleaning, Health or Continuous Improvement, Self-discipline, they are implanted in the organization to generate quality;

PDCA: is a management tool used in companies, made by Walter A. Shewart in the 1920s. It has the steps to plan, execute, check and act to control a process of a company [28].

2.7 KAIZEN PHILOSOPHY

Kaizen is a word of Japanese origin, which means change, it is not only a meeting with the operators to define a timely problem, it is a philosophy or culture of continuous improvement, it is a method that admits to lower costs and improve productivity , for [4], the success of the Japanese administration is based on values and discipline.

In the 1950s, the Japanese retook the concepts of the classic Taylor administration to restore their industry. Thus, the concept of kaizen arose, in Japanese it means "pure and simple change for the better", this technique aims at the good of the organization and employees in Overall, it became famous from 1990 onwards. Seeking this philosophy in organizations is improving their processes and products, to avoid wastage in the productive process.

Any unplanned action leads to wasted resources and, consequently, higher production costs and declining profit margins. The company must be thought of as a system and as such needs all parts of its gear to work in tune so that the whole system can flow [4].

Thus, assuming that time is the best indicator of competitiveness, organizations seek to implement this philosophy. Therefore, this procedure has the objective of distinguishing and eliminating the existing waste in the company, however, this practice establishes changes, to improve, something has to change, the way to accomplish, then to seek kaizen, have to be open to change in the way of working.

The increase in productivity in the Japanese system is based on discipline, on strengthening teamwork, on the use of employees' ideas, which values their self-esteem, as well as on profit sharing [4].

Applying a philosophical goal within the organization is not such an easy practice, however, we have to understand that it is possible to do better, no day should pass without some improvement being implemented, whatever it may be [19], innovation of productive systems has made an evolutionary leap for companies that have followed such developments. The changes made must be gradual and never abrupt so as not to disturb the balance of the structure.

It is natural that all methods have problems, when they arise we can analyze them, understand them and look for the best way to prevent them in the future, problems are good sources for ideas and modifications that will bring about progress, and this continuous improvement is adopted by several companies that aim to achieve ever better results, be they in the external process or in their internal processes, this improvement is achieved through

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good organizational practices and their kaizen philosophy.

III. METHODS OF PROCEDURES

The company TERMOTECNICA implemented the monitoring system after the TIS (information technology) to make several researches using the kaizen philosophy, which consists of the application of an organized form of common sense and the exercise of creativity, focusing on the individual improvement of the process. The INJET system was chosen and installed in the 30 production machines.

The prospect is very promising for the productive system; therefore, the need to look for a new technology tool was to streamline the processes, since they were previously performed manually, and checked item by item and machine per machine, making it a time-consuming service. During the development of the improvement projects, the Thermotechnics carried out a careful advisory work, aiming to transfer the necessary knowledge that will provide the organization with the maintenance and improvement of management, the company also made available tools and practices that best fit the needs of the organization and of customers. With the implementation of the system, if you had more productivity and quality of service, as will be demonstrated in the following cases.

The periods defined for data collection for benefit evaluation were the months from December to January, representing the before and after the implementation of the system. The areas involved are: production planning and production line maintenance.

The data collection of the machines was done differently for the two cases:

• December; collected data from the minutes used in the company as a means of communication and registration;

• January; collected the production data using the Monitoring Terminal of the INJET system.

The proposed solution will demonstrate how the company excels in the quality of products and services, also gaining in productivity, profitability and profitability and thus show that, with a well-structured and qualified team, they obtain results for organization.

Because it is not enough just to seek technological innovations of the highest quality, if it does not enable its employees to perform well and work the perception of each one within the organization, they needed people to follow all evolutions within the company, so that they understand that their collaboration is of paramount importance, and also, they win out with the benefit of the system. A revolutionary vision for the current conditions of the company needs a revolutionary strategy to achieve results.

IV. ANALYSIS OF RESULTS

After all the procedures, we will show the results before the INJET system and then, with the implementation of the system, what were the losses and gains, and, based on the data collected, we will demonstrate, in the first frame, how it was without the system of monitoring.

Case 1: Through the records of all the December notebooks, Table 1 was developed, which contains productivity information and also to specify the stops.

Tab. 1: Before Monitoring

Production time	12 hours
Quantities of parts produced with quality	6770
Quantity of refuse	40
Total Available Time	677
Stop pointed	80
Stops not pointed	110

Based on the results, we analyzed the processes with the Ishikawa and 5W2H tools, as we will see below:

The Ishikawa Diagram in Figure 1 is a graphical tool used for quality management and control, identifying the problem or effect, and helps to raise the root causes of a problem, it considers all the factors that involve the execution of processes.

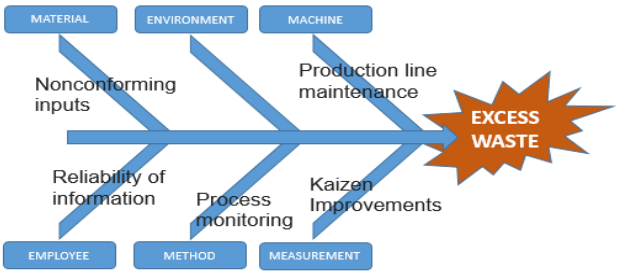

Fig. 1: Analysis of Causes and Effect

The 5W2H shown in Table 2 is a tool that can be used by any company, it has the purpose of assisting in the elaboration of action plans, such as a checklist, which gives clarity to the collaborator about his activities.

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Tab. 2: Check list 5W2H

What?	Who?	How?	Were?	Why?	How much?
Reliability of information	The managers of each sector and area	Having access only to authorized persons	In all sectors of the organization	For clarity and speed of information	No burden
Process monitoring	Supervision of production	Avoid unplanned downtime	Throughout the productive sector	Lest there be a delay in production	No burden
Maintenance in the production line	Company Maintenance Sector	Verifying the machines to avoid defects	In the production machines	Bottlenecks and line breaks	No burden
Non-compliance of inputs	Purchasing Management	Verifying that the inputs are within the normalities	Purchasing and Trading Sector	Avoid out-of-spec production	No burden
Measure work improvements through kaizem and INJET system	Directors	Verifying the best system to aid in decision making	In all sectors of production	To streamline processes and reliability	R $ 600.000.00 with maintenance

With mechanized work, time and productivity were lost, and this ended up at a loss because it would only know the total production at the end of the day. As the market is large and highly competitive, the ideal is to select situations and the paths to be followed, that is what the company did, implementing the system.

The information system is a valuable tool that helps to streamline and integrate the flow of information and knowledge within an organization, the agility of information is fast in the productive sector, thus minimizing costs and maximizing profits. With the introduction of the injet system on production machines, there has been a major change in all aspects of the organization, because the system is fast and accurate in the information.

The monitoring system has brought great benefits, such as reduced time, process optimization and productivity, more efficiency, because the system gives real-time production, organizations have been increasingly concerned about the quality of products and services, and it was what the system added to the organization, more quality and practicality in the production machines. The system is installed on the 30 production machines, one IPE for two machines, which throws the information to the master computer. As shown in figure 2.

Fig. 2: IPE model

With this system, when the equipment stops functioning, the IPÊ generates a visual alarm and starts to signal in the system as stopped equipment, having the reason of the stop as Informed Stop, this alarm is visible until the operator solves the problem and, thus, , to restart the machine, the operator must assign some cause for this stop, for this, there is a table that correlates all types of stops with a certain number.

This table gives a series of numbers that must be entered in the IP, and when this occurs, the status of the stop changes according to the information entered by the operator in the IP system.

Based on the information, we will show, with figures, how the process was done using kaizen, ISHIKAWA and 5W2H tools.

The most important point in applying the kaizen system shown in Figure 3 is the awareness of the improvements that are to come; also an important factor in the implementation of the system, is to determine very well where the efforts of the company will be used.

Problem: Excessive waste in all processes due to machine shutdowns.

Fig. 3: Example of waste

Causes: Lack of employee attention, since the process was done every manual.

Action: Automate the processes with support of the Injet system, to streamline the production process, thus giving real-time production of each machine.

Result of the improvement: obtained a 20% gain in the production of IPS-Styrofoam expanded polyethylene.

Collected production data using INJET, we observed the efficiency of the system, there was a great change in the implantation of the Injet system, as we can observe in Table 3.

Tab. 3: After Monitoring

Production time	12 hours
Quantities of parts produced with quality	8000
Quantity of refuse	25
Total Available Time	30
Stop pointed	71
Stops not pointed	70

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Therefore, with this system it is possible to see clearly the great gain that the company had in the quality of the service in the production line.

Figure 4 demonstrates the efficiency of machine monitoring, these green colors are machines that are running without any intervention, they are 100% working in the production of polyethylene.

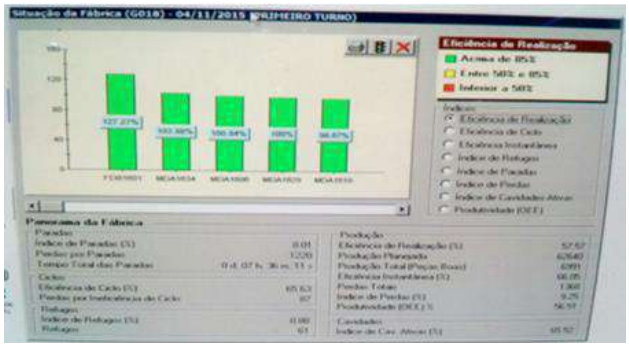

Fig. 4: Machine Monitoring

With the research, we can compare that production had a gain of 20% every three months, and with a year of implementation of the system, we can already observe the great change that occurred in the company, left the mechanical way to the computerized system, and the company has not only gained in productivity, but also in quality, agility and financial gains, thus bringing more benefits and bonuses to employees.

However, despite all the qualities of the system, the same does not work alone, it needs the assistance of trained people and good management, since the functioning of the world is based on administrative bases, so for a project to give good results , has to have a good administration, the function of INJET is not solve problems and produce more, because it is a tool of continuous process and its function is to collect data and demonstrate them in a way that the losses are visible to the collaborator, the system shows where it is to the deficiency in the production line, has to understand the necessity of using this tool and how it helps in the stability of the processes, thus will have a vast knowledge about the system.

The improvement actions, which are developed based on this information, give productivity to the company, with the help of well-trained and qualified employees to operate this system.

V. FINAL CONSIDERATIONS

Looking at the scope of production processes, it is perceived that innovation technology has come to make companies more competitive in the globalized world.

Organizations in general have attached great importance to the area where they are most profitable, which is production, where the factory floor has to be aligned as a whole. In this research, it is clear that the use of the automatic stop monitoring system contributed to the best use of productivity. The use of the INJET system resulted in a 20% improvement in representative productivity growth, since there was an increase in production, with quality without investments in new machines or labor, but there was investment in the information system.

The evolution of production management is a path with no return, old methods are being improved because of new systems that speed up decision making, and manual labor presented many problems, such as the need for time for operators to make notes operations.

The INJET system excels in quality and speed of information about the notes that are made available on the computer screen, thus facilitating the flow and management of company information. The production manager and all support staff have access to the same database information at the same time through the monitor.

With the implementation of this system, the company gains in quality, as it increased the level of production with more speed and agility in the processes of the production line, so with this system we clearly perceive the improvements that the company had with the efficiency of the monitoring, with the implementation of the system, we can already observe the great change that occurred in the company, raising its products with quality.

The monitored system has brought great benefits, such as reduced time, process optimization and productivity, and quality, more efficiency, because the system gives real-time production.

The company TERMOTECNICA, where the research was carried out, was successful with the use of the new machine monitoring technology, since, the increase of the efficiency of its production in the manufacture became more a competitive differential than its competitors, today, in the In the globalized world, companies are looking for innovations so that their products can be manufactured with less time, reducing costs, but always guaranteeing product quality.

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To the engineering coordination of the ESBAM Superior Faculty, and the teachers Dr. Mauro Cezar Aparício De Souza and Dr. David Barbosa de Alencar, for the support in the development of this work.

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Analysis of Robust PID Control with Pre - Filter Using the Perfect ITAE Performance Criterion Applied to the Heavy - Duty Gas Turbine Fuel System

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Abstract *— The study of fuel control of the heavy-duty gas turbine arises naturally with the idea of providing a higher yield to the generation process, which is usually located in the first stage of generation, since the turbine is one of the main components in a thermoelectric plant along with the generator that is connected directly to the turbine. PID control is typically one of the most widely used control models in the industry because it provides the system with satisfactory performance according to the designer's choice using the ITAE performance criterion and a pre-filter can provide robust control for the system in question, which raises the reliability of the control even in the presence of variations of plant parameters. It is proposed to perform the sizing of this fuel control and with the use of MATLAB software to perform the simulation of the performance of the proposed control system, besides evaluating the control performance for hypothetical situations of parameter variations that can certainly occur in a system real subject to intemperes and interference from disturbances.*
Keywords *—* ***Thermoelectric Power Plant, Heavy-Duty Turbine, PID Control.***

I. INTRODUCTION

The increase in electric energy consumption is proportional to the population growth of a developing country, implying in several challenges that this demand for electric energy is met. In Brazil, currently works with the development of power generation projects aimed at diversifying the country's electrical matrix, in order to ensure the availability and reliability of the national electricity system.

In this context, the use of thermal power plants for electricity generation is on the rise, given the need to maintain reliable and more readily available electricity supply. Nowadays, combined cycle plants have become the main form of generation thermal power plants, since this model adds to the same generation power plant, the gas-fired power plants and the steam plant, resulting in an improvement in the thermal efficiency of the process in around 60%, compared to the isolated operation that has its yield of 30 to 40% [1].

The present work presents a fuel control proposal for a Heavy - Duty gas thermal turbine with the use of optimum performance indexes applied to the PID controller. This turbine is designed especially for industrial applications especially in power plants, where this is generally part of the first stage of combined cycle generation. The fuel control of the turbine directly implies the power generated by the generator coupled to the turbine axis, because if the fuel flow is too high, there will be an increase of the turbine rotation in moments when it is not necessary or flow at a time when on demand.

II. THEORETICAL REFERENCE

This stage of the work approaches the conceptual references of the elements necessary to apply the study and development of knowledge.

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2.1 COMBINED CYCLE THERMAL PLANTS

Combined cycle power plants are the most effective form of generation based on fossil fuel combustion such as diesel oil, natural gas, among others. Nowadays, combined cycle plants have become the main form of generation thermal power plants, since this model adds to the same generation power plant, the gas-fired power plants and the steam plant, resulting in an improvement in the thermal efficiency of the process in around 60%, compared to the isolated operation that has its yield of 30 to 40% [1].

2.2 HEAVY DUTY GAS TURBINE

Heavy - Duty Gas Turbines are turbine models designed especially for industrial applications, such models have a high robustness and wide range of power to the system. They have some important characteristics, such as low refrigeration, they can use gases with low calorific value, they usually have simple civil works, low vibration levels, easy operation besides allowing automatic control [2]. The gas turbine has the following components: compressor, combustion chamber and turbine. Its operation is characterized by the air compression that is carried out by the compressor, expansion in the turbine and addition of heat in the turbine realized by the combustion chamber. The heat injected comes from the burning of a fuel, whether liquid or gaseous.

When the turbine is in operation, the compressor compresses the atmospheric air and injects it into the combustion chamber where it is mixed with the fuel and is then burned, shown in Figure 1. The result of this combustion is the generation of hot gases that are expanded through of the turbine, converting thermal energy into mechanical energy on the shaft [3].

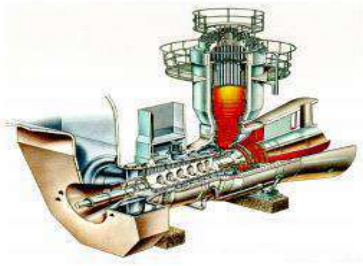

Fig. 1: Heavy Duty Gas Turbine Alstom GT8C, Source: [4].

In his work [5] presents the simplified mathematical model of the gas turbine with simple axis Heavy-Duty, serves as reference base for use in dynamic analysis of the system. This control representation is composed of three main stages of control which are the, acceleration, temperature and speed controls. In this model the main mesh is speed and the temperature and acceleration meshes act as limiters of material temperature and turbine acceleration, respectively [6].

2.2.1 Fuel Grid

The fuel grid consists of two valves in series, the first valve in question being responsible for controlling the pressure between them and is used to extend the ratio of the fuel flow from the maximum to the minimum during the start, the second controls the fuel flow in the turbine [7].

The response of the fuel system determines the responses of adjacent systems such as the pressure system which is changed as the response of the positioner of the first valve upon change. Figure 2 shows the fuel grid of the heavy-duty gas turbine with its variables and constants can on change depending on the type of fuel. And there will only be feedback due to pumping when using liquid fuel [8].

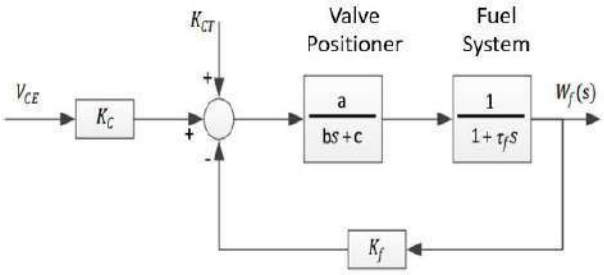

Fig. 2: Turbine Fuel System Plant, Source: [1]

At where:

VCE = Fuel demand signal (pu);

KCT = Constant that represents the own consumption of the turbine (pu);

KC = Constant that represents influence of the fuel demand in the turbine (pu);

Kf = Fuel system feedback (pu);

a, b, c = Values referring to the transfer function of the fuel inlet valve positioner (pu);

Tf = Time constant of the fuel system (s);

Wf (s) = Fuel flow (pu).

2.3 PID CONTROLLER

The PID controller is one of the most widely used compensation devices in the industry, this device consists of a three-term, proportional, integrative and derivative algorithm. The PID controller can be expressed in mathematical form in the time domain and domain of complex numbers in equations 1 and 2 respectively. Kp represents the proportional term of the controller, Ki represents the integrative term and Kd is the derivative term [9].

$$Gc(t) = \mathrm{Kp}E(t) + \mathrm{Ki}\int E(t)dt + \mathrm{Kd}\frac{dE(t)}{dt} \quad (1)$$

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$$Gc(s) = Kp + \frac{Ki}{S} + Kd\,S \quad (2)$$

Figure 3 presents the generic model of the application of the PID control in a plant. The PID controller has been widely used in the industry for a long time, largely because this algorithm allows the designer to control the system in transient and steady-state responses with the same controller.

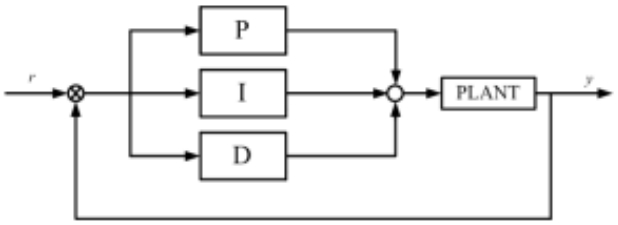

Fig. 3: Block Diagram of the PID Controller, Source: [10].

The PID controller introduces a transfer function with one pole at the source and two zeros that are set to design criteria. As is shown in equation 3.

$$Gc(s) = \frac{Kd(s^2 + as + b)}{s} \quad (3)$$

2.4 ITAE OPTIMUM PERFORMANCE INDEXES

In modern control systems system performance can be specified quantitatively, this specification is called performance index that can be used as a design criterion, in a system the minimization of the indexes can be directly related to reduction of fuel consumption for example. Conceptually performance index can be defined with a quantitative measure of a system's performance and is selected so that emphasis is given to the important specifications. A control system is considered optimal when the system parameters are adjusted until the index reaches an extreme, usually a minimum value [11].

The ITAE performance index is one of the criteria but used because it has better selectivity compared to other indexes that are addressed in [12]. The ITAE performance index is defined through equation 4.

$$ITAE = \int_0^T t\,|e(t)|\,dt \quad (4)$$

In [13] the author demonstrates the expansion of the polynomial coefficients of a transfer function in its generic form. The transfer function can be verified in equation 5, this transfer function has a null error for a step input.

Tab. 1: Optimum polynomial coefficients of the ITAE index for a step entry

$$s + \omega_n$$
$$s^2 + 1{,}4\omega_n s + \omega_n^2$$
$$s^3 + 1{,}75\omega_n s^2 + 2{,}15\,\omega_n^2 s + \omega_n^3$$
$$s^4 + 2{,}1\omega_n s^3 + 3{,}4\,\omega_n^2 s^2 + 2{,}7\,\omega_n^3 s + \omega_n^4$$
$$s^5 + 2{,}8\omega_n s^4 + 5{,}0\,\omega_n^2 s^3 + 5{,}5\,\omega_n^3 s^2 + 3{,}4\,\omega_n^4 s + \omega_n^5$$
$$s^6 + 3{,}25\omega_n s^5 + 6{,}60\,\omega_n^2 s^4 + 8{,}60\,\omega_n^3 s^3 + 7{,}45\,\omega_n^4 s^2 + 3{,}95\,\omega_n^5 s + \omega_n^6$$

Source: [13].

Table 1 shows the expansion of the ITAE coefficients for a step input of a polynomial characteristic of T (s) poles described in equation 5.

$$T(s) = \frac{Y(s)}{R(s)} = \frac{b_0}{s^n + b_{n-1}s^{n-1} + \cdots + b_1 s + b_0}. \quad (5)$$

III. APPLIED METHODOLOGY

This article is of a bibliographical nature, in the context of heavy - duty gas turbine fuel control, the bibliographic study is carried out using mathematical modeling articles using a block diagram, as well as articles, books and texts related to PID control design technique with optimal performance criteria.

The data referring to fuel system control variables are collected quantitatively in reference articles, however system performance comparisons are performed for different data in order to ascertain the robustness of the controller that is performed in a qualitative way. The PID controller design applied to the turbine fuel system is analyzed using the MATLAB computational tool, which enables the designer to observe the controller's performance over the controlled variable in the system in relation to transient and permanent regime errors.

IV. ANALYSIS AND DISCUSSION OF RESULTS

Based on the characteristics and data of the heavy - duty turbine fuel system studied where reference values for the variables of this system are developed either for use of the turbine with liquid fuel or gas. For the performance analysis of the fuel system represented by means of a block diagram in Figure 2, it characterizes the fuel system with its measured constants, which are presented in Table 2.

Tab. 2: Features of the Fuel System

Type	A	b	C	tf	Kf
Gas	1	0.05	1	0.40	0
Liquid	10	1	0	0.10	1

Source: [10]

In this work the entire study was carried out considering the use of liquid fuel because it is more used in this segment, so we can obtain the response of this

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reference system using MATLAB software. Figure 4 shows the turbine fuel system response to the values proposed in (WIRowen, 1983), where it is verified that this response has an Overshoot rate of 16%, peak time of 0.37 the time of establishment of 0.8 was established, and this performance occurs considering that the system does not suffer interference from the environment, that is, it is considered that the terms remain constant.

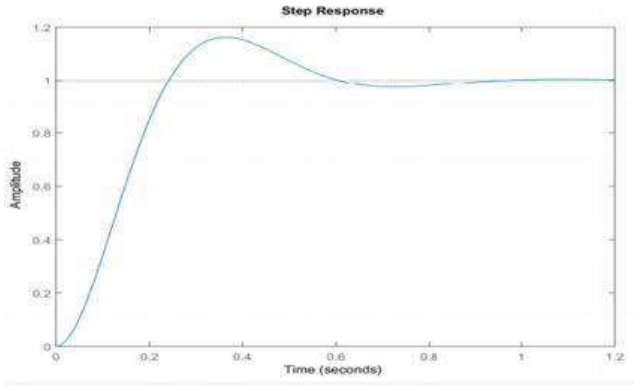

Fig. 4: Response to the reference fuel system step

However, for the application in the real environment where the variables are not linear, that is, it undergoes a change of parameters routinely, and it is necessary that the control systems provide robust performances of the projected response, in other words the system must maintain its satisfactory performance even with small changes in the variables due to external interference.

Based on this situation, it was proposed the implementation of the Robust ITAE PID controller with a pre-filter to perform the best of the system performance, besides providing a robust performance, making the system not sensitive to parameter variations as well as in the presence of external disturbances. Considering an ideal overshoot of 2%, peak time of 0.3 s, establishment time less than 0.8 s, besides adopting the coefficient of damping zeta equal to 0.8 and the natural frequency equal to 10 rad / s.

Tab. 3: Fuel System Characteristics for System Performance Testing

Test	**Type**	a	b	c	**Tf**	kf
1	Liquid	10	1	0	0.10	1
2	Liquid	9	0.5	0	0.10	1
3	Liquid	8	0.2	0.1	0.10	1

Source: [10]

Com base no desempenho desejado em relação à resposta ao degrau unitário do sistema de combustível foi realizado o dimensionamento do controlador PID utilizando o índice de desempenho ótimo ITAE, pré-filtro e executado a simulação do sistema com nova arquitetura que segue o modelo apresentado na Figura 5.

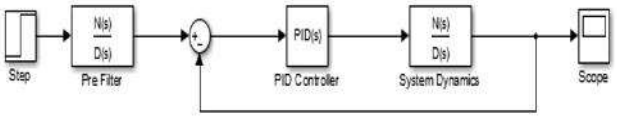

Fig. 5: Function Block Diagram of the PID controller application with Pre - Filter to the system

The first step was carried out with controller sizing and the pre-filter that met the ITAE performance requirements for test 1, using the characteristic parameters of the system made available in [5] with the objective of better performance of the response of the fuel system. Thus, using Table 2, which provides the optimal ITAE coefficients for a step input, in addition to the parameters already mentioned, the derivative, integrative and proportional coefficients of the controller are deduced, which are presented in Table 4.

Tab. 3: Controller gain table

Controller PID	Proportion	Derivative	Integrative
Gain	2.15	0.075	10

These coefficients were found starting from the analysis of the dynamic model of the system that is described in Figure 5 and the criterion of optimal performance ITAE.

$$\mathbf{Gc(s)} = \frac{\mathbf{0.075s^2 + 2.15s + 10}}{\boldsymbol{s}} \quad (6)$$

Where in equation 6 has the representation of the mathematical model that describes the controller, with the analysis in the control mesh, the closed-loop transfer function of the system is presented by equation 7.

$$\mathbf{H1(s)} = \frac{\mathbf{7.5(s^2 + 28.6s + 133.33)}}{\mathbf{s^3 + 17.5s^2 + 215s + 1000}} \quad (7)$$

Following, the choice of a pre-filter was made, so that it cancels the actuation of the controller's zeros in the final transfer function of the system, the pre-filter chosen is that described by equation 8.

$$\mathbf{Gp(s)} = \frac{\mathbf{133.33}}{\mathbf{S^2 + 28.6S + 133.33}} \quad (8)$$

Finally, the final transfer function of this new system described as H (s) is presented by equation 9.

$$\mathbf{H(s)} = \frac{\mathbf{1000}}{\mathbf{S^3 + 17.5S^2 + 215S + 1000}} \quad (9)$$

Finally, to obtain the system response, the MATLAB software was used to perform the simulation of the response to a step, which proved the expected performance expectation previously with an overshoot of 2%, rise time of 0.23 if the time of accommodation of

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0.75. Figure 6 shows the performance of the system for the application of the robust ITAE PID controller and the pre-filter.

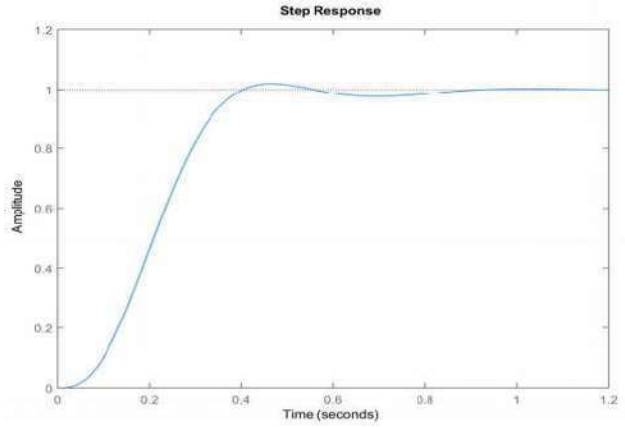

Fig. 6: Response from the system to test 1

With the robust ITAE PID controller already scaled in order to maintain the desired system response, then two tests were performed to verify the reliability of this control in test 2, the controller was applied to the system some parameters changed as shown in Table 3, these changes may be due to external disturbances or changes in the application environment. As soon as a new closed-loop transfer function is found just as a new pre-filter is to be used, in equations 10 and 11 the final transfer function and the pre-filter of the system respectively are presented.

$$\mathbf{H(s) = \frac{1800}{s^3 + 35s^2 + 387s + 1800}} \quad (10)$$

$$\mathbf{Gp(s) = \frac{10}{0.075s^2 + 2.15s + 10}} \quad (11)$$

After performing the simulation of the transfer function H (s), we obtained an overshoot rate of approximately 2%, time of rise 0.28 if time of accommodation of 0.60 s, that is, even with the system suffering variations of parameters the system is robust in relation to the response, Figure 7 shows the graph of the step response of the system.

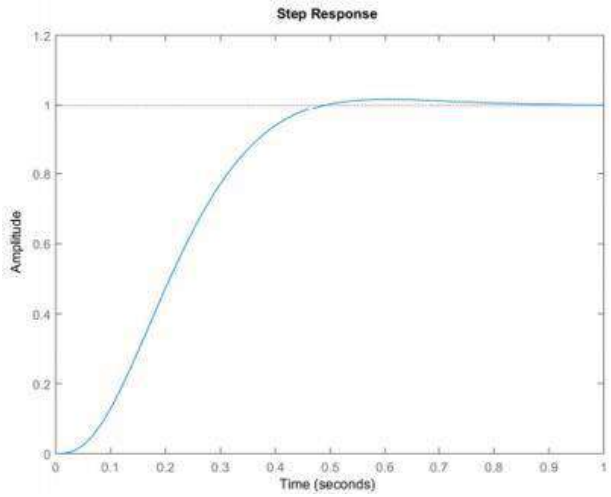

Fig. 7: Response from the system to test 2

Using the same reasoning, the simulation of the system transfer function was performed with the parameters described in test 3 of Table 3, where the transfer function is represented by equation 12.

$$\mathbf{H(s) = \frac{4000}{s^3 + 40.5s^2 + 865s + 4000}} \quad (12)$$

The pre-filter by equation 13, in addition to validating the robustness of the controller described by equation 6, the system response was very satisfactory with a small improvement, that is, the robust ITAE PID control is effective even with relatively large variations of the parameters of the system plan.

$$\mathbf{Gp(s) = \frac{10}{0.075s^3 + 2.15s + 10}} \quad (13)$$

The result after the simulation the system presented an overshoot rate of approximately 0% a rise time around 0.36s and establishment time of 0.7s.

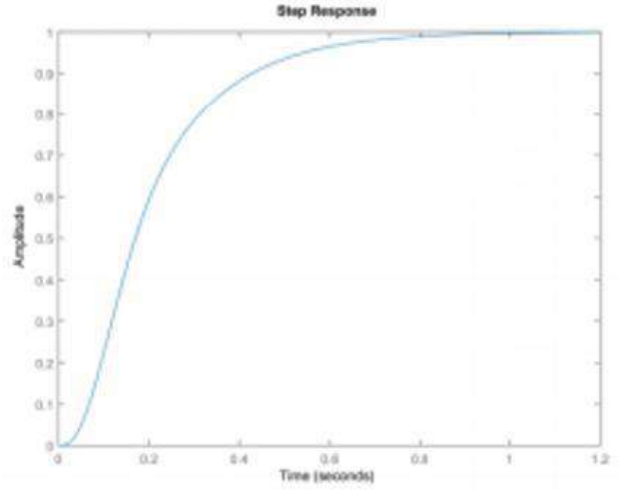

Fig. 8: Response from the system to test 3

Figure 8 shows the response to the unitary step of the fuel system with the variations of the parameters of test 3.

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V. CONCLUSION

With the continuous need for improvement in the electric power generation systems, in order to favor greater generation reliability, the engineering as a whole, and especially the electric, makes it possible to innovate and propose improvements to the generation systems.

A combined cycle thermoelectric consists of several systems. In particular, the turbine plays a key role in the process, so the heavy - duty turbine comes with a study source for individual performance improvement purposes that can affect the performance of other adjacent components, such as the generator.

Therefore, it is evident in this paper that the use of the robust ITAE PID control with a pre - filter to improve the fuel system performance of the heavy - duty gas turbine using liquid fuel, is efficient for applications in non - fully linear environments, or whether or not they change internal parameters due to interference from the external environment. This analysis and proposed solution to improve the system's response favors a reduction or consumption with greater fuel efficiency of the turbine, since it controls the system response to a demand demanded of output, even occurring possible variations of plant parameters, which implies a higher yield value in relation to the non - use of the robust ITAE PID controller applied to the heavy - duty turbine in the electric power generation system in combined cycle thermoelectric plants.

However, the application of the ITAE PID control theory is not restricted to the model developed here, quite the contrary, the application of this theory can provide the performance improvement of nonlinear systems in other areas of science, such as aerospace, electronics and communications, in addition to robotics itself.

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Investigating the Efficacy of Brazilian Public Policies for Ethnic-Racial issues in Higher Education: The Case of Tocantins State in ENADE 2014

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Abstract *— This paper aims to investigate the demand for public policies in the light of data science evidence, namely, from a technical perspective. In order to reach this goal, we analyzed the data set of the Brazilian government on the ENADE, the national examination of student performance, for 2014, considering socioeconomic and ethnic-racial issues. The results showed that socioeconomic factors could influence the student performance in the tests. However, from the point of view of ethnic-racial elements, it was not possible to perceive statistically significant evidences that could influence the student's performance in the ENADE exam. The result suggests that there is no differences in intellectual capacity between the race ethnicities studied.*
Keywords *— **education, public, policies, data mining, ENADE.***

I. INTRODUCTION

The continuous and fast technological advances have contributed to the acquisition and increase in the volume of data, from different segments, stored in databases, data warehouse and other types of data repositories. Potential valuable information is hidden in these data (PANDA e PATRA, 2008). The huge volume makes it very difficult, if not impossible for humans, to extract information without the help of appropriate computational tools (ZHOU, 2003). Thus, the so-called data science is dedicated to the extraction of knowledge from large databases with the help of computational tools, to deals with these situations.

Data science uses information technology techniques to identify useful information in large masses of data and may be applied in information management, information retrieval processing, decision making, process controls and in several other applications (GOLDSCHMIDT and PASSOS, 2005). The data science process was normalized by a group of researchers in the late 1980s (DIAS, 2008), and can be described, according to Fayyad (FAYYAD et al., 1996), as "a multi-step, non-trivial, interactive and iterative process for identifying understandable, valid, new, and possibly useful patterns from large data sets."

The area of Education can benefit from this process, due to the generation of a great amount of information. In Brazil, INEP (National Institute of Educational Studies and Research Anísio Teixeira) conducts regular evaluations on the quality of education in the country, from basic education to higher education. In this way, it has several open databases available for downloads, with microdata generated by these evaluations, that can be explored by education researches and by investigatory entities (INEP, 2016).

The constant evaluations carried out by INEP on education in Brazil, generates bases with giant volumes of data, which are constantly publicized. These data can be used for specific studies generating information with a high degree of relevance. Therefore, INEP data was analyzed concerning on the performance of undergraduate students in the State of Tocantins for the ENADE (National Exam of Student Performance) 2014 exam.

This article intends to first present the material and methodology applied to operate the data science on the ENADE database and, then, to analyze the results of the study at the final topic.

II. ENADE

In recent years, higher education in Brazil have been widely expanded, increasing the number of institutions and courses, and the access of the students to the universities has been facilitated. The Institutions of Higher Education had a significant increase in the number of students, and this growth can have consequences, for example, may affect the quality of teaching. Such issues

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show the importance of conducting researches that may contribute to the advancement of higher education, especially in what concerns the quality of teaching, enabling universities to meet the greater demands of country education.

INEP conducts periodic research on education in Brazil; one of these surveys is ENADE. This examination is one of the procedures of evaluation of the National System of Evaluation of Higher Education (Sinaes), carried out by INEP; according to guidelines established by the National Commission for the Evaluation of Higher Education (Conaes), a collegiate body for coordination and supervision of Sinaes (INEP, 2016).

The purpose of ENADE is to follow the students' learning process and academic performance in relation to the programmatic contents provided in the curricular guidelines of the respective undergraduate course. The skills has to be adjusted to the requirements arising from the evolution of knowledge and their competences to understand subjects outside the specific scope of profession, linked to the Brazilian and worldwide reality, and other areas of knowledge.

The ENADE surveys help to formulate the objective of this work, that is, to use the ENADE database to verify the performance of undergraduate students from the State of Tocantins in this evaluation, and to discover if socioeconomic factors, such as family income, and ethnic-racial factors could influence the performance of these students on the exam.

III. MATERIALS

The ENADE microdata are available for consultation on the INEP Portal, and can be downloaded via ASCII format. The exam consists of general training issues (common to all areas of knowledge) and specific training issues. For the all knowledge areas evaluated in ENADE 2014, the analysis considered only records that corresponded to students who took the test in the state of Tocantins.

The socioeconomic survey questionnaire consists of 81 questions, of which thirteen are exclusive questions for undergraduate students. The "gross test grade", the "nt_ger" attribute, can vary from 0 to 100, which is the weighted average of the general training grade (25%) and the specific component grade (75%).

Data preparation was performed in Microsoft Office Access 2016. The file "microdados_enade_2014.csv" has 481,720 records.

For the study, a data cleaning was performed selecting students from the State of Tocantins, resulting in 6,488 records. In order to avoid interferences in the result, students with "Present" status in the test and the "gross test" variable through the "nt_ger (general grade)" attribute with “not null” were considered, leaving 3,182 records remaining.

The original database consists of 156 attributes, which correspond to the variables of higher education institution: variables of the course, variables of the enrollee, variables of presence, performance variables, perception of the test variables, and variables of the socioeconomic questionnaire. According to the objective of the research, the variables that compose the socioeconomic questionnaire were selected as study variables, besides the variable "gross grade of the test", resulting in 87 attributes considered for the study.

One of the objectives of this work is to find out if socioeconomic factors influence the performance of Tocantins students in ENADE. One way to achieve this goal is to apply the J48 algorithm (SAHU and MEHTRE, 2015) to categorize each record into a "performance range", to find out if family income can influence the performance of the student in the test.

For the application of the J48 algorithm, it was necessary to categorize the numerical variable "gross grade of assessment", the target attribute, into categories, since this is a prerequisite for the algorithm. Thus, four classes were created for the variable "grade level": class "[D]", with grades between 0 and 24.9, class "[C]" with grades between 25 and 49.9, class " [B] ", with grades between 50 and 74.9, and class " [A] ", with grades between 75 and 100 inclusive.

The result of the cleanup and preparation of the data, generated by Access 2016, was the file “Enade Students present.csv.” This file was used in the modeling step into WEKA tool, converting the file with extension ".csv" to a file with extension ".arff".

IV. DATA MODELING AND EVALUATION

After the data general study and groundwork, the data-modeling step is started. In this step, the data mining algorithms are chosen and applied in the database, in order to find valid and understandable patterns that can be used in the study. To support the data mining process, the WEKA computational tool has several algorithms to mine data, and it is an open source.

Data mining techniques (CABENA, 1998) are commonly categorized as supervised (predictive) learning and unsupervised (descriptive) learning (LAROSE, 2014). The limits that define the differences between the techniques are subtle, since some descriptive methods can be predictive or vice versa.

In data analysis, as well as data mining, variables can be

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classified into one of two types: quantitative or categorical. Quantitative variables assume numerical values and represent some kind of measurement. On the other hand, categorical variables, take a category or labeled values and place the observation of the individual in one of several groups. Unsupervised learning does not require a preliminary categorization of its records, and it is not necessary to give a semantic meaning to the data, that is, the data are treated by their similarities of values (SILVA et al., 2014). The difference of the supervised learning method is the fundamental existence of a predetermined target attribute, so the algorithm can learn which target attribute values are associated with it. In this work, supervised learning was applied to semantically classify data into categories.

For the analysis of this work, the method of classification by Decision Tree (WITTEN et al., 2011) using the algorithm C4.5 (in its implementation J48) was adopted. Decision tree is a well-known supervised learning technique, which is suitable for data analysis involving continuous and discrete qualitative variables presented in the databases. It may promote accuracy, speed and ease of understanding of results. Decision trees uses information gain (entropy) to generate tree, which brings the extremely important concern on which are the optimal attributes to be considered in the analysis. The attribute evaluator algorithm "InfoGainAttributeEval" of the Weka tool was used in order to assess the attributes, and the search method "Ranker", to classify the individual attributes. The attributes considered in order to meet the objectives of this study are shown in Table 1.

Table 1: Attributes considered for the study.

Attribute	Description
qe_i8	Item 8 of the student questionnaire. "What is the total income of your family, including your income?"
qe_i13	Item 13 of the student questionnaire. "Throughout your academic career, have you received any kind of academic scholarship? In case there is more than one option, mark only the longest scholarship) "
qe_i15	Item 15 of the student questionnaire. "Did you enter the undergraduate course through affirmative action or social inclusion policies?"
qe_i17	Item 17 of the student questionnaire. "What kind of school did you attend high school?

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In order to analyze the student's grade in ENADE, in relation to the classification of performance levels, a confidence factor of 0.25 was used. The statistics information about the generated decision tree shows that the model created for the student performance obtained an excellent result, with the classification of correct instances of 99.9686%, with only 0.0314% of instances classified incorrectly.

It can be noted that the accuracy distribution per class was 0.9999%, and the consistent confusion matrix shows that the algorithm performed optimally. In order to validate each of these relations, the test of variance was applied. The variance test (ANOVA) was performed in the SAS environment using the SAS Studio tool, with the procedure PROC ANOVA. The hypotheses considered for the Anova test are as follows:

• H0 = null hypothesis, all means are equal:

- $\mu a = \mu b = \mu c = \mu d$

• H1 = Alternative hypothesis, at least one of the averages is different from the others.

When entering SAS Studio you must upload the file, in .csv format, of the database that will be carried out the test containing only the response variable and the independent variable.

V. RESULTS

The results obtained in the accomplishment of this work were composed by the last phase of the CRISP-DM (BOSNJAK et al., 2009) methodology, the deployment. This phase aims to organize the knowledge acquired by analyzing the results in order to be presented in an understandable way so the client can use to support decision-making. The objective of this study is to analyze the performance of Tocantins students in the ENADE 2014 exam and to determine if certain socioeconomic factors may exert some influence on this performance. Thus, the original database had to be prepared and adapted, being composed only of data that were inherent in the study.

The database collected on the INEP website presents the students' grades through the variable "gross test score (nt_ger)", composed of the weighted average of 75% of the specific components and 25% of the general components, represented by a numerical type data varying from 0 - 100 points. This variable of the note was discretized for the attribute "level of notes (nt_nable)" and allocated in classes, "A" being the highest level grouping notes from 75 to 100 points, "B" grouping notes from 50 to 74.9, "C" with notes from 25 to 49.9, and "D" with grades ranging from 0 to 24.9.

The first result obtained with the modeling stage was the distribution of the performance of the students from the higher education of the State of Tocantins by level, through the application of the decision tree algorithm J48. Based on Figure 1, 3182 students who took the ENADE exam in Tocantins in 2014, 63.17% had "C" level of performance [24.9 - 50] and 13.39% had "D" level of performance [0 - 24.9], resulting in 76.56% of students with a level below the ENADE score average of 50 points. Only 23.44% of the students had scores above the average of 50 points, with 22.72% having B [50-74.9] performance and only 0.72% having A [75-100] performance.

In order to accomplish the objectives of this work, the performance of the students (target attribute) considering some socioeconomic factors, were obtained through the selection of attributes. The attribute evaluator algorithm "InfoGainAttributeEval" was applied by the combination with the search method "Ranker", to find out if these related socioeconomic factors can influence students' performance in the exam.

The first socioeconomic factor analyzed to confront with the student's grade was the family income, reported by the students in the socioeconomic questionnaire, Figure 2.

A) Up to 1.5 minimum salary (up to R $ 1,086.00);

B) From 1.5 to 3 minimum wages (R $ 1,086.01 to R $ 2,172.00);

C) From 3 to 4.5 minimum wages (R $ 2,172.01 to R $ 3,258.00);

D) From 4.5 to 6 minimum wages (R $ 3,258.01 to R $ 4,344.00);

E) From 6 to 10 minimum wages (R $ 4,344.01 to R $ 7,240.00);

F) From 10 to 30 minimum wages (R $ 7,240.01 to R $ 21,720.00);

G) Above to 30 minimum wages (more than R $ 21,720.01).

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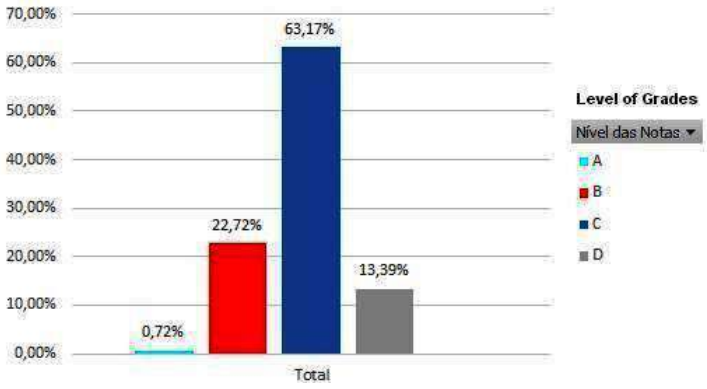

Fig.1: Distribution of students by performance level.

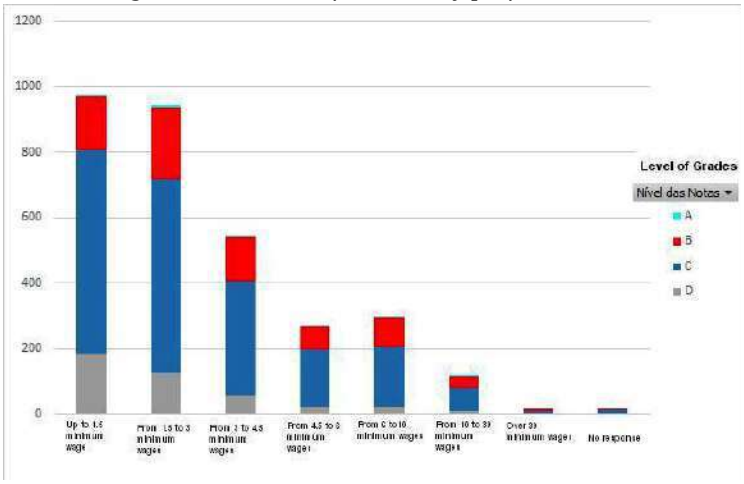

Fig.2: Distribution of students' performance by family's income.

It can be observed that the highest percentage of students who had a "D" level of performance, the lowest level of the scale, has a family income up to 1.5 minimum salary. This amount corresponds to 42.94% of the total of "D" level students. The 31.04% of the students who obtained "C" level (63.17% represented in Figure 1) also have income up to 1.5 minimum wages. Levels C and D represent grades up to 49.9 points of the exam, and it means grades below the ENADE rate.

Considering the students with scores above the ENADE average (50 points), the largest portion of the students has income ranging from 1.5 to 3 minimum salaries. The percentage of students in "B" level was 30.15% (of the overall total of 22.72%, Figure 1) and 34.78% (of the overall total of 0.72%, Figure 1) are on "A" level.

According to the absolute values shown in Figure 1, it can be seen a gradually improvement in the exam performance regarding the growth of the family income. To prove this hypothesis, the higher the performance the higher the family income, the variance analysis test was performed. For this, the file containing the occurrences of the general grade (nt_ger) attribute, and the family student income (qe_i8), the independent variable, was submitted. The command "ODS graphics on" of SAS was also used to generate the boxplot, Figure 3.

https://dx.doi.org/10.22161/ijaers.6769 *ISSN: 2349-6495(P) | 2456-1908(O)*

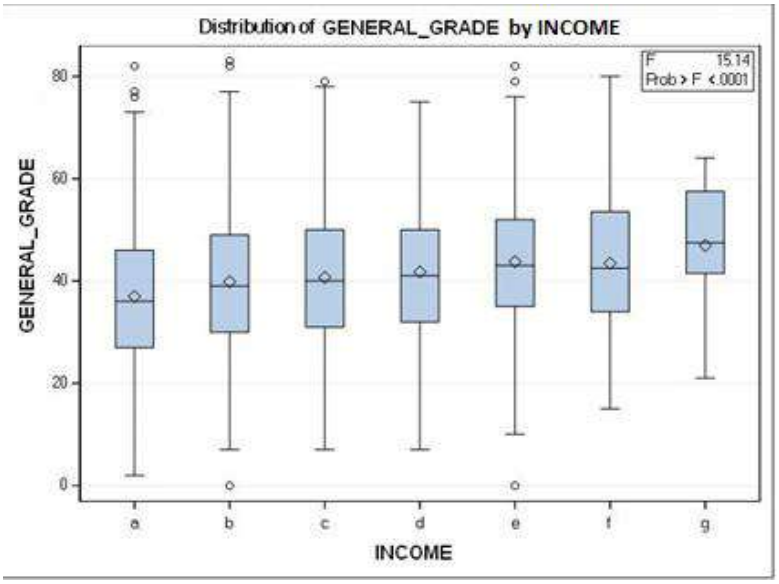

Fig.3: Anova test box plot.

In the box plot of Figure 3, it is possible to see an increase from box "a" to box "g", a proportion relation between student performance and income, suggesting an improvement in student performance with family incomes raise. The "a" box represents the family income of 1.5 minimum salaries. The data distribution of "a" box is between 27 and 46. From this, there is a growing trend as family income increases, e.g., the "f" box represents incomes from 10 to 30 minimum salaries, with distribution between 35 and 53. In this way, the alternative hypothesis that income can be an influence factor to the student's performance is accepted, $F = 15.14$, $p < .0001$.

It is also possible to visualize in Figure 4, the number of "observations read" and "observations used". It is noticed that the value used is less than the amount available in the database. This is due to the null values, namely, students who did not answer the family income-question in the questionnaire.

The ANOVA Procedure

Class Level Information		
Class	Levels	Values
RENDA	7	a b c d e f g

Number of Observations Read	3182
Number of Observations Used	3167

Fig.4: Number of observations for the income family.

The next Anova test intends to validate the relationship between students' performance by the type of school they finished the high school.

A) All in public school;
B) All in private school;
C) All out of the country;
D) The majority in public school;
E) Most in private school;
F) Partially in Brazil and partially out of the country.

It is possible to verify, in Figure 5, that the database has been correctly read through the alphabetical list of variables and attributes. The level information of the class displays the values of the attribute CONCLUSAO_EM, which represents the 6 alternatives of the question for the socioeconomic questionnaire. Each letter corresponds to an answer about the type of school that the student completed in high school.

The ANOVA Procedure

Class Level Information		
Class	Levels	Values
CONCLUSAO_EM	6	a b c d e f

Number of Observations Read	3182
Number of Observations Used	3167

Fig.5: Number of observations for the type of school the student accomplished in high school.

In Figure 6, it is shown the proportional values for the distribution of student's performance relatively to the type of school, which the student had completed the high school. The "b" box corresponds to the students who finished high school in a private school. It is highlighted by having achieved scores above to 80 points. In addition, its distribution obtained a score between 35 And 55

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points. While the "a" box representing students who completed high school entirely in public school scored 30 to 49.

It is also observed that the majority of the students who finished high school in public school, 63.73% obtained below-average performance, and the highest percentage had a C-level performance. In order to endorse that the type of secondary school accomplished by the student is one of the factors that can influence the performance of the students in the ENADE exam, the test of variance analysis was performed with F = 12.26, and p < .0001.

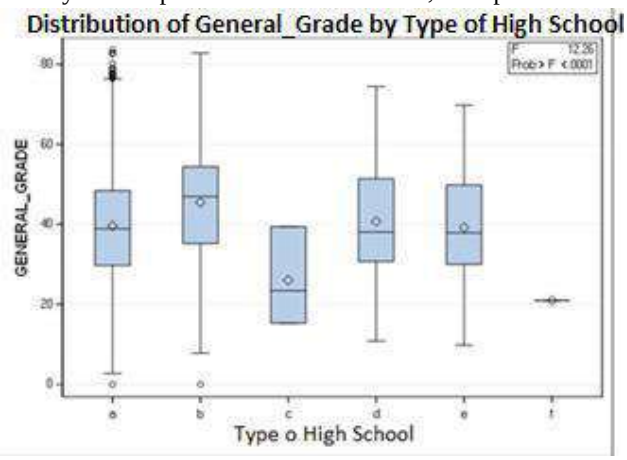

Fig.6: Box plot of the Anova test for the relationship between student performance in ENADE and the type of high school attended by the student.

Seeking to better understand which of the categories have statistically significant results between them, and, in a special highlight, between private and public high schools, the Anova test was performed for the two.

In Figure 7, it is possible to perceive that the students who had the opportunity to study in private school, showed a statistically significant result to be more qualified and to achieve superior performance compared to those who studied in public school. From the test of the variance analysis, F = 55.04 and p < .0001, the hypothesis that the type of high school accomplished by the student can influence the students' performance in ENADE exam is accepted.

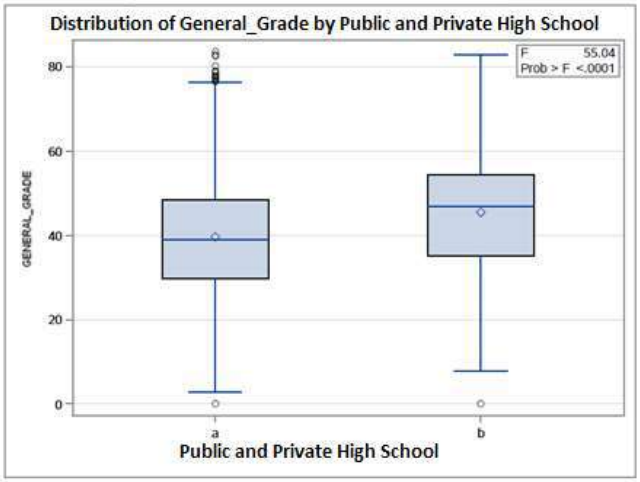

Fig.7: Statistically significant result of the Anova test to the relationship of the student's performance in ENADE exam to public and private high school attended by the student.

The following Anova test aims to validate the relation between student's perform in ENADE exam and the type of criterion used to enter into the undergraduate degree. The correct reading of the informed base is shown in Figure 8, through the alphabetical list of variables and the attributes of GENERAL_GRADE and INGRESS__IES. The information level of the class displays the values of the INGRESS_IES attribute, which represents the 6 alternatives of the question in the socioeconomic questionnaire. Each letter corresponds to an answer about the criteria used to enter to the undergraduate course.

A) No;

B) Yes, by ethno-racial criteria;

C) Yes, by income criteria;

D) Yes, for having studied in public or private school with scholarship;

E) Yes, by the combination of two or more previous criteria;

F) Yes, but a different system from the previous ones.

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Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat
2	INGRESSO_IES	Char	1	$1.	$1.
1	NOTA_GERAL	Num	8	BEST12.	BEST32.

The ANOVA Procedure

Class Level Information

Class	Levels	Values
INGRESSO_IES	6	a b c d e f

Number of Observations Read	3182
Number of Observations Used	3167

Fig.8: Criteria used by the student to be admitted to the undergraduate course.

The box blot, Figure 9, shows the distribution of the types of criteria used for entry into undergraduate course by the student's performance in ENADE exam. There is a great variation between the means of the criteria type alternatives.

In Figure 10, the Duncan test for ANOVA shows ethno-racial criteria in "A" group of Duncan, which has the higher-grade means. In the other side, the income criteria is in "C" group of Duncan, which is part of the minor-grade of means.

The last Anova test validated the relationship between students' performance and the receipt of an academic scholarship during the undergraduate course. The correct reading of the informed database, Figure 11, through the alphabetical list of variables and attributes shows the attributes of GENERAL_NOTE and ACADEMIC_SCHOLARSHIP. The class level information displays the values of the ACADEMIC SCHOLARSHIP attribute, which represents the 6 alternatives of the question in the socioeconomic questionnaire. Each letter corresponds to a response on receiving an academic scholarship during the undergraduate course.

A) None;
B) Scientific initiation scholarship;
C) Monitoring / mentoring scholarship;
D) Extension scholarship;
E) PET scholarship;
F) Another type of academic scholarship.

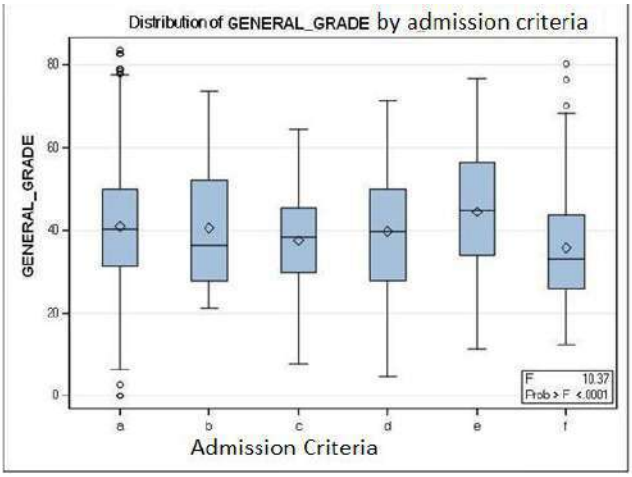

Fig.9: Anova box plot for student performance vs. criteria types used for admission in the undergraduate course.

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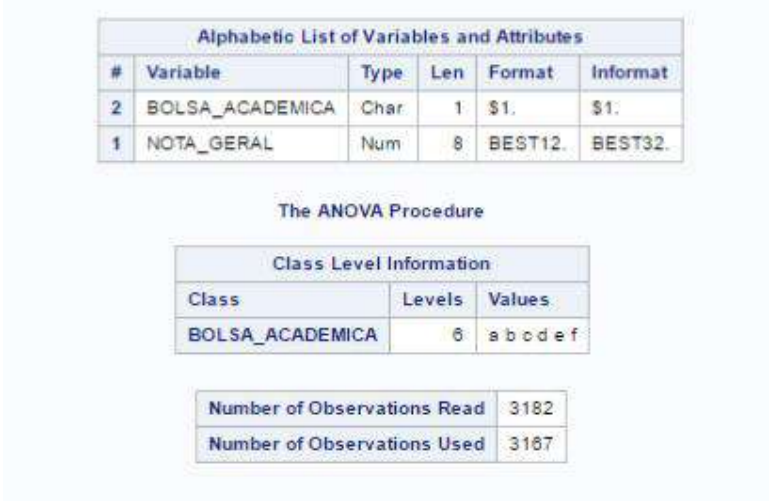
Means with the same letter are not significantly different.				
Duncan Grouping		Mean	N	INGRESSO_IES
	A	44.477	35	e
	A			
B	A	40.947	2569	a
B	A			
B	A	40.602	44	b
B				
B	C	39.791	80	d
B	C			
B	C	37.502	109	c
	C			
	C	35.710	330	f

Fig.10: Duncan Test of ANOVA for Student Performance vs. Criteria Types Used for Admission to Higher Education.



Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat
2	BOLSA_ACADEMICA	Char	1	$1.	$1.
1	NOTA_GERAL	Num	8	BEST12.	BEST32.

The ANOVA Procedure

Class Level Information		
Class	Levels	Values
BOLSA_ACADEMICA	6	a b c d e f

Number of Observations Read	3182
Number of Observations Used	3167

Fig.11: Student's performance in ENADE exam versus receipt of an academic scholarship during undergraduate course.

The box plot, Figure 12, shows the distribution of the alternatives for receiving an academic scholarship during graduation. There is a small variation between the averages of boxes b, c, d and e, which refers to each of the discriminate alternatives of scholarships: scientific initiation; monitoring / tutorial, extension, and PET scholarships, respectively.

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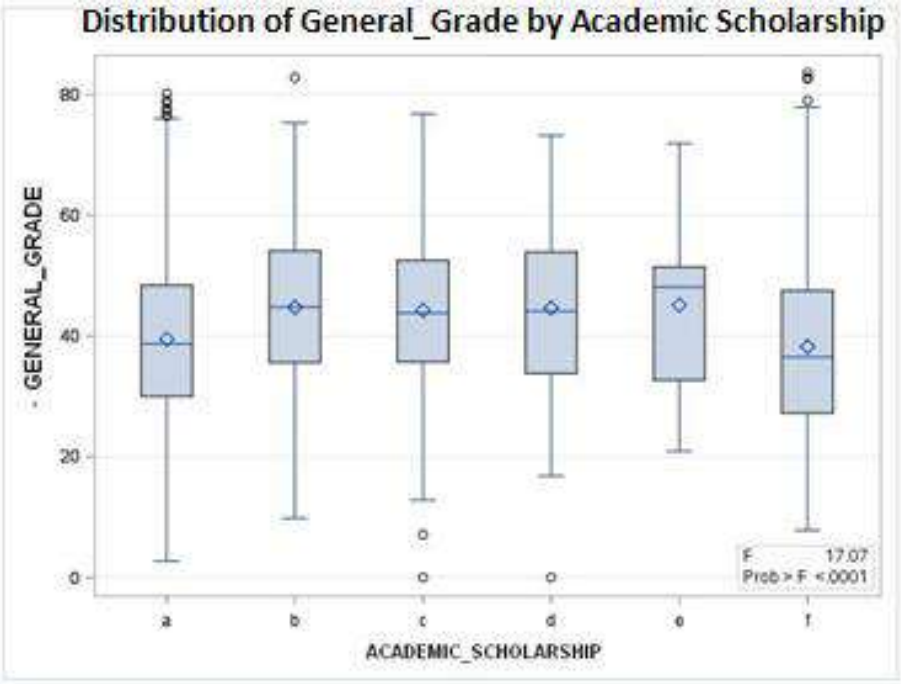

Fig.12: Anova Test for the student's performance versus receipt of an academic scholarship during the undergraduate course.

In Figure 13, the Duncan test for ANOVA shows a statistically significant result for the student performance to whom received discriminated academic scholarship and who not received, distinguished by "A" and "B" groups of Duncan test.

Means with the same letter are not significantly different.			
Duncan Grouping	**Mean**	**N**	**BOLSA_ACADEMICA**
A	45.114	29	e
A			
A	44.772	326	b
A			
A	44.614	137	d
A			
A	44.263	134	c
B	39.489	1980	a
B			
B	38.247	561	f

Fig.13: Duncan Test of ANOVA for Student's Performance in ENADE exam versus Receipt of Academic Scholarship during undergraduate course.

VI. CONCLUSION

Considering the factors selected to be analyzed, the results obtained in this study indicate that the socioeconomic factors can influence the performance of Tocantins' students in the ENADE exam. This assertion is based on the analysis of the selected attributes with the

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target attribute (student general grades performance). The results were obtained through the analysis for the distribution of the absolute values, and also proved by the distribution of the proportional values in the graphs generated by the variance analysis test of ANOVA. According to the results obtained, it can be inferred that the students with higher family income have higher grades in the exam.

In this scenario, a higher family income can somehow provide the student with better conditions to carry out his or her activities during their graduation journey. On the other hand, when the analysis is made from the point of view of the ethnic-racial elements, we do not perceive a relevant influence for the race-ethnicity of the student to a low performance in the exam. It was verified by the ANOVA and Duncan tests performed between general grades and the criteria used to enter to the undergraduate course of Institutions. Conversely, the ethnic-racial element had statistically significant to a better performance of the students as well as higher incomes, as we can see in the results for the "A" group of Duncan in the same test. This result also suggests that there is no differences in intellectual capacity between race ethnicities.

The results indicate that, for the application of affirmative action policies related to social quotas and the distribution of scholarships, it is fairer to provide socially economically disadvantaged groups, putting in practice, in this way, distributive justice.

The research was based on the study of data from the ENADE 2014. It was considered only records of students from the state of Tocantins. Nonetheless, it is necessary to have a more comprehensive study and to find out if this is the reality only of students from federal state of Tocantins or if this result can be extended to the rest of the country.

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Economic and Financial Performance of the Brazilian Pulp and Paper Industry.

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Abstract*—The evaluation of economic, property and financial aspects of the economy can be made through analysis of the Financial-Economic indicators that, when properly forecasted, can bring great benefits to the company and its shareholders. Over the last few years, several authors have studied the relationship between these indicators and macroeconomic variables. The objective of this paper is to determine the influence of GDP (Gross Domestic Product), Exchange Rate, SELIC Rate (Brazil's interest base rate) and inflation rate on the performance of four publicly held company of Brazilian pulp and paper sector: Fibria, Suzano Papel e Celulose, Celulose Irani and Klabin. For this analysis, two models were applied to the database, one using only the past data of the indicators themselves and another using past both data and macroeconomic variables. According to the evaluation criteria used, for the studied period, the performance of the macroeconomic variables was significant to predict the changes in the economic-financial indexes.*

Keywords*—*Macroeconomic Variables, Neural Network, Paper and pulp Sector, Performance Indicator.

I. INTRODUCTION

The pulp and paper sector in Brazil has considerably increased its share on worldwide traded volume. The performance it is explained by Hora and Melo [18], and shows that high productivity of forestry activity – resulting from extensive investments in research and development – associated with proper climatic conditions brings a competitive differential to the Brazilian pulp and paper industry. Production capacity is also at focus, and the main companies in the sector make important investments, in order to keep the supply of wood in expansion. According to Biazus *et al*.[5], a new pulp mill has a capacity of up to 1.5 million tons / year, with investments of up to R$ 4 billion. In 2015, the Pulp and Paper sector accounted for 6% of the Brazilian Industrial GDP.

In this article, we analyze the results of some of the main market players such as Suzano, Fibria, Klabin and Celulose Irani, which accounts for more than 85% of the industry market share, and how they boosted the industry with their projects between 2000 and 2010 (Vidal and Hora, [37]). Now, the sector is expected to face some major changes resulting from the merger of Suzano and Fibria, as it was recently announced in the main Brazilian national media[1] , forming together the largest market pulp company in the world, with a 70% of national market share. Within this context, the industry in the country, between the years of 1970 and 2013 had annual growth rates for pulp and paper, respectively, of 7.1% and 5.4%, placing Brazil in a leading position worldwide.

Recent studies have found evidence of the relationship between macroeconomic variables and economic and financial indicators of different sectors and companies. Costa *et al*.[8] used financial statements of 82 companies and three macroeconomic variables (GDP, SELIC and IPCA - Extended Consumer Price Index) to analyze that relation. Guidini *et al*.[16], analyzed 111 companies from the main sectors of the Brazilian economy, and their financial indicator's behavior to the exchange rate, interest rate, inflation, exports and imports, as well as external growth. Those studies, as well as others exposed in this paper confirm the aforementioned relationship.

The objective of this article is to analyze the influence of macroeconomic variables on the economic and financial performance of the Brazilian pulp and paper sector from 2002 to 2017. In an initial stage, we used the methodology of Toda and Yamamoto[36] to investigate

[1]See Veja [9] magazine.

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whether there is a dependence between the variables. In the second stage, the relationship between the variables is tested using Artificial Neural Networks (ANN) to model the indicators of the Brazilian Pulp and paper sector, considering some macroeconomic variables as explanatory variables.

The article is structured in five parts, in addition to the introduction. Section 2 presents the Pulp and Paper sector, its dynamics and importance to Brazil and world economy. Financial indicators are presented in section 2.2, classified into four groups: Liquidity, debt and structure, activity, performance and profitability. Macroeconomic variables are then presented in the following, and the way they are able to influence the economic-financial indicators of companies. Section 3 presents the Toda-Yamamoto test and section 4 presents the Neural Networks and the architecture adopted in this article, with the discussion of the metrics used to compare the results. In section 5, we present the descriptive statistics of the variables used and the analysis of the results obtained. Finally, in section 6, we present some conclusions.

II. LITERATURE REVIEW

2.1 Pulp and paper industry

The pulp and paper industry is composed of two large industrial segments that, although making part of the same industry, are distinct from each other, each one with its own production process. The first one is the pulp, which produces different types of cellulose and pastes. The second industrial segment in this sector is paper production, responsible for the production of several related products.

Cellulose is the main raw material for paper production, but not every industry works with both processes. Santos [34] explains that pulp and paper production presents a production chain with technically independent steps. This implies that not every paper mill produces or needs to produce pulp, and not every pulp mill produces paper.

According to Indústria Brasileira de Árvores (Brazilian Tree Industry) (2015), there are two types of pulp: short fiber, which is mainly derived from eucalyptus, ideal for the production of paper for printing, writing and sanitary purposes (toilet paper, paper towels, napkins). The other type is long fiber, which derived from coniferous species such as pine, used in the production of more resistance types of papers, such as those designated for packaging and for the use as inner layers of paperboard. Beyond packaging, newsprint is also one of the uses for long fiber pulp.

Hora and Melo [18] explain that the Brazilian pulp and paper industry is very competitive, associating that prominent position to the high productivity of forestry activity, derived from decades of intensive investments in research and development, as well as Brazil's soil and climatic conditions.

According to Vidal and Hora [37], Brazil is in a prominent position in world pulp production, especially considering the production of short-fiber market pulp, with a 38% share in 2010 in the world market.

In this scenario, Hora and Melo [18] report that between 1970-2013, Brazilian pulp production grew at an average rate of 7.1% per year, and paper production accompanied this movement at a rate of 5.4% per year, placing Brazil among the world's largest pulp and paper producers. Recent data from the Indústria Brasileira de Árvores (IBÁ, 2017) indicates that from January to October 2017, pulp exports grew at 2.9% growth rate, in comparison with the previous year, reaching 16 million tons traded, reaffirming the importance of this sector for the Brazilian economy.

2.2 Economic and financial indicators

According to Adamowicz *et al.* [1] in the business world, the terms "economic" and "financial" are daily employed. Thus, the authors explain that Economic Analysis is the study of equity, its capacity of generating profit or loss, and the payment capacity of the company.

To evaluate the economic and financial performance of the Brazilian pulp and paper industry, sixteen indicators were selected and classified into four groups: Liquidity, debt and structure, market/risk analysis and performance and profitability. The liquidity indicators used in this research are: Overall Liquidity, Current Ratio and Quick Liquidity. The indicators of debt and structure selected for this article were: Fixed Assets to Equity Ratio, Total Liabilities divided by Total Assets, Debt/Equity Ratio, Interest Rate Coverage Ratio and Cash and Cash Equivalents to Equity Ratio. The activity indicators (market / risk analysis) used in this research are: Days of Payables Outstanding, Days of Inventory Outstanding, Days of Sales Outstanding, Operating Cycle and Financial Cycle. The indicators of performance and profitability are: Asset Turnover, Return on Assets and Net Margin.

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The Overall Liquidity Ratio shows the company's payment ability (in the long term), relating (in the short and long term) everything that has already been assumed as debt with everything that might be converted into cash. The Current Ratio shows whether the company will be able to pay its (short-term) commitments. The Quick Liquidity Ratio, on the other hand, calculates the corporate payment capacity, disregarding its inventories. One of the possibilities is that it might be understood as an early indicator on the probability of a company to fulfill or not with its (short-term) obligations.

The debt and structure ratios calculate the company's financial situation, considering the average profile of other companies operating in the same segment. According to Marion [22], debt ratios shows the level of indebtedness of a company and the composition of his debt. On the other hand, Fixed Asset to Equity Ratio shows how much of the Equity is applied into Permanent Assets, which might result on weaker or stronger dependence on third party resources for the maintenance of the company.

> "Growing investments on Fixed Assets refers to the percentage that noncurrent assets, with exception of long term assets, represents when divided by the Equity and has the objective of showing if company's resources are mainly allocated into fixed assets, investments or intangible assets (which is the same of the difference between Non-current assets and Long-Term asses) or if there is a surplus of own funds to finance working capital." (Saporito, [35], p.162, translation by authors)

According to Berto [4], the Total Liabilities Index on debt-to-equity ratio, shows the total levels of third-party capital use, composed of short-term (Current Liabilities) and long-term (Long Term Liabilities) sources, in relation to shareholders equity (Shareholders' Equity). The Interest Rate Coverage Ratio and Cash and Cash Equivalent Ratio measures the company's ability / capacity to make the expected interest payments on outstanding contracts. According to Athar [2], this index can also measure the number of times the company's profit can decrease without affecting the remuneration due to third party resources.

Activity indicators represent the assessment of the uncertainties inherent in the company's operations and how they affect its financial operations, from cash flow management to investment resource allocation. Its main objective is to help decision making by the company manager, whose decisions are always related to risk avoidance or minimization.

According to Marques *et al.* [23], Days of Payables Outstanding covers the period between the purchase and payment of goods (or raw materials). According to Gitman [15] (p. 54), Days of Payables Outstanding accounts for "average payment period of debts to company's suppliers". This index indicates the number of days that the company takes to pay its suppliers.

Days of Inventory Outstanding has the objective of calculating the average period that products stays in the stock during the year, from the entry of the raw material (purchase) to the output as finished products (sale). "This index shows the average number of days a unit is in stock." (Blatt, [6]). Through Days of Inventory Outstanding ratio, the company can determine if the average receivable period is aligned with the desired prospects, regarding the current cash flow path to the planned cash flow.

According to Ross *et al.* [31] the Operational Cicle is the necessary time to acquire the stock, process and sale, receiving the payment of this Sale. According to Gitman [14](p.509), "... the period between the beginning of the production process and the payment of sales of the finished product to the customer." In turn, in the Financial Cycle everything will depend on the bargaining power a company has with suppliers. According to Marques *et al.*[23], the Financial Cycle is the time between payment to suppliers and receipt of sales. The greater the negotiating power of the company with suppliers, the lower the Financial Cycle.

The performance and profitability indicator measure the performance the company achieved in that period. "A possible conceptualization of performance within organizations is the ability of the company to achieve its strategic objectives through the implementation of strategies within its planning process" (Fischmann and Zilber, [12], translated by authors).

The Return on Asset, also known as ROA, shows the company's performance and its calculation aims to estimate the total profit of the company, identifying the proportion of net profit in relation to Total Assets of company. According to Junior and Begalli [21], this indicator shows the return on Total Assets without looking at the source, either from owners, company's operations or third parties. For these authors, the bigger the indicator, the better it will be for the company. The Turnover reveals how much the company has sold to each

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currency unit invested in its Total Asset, and in the same way as ROA, big values reveals a positive situation for the company.

The Net Margin shows us whether the company is obtaining net profit: it informs the value of the net profit for each unit of sale or the net profit by period. According to Junior and Begalli [21], this indicator demonstrates the company's ability to generate profit compared to net sales revenue.

2.3 *Economic-financial indicators and macroeconomic variables*

The relationship between national/foreign economic cycles and business activity has always been at focus both by academic and corporate research, looking for ways of connecting and forecasting the interactions between them. In this sense, there is a constant attempt to capture those interactions through the use macroeconomic variable and financial/economic indicators, combined and studied with the assistance of the available statistical tests. Santos *et al*. [33] analyzed the relationship between economic cycles in Brazil and the economic-financial performance of publicly traded companies using real GDP per capita as economic performance indicator through the cross-correlation test. To measure the economic and financial performance of the companies, the authors selected nine indicators classified into four groups: profitability; liquidity, debt and structure, market/risk analysis. According to the authors, the results suggest that, for some sectors, the evidence for economic and financial indicators is robust for the economic cycle from 1995 to 2005.

According to McGahan and Porter [24], there are four factors that can influence companies' performance: (i) macroeconomic factors - common to all companies; (ii) sectoral factors - that influence companies of the same sector, such as rivalry among companies, consumer preference, taxation; (iii) conglomerate factor - as corporate culture; and (iv) company-specific factors such as products and processes, human capital and competitive advantage. Oxelheim [28] suggested that shareholders need to be informed about the effects of macroeconomic variables on earnings as a measure of the macroeconomic risk in the business. On the other hand, companies need to be aware of the behavior of some macroeconomic variables such as: interest rate, exchange rate, inflation, unemployment, exports, imports, political instability.

The macroeconomic variable GDP can be used to evaluate, for example, how economic-financial indicators behave through economic cycles, especially in Pulp and Paper sector, which presents a strong connection to growth cycles through overall industry needs. The tree industrial sector in Brazil, according to Carvalhaes[7], is responsible for 6.2% of the Industrial Gross Domestic Product (GDP), with gross revenue of R$71.1 billion in 2017, and US$ 8.9 billion on exportation, occupying 0.9% of the national territory. These data ratify the importance of the sector in the national economy.

The exchange rate is another macroeconomic variable which can be connected to business activity and from which researches can find valid information with forecasting potential about business. Regarding the Pulp and Paper, which produces and trade commodities priced in international markets, this relation is of major importance. In case of this sector in Brazil, the exchange rate can be used to evaluate how economic and financial business indicators react to the appreciation or devaluation of the Real against the US Dollar.

Base interest rate is also one macroeconomic variable, which traditionally appears in economic analysis, being connected to the pace of investments. In the case of Brazil, the base interest rate is the SELIC rate[2] . As the base rate defined by monetary authorities, it serves as the basis for all other market rates or investments decision and can be used to assess how economic and financial indicators behave through changes in rates on loans, financing and forward sales/receipts. Medeiros *et al*.[25] analyzed the financial statements of Petrobras, using variables such as Brazilian GDP, domestic and foreign interest rates, international oil prices, exchange rates and country risk. In making this econometric model, the author states that despite the chosen company for the study, the model could be generalized to analyze the financial statements of any company. As a result, Medeiros *et al*.[25] concluded that the domestic interest rate has a direct impact on the company's financial assets and liabilities, as well as on financial income and expenses, referring respectively to receivables and payables and to loans and financing in the currency of the country. Furthermore, Medeiros *et al*.[25] also point out GDP in the article as the main economic activity indicator of a country, with direct impact on a company's Net Revenue, expressing the value of the country's production

[2]SELIC comes from the initials of Special Settlement and Custody System, electronic platform of Brazil's Central Bank for managing government bonds. See: http://www.bcb.gov.br/htms/selic/selicintro.asp?idpai=SELIC for further details.

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during a determining period and being independent of the nationality of the production facilities.

Lastly, the variable that measures inflation – IPCA – can be used to evaluate how the economic-financial indicators react to the increase (fall) of prices in the economy. Paredes and Oliveira [29] presents an investigation on the impact of macroeconomic and risk factors on the measurement of company's corporate value. Using data from Bovespa enlisted companies between 1995 to 2013 and applying Ohlson Model (MO) with a set of macroeconomic variables[3], Paredes and Oliveira [29] verified that the Consumer Price Index (IPCA) was statistically significant for the calculation of the behavior of the market value of companies from certain sectors.

2.4 Data Collection and Processing

The data used in this article is divided into two groups: economic-financial indicators and macroeconomic variables. The economic-financial indicators were calculated based on the financial statements provided by the companies of the sector and available at the companies internet websites. The time series of macroeconomic variables exchange rate and SELIC interest rate were collected on the website of Brazil's Central Bank (BACEN) and GDP/ IPCA time series data were collected on the website of the Applied Economic Research Institute (IPEA). All data used on the research is on quarterly basis and the analysis covers the first quarter of 2002 and the third quarter of 2017, on a total of 48 quarters or 192 months.

The software used for the application of Artificial Neural Networks was the R-Project. The "neuralnet" package provided a great tool for application of the proposed model in this article because it allowed flexible configurations, through customized choice of error and activation function.

III. THE TODA-YAMAMOTO TEST

In order to investigate whether is there any dependence between macroeconomic variables and the economic and financial performance of the Brazilian pulp and paper industry from 2002 to 2017, it was used the causality test following the methodology of Toda and Yamamoto [36]. According to Fochezatto *et al* [13], the test can be applied to a co-integrated systems without the need for unit root pre-tests, also allowing variables to have different integration orders.

According to Morrone [26], the Toda-Yamamoto test contemplates four steps. First, it is necessary to define the number of lags (h) according to the maximum order of integration of the VAR model (Auto-Regressive vectors) to be applied; the. The next step consists in the direct estimation of a VAR for the analyzed variables at level; and finally, the last step involves performing the Wald constraint test on the first (k) parameters, in order to examine Granger's non-causality hypothesis.

On the other hand, the application of the Toda-Yamamoto procedure involves three steps according to Fochezatto *et al*. [13]. The first is the definition of the optimal number of lags (z) and the maximum order of system integration (e). The second is the estimation of a VAR with variables at level with a total of (z + e) lags, as follows:

$$\boldsymbol{y_t = \mu + \sum_{i=1}^{p+m} \alpha_i y_{t-i} + \sum_{i=1}^{p+m} \beta_i x_{t-i} + u_{1t}} \quad (1)$$

$$\boldsymbol{x_t = \mu + \sum_{i=1}^{p+m} \gamma_i x_{t-i} + \sum_{i=1}^{p+m} \delta_i y_{t-i} + u_{2t}} \quad (2)$$

Where $\boldsymbol{y_t}$ represents the economic-financial performance index; $\boldsymbol{x_t}$ the macroeconomic variables; $\boldsymbol{\mu}$ is a constant; $\boldsymbol{\mu}$ is a white noise error term assumed as ~ (0, σ2) and without autocorrelation; the subscript $\boldsymbol{t}$ refers to the time period and $\boldsymbol{i}$ denotes the lag $(\boldsymbol{i = 1,\ldots, k})$. The subscript $\boldsymbol{m}$ is the maximum order of integration of the variable in the system and $\boldsymbol{p}$ is the optimal lag length of $\boldsymbol{y_t}$ and $\boldsymbol{x_t}$

The maximum order of integration m in the VAR system was defined through the "*var.select*" function available in the "*vars*" package from the R-Project software. The function gives the information criteria and final prediction error for the sequential increase of the order of delay until a VAR (p) process, based on the same sample size. We then used the Akaike, Schwartz and Hannan-Quinn information criteria for the decision of the maximum lag applied to the VARs models.

The third step consists in the application of the Wald constraint test in the first p coefficients to test the non-causality hypothesis. In this sense, there will be causality from x to y if the hypothesis H_0: β_i = 0 is rejected and the hypothesis H_0: δ_i = 0 is not rejected[4].

[3]GDP per capita, SELIC rate, Consumer Price Index (IPCA), Exchange Rate and Risk as variables. See Paredes [29] for further details of the model.

[4]For further details, see Fochezatto *et al*. [13].

https://dx.doi.org/10.22161/ijaers.6770 ISSN: 2349-6495(P) | 2456-1908(O)

IV. ARTIFICIAL NEURAL NETWORKS

Artificial Neural Networks (ANN) models constitute a method of solving computational problems by constructing a system that simulates the human brain operation and thus reproduces its characteristics, such as learning, association and generalization. According to Ferneda[11], Neural Networks constitute a field of computer science linked to artificial intelligence, seeking to implement mathematical models that resemble biological neural structures.

According to Fayal [10], the ANN models constitute an important nonlinear statistical technique capable of solving a great range of highly complex problems. Therefore, they are useful models in situations where it is not possible to explicitly define a list of rules.

There are already several studies on the use of computational intelligence on time series forecasting. Bebarta *et al.* [3] presents a model of recurrent neural networks using technical indicators to predict future prices in the Indian stock market. Pommeranzenbaum [30] through Artificial Neural Networks proposes a prediction model of the price series of the Ibovespa index. Jaybhay *et al.*[20] proposes a model to predict the daily closing price of the Bombay Stock Exchange Index (BSE) by combining price and news data into a feed-forward neural network, obtaining results with high accuracy.

The basic unit of a neural network is the artificial neuron, which processes its inputs through a weighted sum considering pre-selected weights or parameters of the network, and an activation function. Gurney [17] and Ortega [27] presents a detailed discussion on the information processing by ANN. By combining several neurons, an artificial neural network is formed. Each of these neural networks differentiated themselves through their architecture and the way that the weights and connections are associated and adjusted during the learning process. This architecture depends on the type of problem in which the network can be used. (Ferneda, [11]).

Data modeling through neural network goes by the following process. Initially, the network is presented with a data set. This phase is called training and, at this moment, the learning process takes place through a continuous adjustment of the synaptic weights. Subsequently, this network must be tested by presenting patterns never seen by it, and its performance is evaluated.

4.1. The Adopted Architecture

In this paper, the Multi-Layer Perceptron (MLP) network architecture was used. An MLP typically consists of an input layer, with one or more hidden layers and an output layer. It has a feedforward architecture type, which is characterized by the direction of data propagation and the interconnection structure. In this network, data is propagated from input to output and there are no connections between neurons of the same layer or of previous layers (Pasquoto, 2010).

Neural network learning process occurs in two phases (Rumelhart *et al.*, [32]). In the first phase, an input pattern is presented to the neurons and its effect propagates through the network, layer by layer, producing a network output. The network output is subtracted from a desired output producing the error. Then, this error is retro propagated backwards, which causes adjustments in the synaptic weights.

In this article, we tried to estimate the performance of the economic-financial indicators through two models, one using only the past data of the indicators themselves and another using past data and macroeconomic variables. As can be seen:

$$Ind_t = f(Ind_{t-1}) \quad (3)$$

$$Ind_t = f(Ind_{t-1}, GDP_t, Interest\ rate_t, Exchange\ Rate_t, Inflation_t) \quad (4)$$

In model (3) the economic-financial indicator depends only on its past data. In the model (4), besides depending on its past data, it depends on four contemporary macroeconomic variables, they are: The Gross Domestic Product (GDP or PIB), the interest rate represented by the SELIC rate, the exchange rate ("Câmbio") and the inflation represented by the IPCA.

The parameters involved in defining an MLP network range from the number of intermediate layers, the number of neurons in these layers, the definition of activation functions up to the training algorithm. In this case, we use only one hidden layer and we vary from 1 to 7 the number of neurons in that layer. For the activation functions, it was used the tansig (Hyperbolic tangent sigmoid) and logsig (Logarithmic sigmoid) functions. For the training algorithm, it was used the traingdx (Gradient descent backpropagation with momentum and adaptive rate).

The definitive configurations of each network were based on the Mean Absolute Deviation (MAD), on the Mean Absolute Percentage Error (MAPE) and on the

https://dx.doi.org/10.22161/ijaers.6770 *ISSN: 2349-6495(P) | 2456-1908(O)*

Root Mean Square Error (RMSE) metrics, and the selection criteria for the networks was lowest values for each of the selected metrics. The time equals 3,000 and the training error is close to 2%.

4.2. Model Comparison Metrics adopted

When projecting the historical values, it is possible to compare the actual values with the estimated values. This comparison provides the error level of the forecast generated by the model when making projections over the historical data. From this error, you can calculate metrics to measure the model performance and is possible to compare results from different methods.

There are several metrics used, in this case we use MAD, MAPE and RMSE. The MAD represents the standard deviation of the fitted value against the mean in the same data units.

$$MAD = \frac{\sum_{k=1}^{N} |a_k - y_k|}{n} \quad (5)$$

Were n being the number of forecasted values, a_k is the desired output for the prediction index k, and y_k is the forecasted output for the index k. MAPE is a measure of precision, expressed as a percentage through the following formula:

$$MAPE = \frac{\frac{\sum_{k=1}^{N} |a_k - y_k|}{a_k}}{N} X\ 100\% \quad (6)$$

Where N is the number of forecasted values, a_k is the desired output for the prediction index k and $y_k$is the forecasted output for the index k. The RMSE does a similar calculation to the MAPE for the quadratic error as can be seen below:

$$RMSE = \sqrt{\frac{\frac{\sum_{k=1}^{N} |a_k - y_k|^2}{a_k}}{N}} \quad (7)$$

Larger errors are penalized in this metric. In this way, a technique that presents optimal results in most forecasted values, but has high errors in a specific forecast, will presents a high RMSE.

V. ESTIMATION RESULTS

Table 1, 2, 3, 4 and 5 presents the descriptive statistics on the analyzed variables in the article. For each series containing the variations of the indicators of the pulp and paper sector we present the maximum and minimum variation of the indicator for the period (July 2002 to November 2017), the mean, standard deviation and variation coefficient.

Table 1 - Debt Descriptive statistics of variables and indicators.

Indicator	Maximum	Minimum	Mean	Standard-deviation	Variation Coefficient
Interest Rate Coverage Ratio	458%	-593%	-16%	143%	-920%
Total Liabilities divided by Total Assets	10%	-21%	0%	5%	1799%
Debt/Equity Ratio	63%	-53%	2%	18%	898%
Fixed Assets to Equity Ratio	47%	-34%	1%	12%	1678%
Cash and Cash Equivalent to Equity Ratio	240%	-87%	1%	51%	8397%

Source: Elaborated by authors based on data provided by companies' websites, BACEN and IPEA.

Table 2 - Liquidity Descriptive statistics of variables and indicators.

Indicator	Maximum	Minimum	Mean	Standard-deviation	Variation Coefficient
Overall Liquidity	60%	-16%	1%	10%	1155%
Current Ratio	47%	-26%	2%	13%	619%
Quick Liquidity	47%	-34%	2%	14%	602%

Source: Elaborated by authors based on data provided by companies' websites, BACEN and IPEA.

Table 3 - Activity Descriptive statistics of variables and indicators.

Indicator	Maximum	Minimum	Mean	Standard-deviation	Variation Coefficient
Days of Inventory Outstanding	25%	-20%	0%	8%	1798%
Days of Payables Outstanding	65%	-39%	2%	17%	903%
Days of Sales Outstanding	361%	-30%	7%	47%	682%
Financial Cycle	79%	-35%	3%	19%	631%
Operating Cycle	49%	-20%	1%	10%	703%

Source: Elaborated by authors based on data provided by companies' websites, BACEN and IPEA.

Table 4 – Performance and Profitability Descriptive statistics of variables and indicators.

Indicator	Maximum	Minimum	Mean	Standard-deviation	Variation Coefficient
Asset Turnover	426%	-34%	8%	58%	696%
Net Margin	270%	-395%	-4%	106%	-2669%
Return on Asset	799%	-273%	23%	173%	761%

Source: Elaborated by authors based on data provided by companies' websites, BACEN and IPEA.

Table 5 – Macroeconomic Variables Descriptive statistics of variables and indicators.

Indicator	Maximum	Minimum	Mean	Standard-deviation	Variation Coefficient
Exchange rate	30%	-12%	1%	8%	1203%
GPD (PIB)	8%	-7%	3%	4%	149%
Interest rate (SELIC)	39%	-23%	-1%	1%	-130%
Inflation rate (IPCA)	7%	0%	2%	1%	65%

Source: Elaborated by authors based on data provided by companies' websites, BACEN and IPEA.

According to Table 1, 2, 3, 4 and 5, the sector presented variation of -4% for the mean Net Margin,

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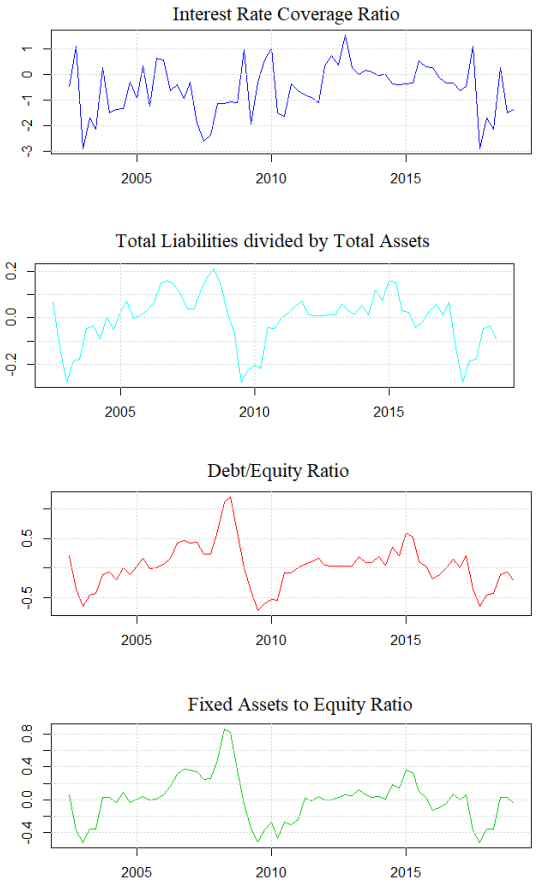
which indicates that the sector presented stable average performance in the analyzed period. The sector presented a variation of the average Financial Cycle in the period of 3% and a standard deviation of 19%, revealing some stability in the bargaining power of the companies that make up the sector with its suppliers. The Return on Asset Index showed a maximum growth of 799% and a minimum of 273% in the analyzed period, which reveals some variability in the efficiency of the asset application. Regarding the behavior of the macroeconomic variables, as can be seen in Table 1, 2, 3, 4 and 5, the Interest Rate presented in average a fall of 1% with a standard deviation of 1%. The exchange rate, the GDP and the Inflation rate presented average growth in the analyzed period of 1%, 3% and 2%, respectively.

Fig. 1, 2, 3 and 4 show the quarterly variation of the indicators over the analyzed period.

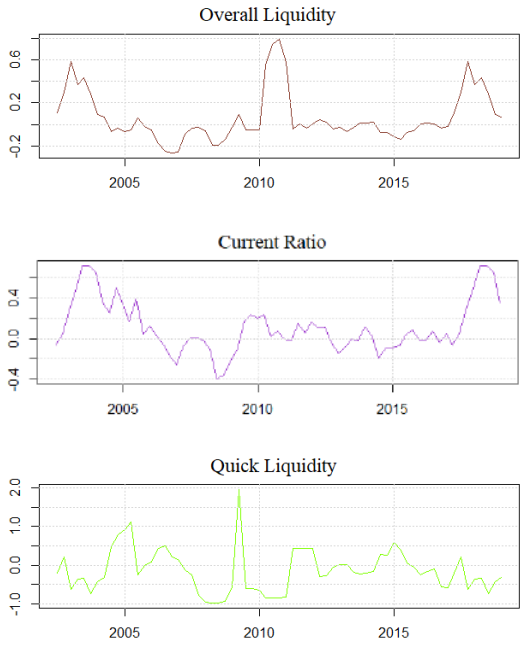
Fig. 1 – Debt Group



Source: Authors based on the data provided in the Balance Sheets of companies in the paper and pulp sector.

As can be seen in Fig. 1, the indicators show variability in the analyzed period. The Interest Coverage Index Ratio shows variability around (-1%) over the period, while the Total Liabilities divided by Total Assets, Total Liabilities over Equity (Debt / Equity Ratio) and Fixed Assets to Equity Ratio showed a growth trend at the beginning of the series and stability at the end of the period. The level of cash and cash equivalents varied around (0.0%) with a peak in 2009.

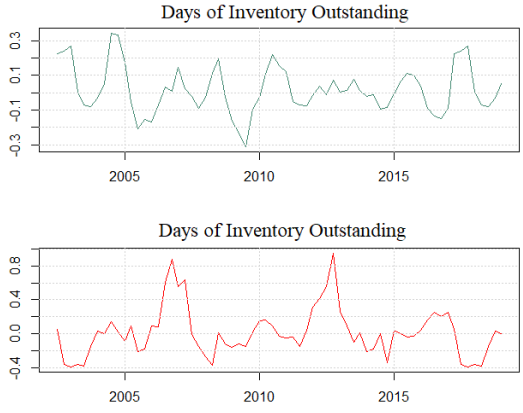
Fig. – Liquidity Group



Source: Authors based on the data provided in the Balance Sheets of companies in the paper and pulp sector.

As can be seen in Fig. 2, Overall Liquidity peaked in 2011 and at the end of the analyzed period (2017), while the Current Ratio showed a downward trend and subsequent stability until the end of 2015. Quick Liquidity presented moderate variability and a peak in 2019.

Fig. 3 – Activity Group



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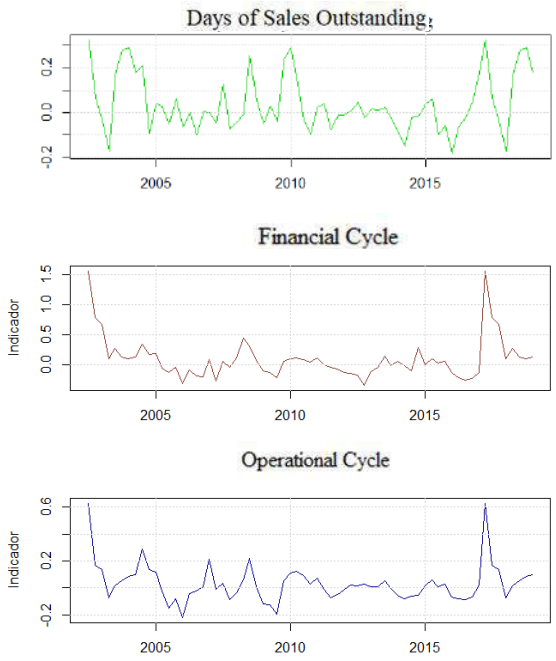
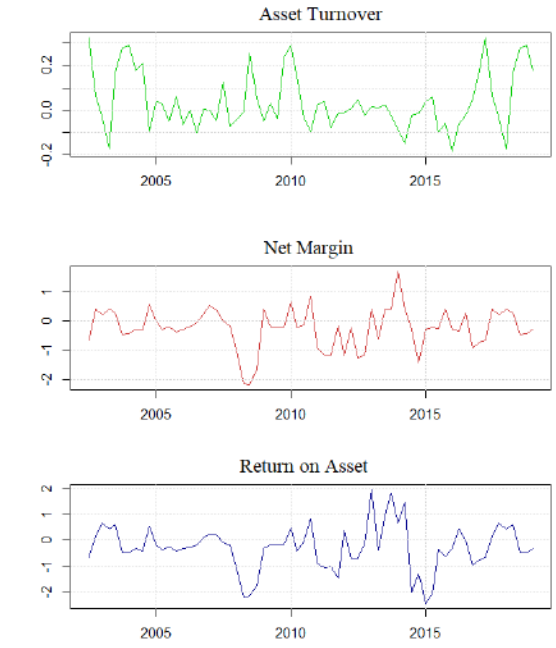


Source: Authors based on the data provided in the Balance Sheets of companies in the paper and pulp sector.

The indexes that compose the Activity Group do not present similar movements. Financial Cycle (days) is the most stable and Days of Sales Outstanding (days) is the most unstable index.

Fig. 4 – Performance and Profitability Group



Source: Authors based on the data provided in the Balance Sheets of companies in the paper and pulp sector.

The Asset Turnover showed the lowest variability in the period, while the Net Margin and Return on Asset presented similar movements. As can be seen, all the indicators presented some stability in the last quarters of the sample.

Table 6 - P-values from Toda-Yamamoto test [36]

Economic-financial indicators		Macroeconomic Variables			
		Exchange Rate	GDP	Interest rate (SELIC)	Inflation rate (IPCA)
Debt	Interest Rate Coverage Ratio	0,220	0,600	0,000	0,002
	Total Liabilities divided by Total Assets	0,000	0,045	0,000	0,006
	Debt/Equity Ratio	0,043	0,000	0,040	0,013
	Fixed Assets to Equity Ratio	0,001	0,000	0,000	0,000
	Cash and Cash Equivalent to Equity Ratio	0,038	0,000	0,000	0,000
Liquidity	Overall Liquidity	0,000	0,510	0,000	0,000
	Current Ratio	0,730	0,014	0,001	0,000
	Quick Liquidity	0,000	0,000	0,000	0,001
Activity	Days of Inventory Outstanding (days)	0,001	0,400	0,000	0,000
	Days of Payables Outstanding (days)	0,052	0,002	0,016	0,000
	Days of Sales Outstanding (days)	0,001	0,001	0,000	0,001
	Financial Cycle (days)	0,380	0,000	0,001	0,000
	Operating Cycle (days)	0,019	0,700	0,130	0,000
Performance and Profitability	Asset Turnover	0,000	0,002	0,000	0,048
	Net Margin	0,048	0,000	0,000	0,000
	Return on Asset	0,050	0,000	0,009	0,001

Source: Elaborated by authors based on data provided by companies websites, BACEN and IPEA.

Table 6 presents the p-values of the Toda-Yamamoto test applied to determine the dependence between macroeconomic variables and the economic and financial performance of the Brazilian pulp and paper sector from 2002 to 2017. Note that the tests and the modeling were applied to the quarterly variations of the series (Figs, 1, 2 and 3).

As can be seen in Table 6, the macroeconomic variables that were related to the Interest Rate Coverage Ratio were only the Interest Rate (SELIC) and the inflation rate (IPCA). It should be noted that: (i) the SELIC Rate is the base interest rate of the economy, so all other rates are related to it in some way and (ii) the SELIC Rate is a monetary policy instrument used by the government to curb inflation. Therefore, the test result corroborates our expectations that these two variables were related to the Interest Rate Coverage Ratio.

According to the p-value found, for all the others indicators in the "Debt" group, the macroeconomic variables tested (Exchange rate, GDP, Interest rate and Inflation rate) presented p-values lower than 0.05. Therefore, for the estimation and forecasting of debt indexes we can use the four macroeconomic variables mentioned above.

The application of the Toda-Yamamoto test [36] on the diagnose about the existence of any relationship between the Overall Liquidity Index and the

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macroeconomic variables allowed us to find that the variables Exchange Rate, Interest Rate and Inflation Rate presented p-values close to zero, which indicates the possible dependence of the liquidity index to these variables. The test result corroborated our expectations, as the index measures how much liquid resources the company has to cover each monetary unit of (short and long term) contracted debts. As mentioned above, the debts are related to interest and, depending on the company, may be tied to the exchange rates.

The test also revealed that the variables GDP, Inflation and Interest Rate are relevant for the estimation and forecast of the Current Ratio. It is known that Inflation rate, recession or economic expansion and the base interest rate can influence the demand and supply of goods produced by a company. Since the Current Ratio includes information on these variables, we can confirm the result of the test.

In relation to the Days of Inventory Outstanding, it was verified the dependence on the following variables: Exchange Rate, Inflation and Interest Rate. Since the Days of Inventory Outstanding calculates the average term that the products stay in stock throughout the year, it is assumed, at first, that the Exchange Rate, Inflation and Interest Rate can influence the sales flow of the company and consecutively the inventory of the same. Therefore, the test result seems consistent.

The test results for the Financial Cycle and the macroeconomic variables revealed that the variables GDP, Interest and Inflation rates presented p-values equal to or close to zero. It should be noted that the financial cycle is the time between the payment made to suppliers and sales receipt. In the process of buying raw material, producing, selling and receiving the value from its customers the company can be influenced by the interest rate, for example, and this may be important for the buyer's decision to buy something (in) cash or to finance their purchases. GDP and Inflation can influence the postponement of the final consumer purchase, increasing the sale time of the product and consecutively the receipt. Therefore, the test result corroborates our expectations.

According to the performed simulations, the variables Exchange Rate and Inflation Rate are relevant for the estimation and forecasting of the Operating Cycle. The fact that companies in the pulp and paper sector export their production justifies such dependence on the Exchange Rate. As previously mentioned, inflation rate is a key variable for the decision of the demanders of goods and services in general.

As can be seen in Table 6, all macroeconomic variables used in the analysis were relevant for forecasting and estimating the Performance and Profitability Indexes. It is worth mentioning that these indicators measure the profitability and performance that a company can present for a given period. We consider, according to all the above assumptions, that for these indicators of profitability and performance the Exchange Rate, GDP, Interest Rates and Inflation rate were relevant, since the Performance and Profitability Indexes are final indicators of the manufacturing, storage, sales and receipts process.

After performing the tests previously mentioned by the authors, we used the Neural Networks to model the economic-financial indexes together with the selected macroeconomic variables. For the Neural Network training, we used the first 30 observations from each time series. Later, in order to evaluate the performance of the Neural Networks we used the rest of the series formed by the variations of the performance-financial indexes and the macroeconomic variables. Table 6 shows the error measures for the two models applied, the first model using only the past data of the indicators themselves (Equation 1) and another (Equation 2) using the macroeconomic variables.

According to Table 7, 8, 9 and 10, for the great majority of the variations of the economic-financial performance indexes the macroeconomic variables brought improvements in the neural networks performance, reducing the forecast errors. In these examples, the three error measures (MAD, RMSE and MAE) presented some decrease, in comparison with the measures calculated using the errors coming from the network with only one entry (the time series itself, with one period lag). For all variations of the economic-financial performance indexes, at least two of the three adherence measures presented improvements for the network that used macroeconomic variables among their inputs.

Table 7 – Debt - Error measures calculated from the forecasted errors obtained by the Neural Networks

Indicator	Error measures					
	MAD	RMSE	MAE	MAD	RMSE	MAE
	without macroeconomic variables			with macroeconomic variables		
Interest Rate Coverage Ratio	47,7%	23,6%	74,0%	24,1%	21,7%	67,9%
Total Liabilities /Total Assets	2,9%	1,3%	4,5%	2,1%	1,2%	3,4%
Debt/Equity Ratio	10,1%	3,2%	11,2%	5,3%	3,3%	9,8%
Fixed Assets to Equity Ratio	9,4%	11,8%	26,6%	7,9%	10,8%	23,0%
Cash and Cash Equivalent to Equity Ratio	10,9%	11,3%	25,8%	8,0%	11,2%	23,3%

Source: elaborated by authors based on data provided by companies websites, BACEN and IPEA.

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Table 8 – Liquidity - Error measures calculated from the forecasted errors obtained by the Neural Networks

Indicator	Error measures					
	MAD	RMSE	MAE	MAD	RMSE	MAE
	without macroeconomic variables			with macroeconomic variables		
Overall Liquidity	3,0%	2,6%	7,5%	4,3%	2,4%	6,3%
Current Liquidity	9,4%	2,4%	9,0%	6,8%	2,2%	8,3%
Quick Liquidity	8,7%	2,6%	9,6%	8,3%	2,3%	8,6%

Source: elaborated by authors based on data provided by companies websites, BACEN and IPEA.

Table 9 – Activity - Error measures calculated from the forecasted errors obtained by the Neural Networks

Indicator	Error measures					
	MAD	RMSE	MAE	MAD	RMSE	MAE
	without macroeconomic variables			with macroeconomic variables		
Days of Inventory Outstanding	6,6%	2,5%	9,2%	1,1%	0,5%	2,0%
Days of Payables Outstanding	8,8%	5,2%	15,7%	7,3%	4,1%	12,2%
Days of Sales Outstanding	6,7%	2,2%	8,0%	6,1%	1,8%	7,0%
Financial Cycle	10,5%	3,4%	14,7%	10,4%	4,6%	12,2%
Operating Cycle	5,2%	2,1%	7,6%	3,9%	1,1%	4,4%

Source: elaborated by authors based on data provided by companies websites, BACEN and IPEA.

Table 10 – Performance and Profitability - Error measures calculated from the forecasted errors obtained by the Neural Networks

Indicator	Error measures					
	MAD	RMSE	MAE	MAD	RMSE	MAE
	without macroeconomic variables			with macroeconomic variables		
Asset Turnover	21,2%	8,5%	30,6%	2,8%	4,8%	17,7%
Net Margin	53,7%	27,8%	87,9%	45,6%	27,5%	84,5%
Return on Asset	114,8%	62,4%	198,3%	63,4%	60,6%	172,3%

Source: elaborated by authors based on data provided by companies websites, BACEN and IPEA.

It should be noted that for the evolution of the Interest Rate Coverage Ratio, Net Margin and Return on Asset, the applied neural networks presented high error measures, thus requiring a little more attention in the analysis.

Thus, for the Brazilian pulp and paper sector, during the studied period, it was verified that the performance of the macroeconomic variables was significant to forecast the changes in the economic-financial indexes. The obtained results in our tests are consistent with those presented in the articles by Guidini *et al.*[16], Santos *et al.*[33], Costa *et al.*[8] and Medeiros *et al.*[25].

VI. CONCLUSION

The Pulp and Paper sector plays a fundamental role in the Brazilian economy. The differentials and advantages Brazil have on rotation cycle time and productivity makes Brazil one of the main territories for the development of this industry, essential in the contemporary world.

The economic-financial indicators place us in relation to a company situation. When such information is organized as a time series data set, it reveals the evolution of a corporation over time, providing data for analysis to be measurable.

The causality test following the approach defined by Toda and Yamamoto [36] to investigate the existence of dependence relation between macroeconomic variables and the economic and financial performance indicators of the Brazilian pulp and paper sector was extremely relevant. When considering only the macroeconomic variables indicated by the test as inputs to the Artificial Neural Networks (ANNs), the error measures presented a decrease, compared to the measurements when we used all the macroeconomic variables, thus proving the importance of the dependency relationship test approach proposed by Toda and Yamamoto[36].

Neural Networks used as a forecasting tool has shown again its promising ability, since only few errors presented in this study exceeded the ratio of 10%. That is, when comparing the actual indexes with those predicted by the neural network, the difference was small in most comparisons, confirming the effectiveness of the ANNs for the anticipation of scenarios. The exceptions were the Return on Asset, Interest Coverage Ratio and Net Margin, which will require a more detailed analysis in future works.

As for the main objective of this article, it was verified that the 16 indexes of economic-financial performance analyzed by the neural networks performed better when it was also used GDP, SELIC Rate, IPCA Rate and Exchange Rate as information inputs to the analysis. The results obtained corroborate with those presented by Guidini *et al* [16], Santos *et al*[33], Costa *et al*[8] and Medeiros *et al.* [25].

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Cultural environment: Legal Protection of Intangible Cultural Heritage in Amazonas and Popular Participation.

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Abstract— *This article presents a critical approach on the legal instruments for the protection of Brazilian cultural heritage, intangible assets in Amazonas. It develops considerations about the importance of popular participation and awareness as a direct participant in this process of safeguarding the intangible assets (beliefs, identity, memory, forms of manifestation and culture of a people) for present and future generations. This theoretical discussion goes through the brief analysis of the normativity, of the actors involved in this process, of the effective search to ensure that intangible assets are perpetuated.*
Keywords— ***cultural heritage, legal instruments, immaterial goods, popular participation.***

I. INTRODUCTION

The historical memory of a people is revealed in a variety of ways, not only material but immaterial (or intangible), such as beliefs, dances, knowledge, stories and other, passed on from generation to generation that constitute the Cultural Historical Patrimony.

The research intends to analyze the legal instruments available for protection of intangible assets in the State of Amazonas and the importance of the accessibility of popular participation in policies aimed at ensuring that these intangible cultural assets have their perennial present and future generations.

This discussion is important because it refers us to the reflections that correlate with the theoretical roots of the environmental movements that do not have a historical framework, but in the early days they related environmental issues to the local, through the mystic (protection of forests), to observation and (empirical) . On the other hand, already in an anthropocentric view advocated by Keith Thomas in his work, Man and the Natural World: Changes in Attitude Regarding Plants and Animals, reinforces that the relationships of humanity are intrinsically linked with the natural world. The unitary (holistic) and holistic view of the environment aggregates natural, sociocultural, and economic elements.

It analyzes the mechanisms available to safeguard registered intangible assets against the risk that the present and future generations reached by the models of development and globalization may forget their roots, neglecting their own meanings that made up the essence of their ancestors. The way of life, the expressions, the identity, the memory of different groups, the manifestations of a people, which are references and are part of Brazilian and local society, must be perpetuated, in order to be lost.

Not so distant, immaterial or intangible assets in Brazil, began to have relevance and legal protection from the Federal Constitution of 1988, before focusing on the material assets to compose the Cultural Historical Patrimony. With the scope of legal protection for intangible goods, instruments provided for in legislation were essential to ensure the safeguarding of the cultural environment and the full exercise of citizenship.

The analysis will be developed from the bibliographical review under the bias of the critical reasoning of the researcher. In this way the research is of scientific, personal and social relevance.

II. CULTURAL ENVIRONMENT - JURIDICAL NATURE AND HOLISTIC VISION

The perception of the inseparability of the natural, artificial and cultural elements that compose the environment in the pursuit of the sound quality of sight finds shelter in the unitary (integrative) and holistic

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(broad) conception. In this sense, Pellegrini Filho (1993, page 30) argues that the ecological and biological aspects must be conjugated with the historical patrimony "the human right to dispose of quality of life, with the right to land, decent housing, health, education, maintenance and preservation of their culture. "

From the prism of comprehensiveness and interrelationship of these elements indispensable to the dignity of the human person, thus carrying out "a more comprehensive environmental analysis the socio - cultural and economic factors of the environment, in fact it is difficult and undesirable to try to separate the physical and socio - economic components of the environment "(Lickorish and Jenkins, 2000, p.117).

One cannot forget that the conception of collective memory, aspects of history, the multiple cultural dimensions sedimented in the past is closely linked to what we call "cultural patrimony", recognized as a legal good that goes beyond, being elevated to the condition of interest.

The protection of cultural heritage as a legal asset is contextualized in the social cries and challenges imposed by the constant situation of existential risk of this patrimony that reflects the culture itself, past and memory of the people. In this way, the Right reestablishes the balance and security in the socio-cultural relations, contemplating the values and the principles of the Democratic State of Right.

In the lessons of Cecilia Londres:

"This extension of the notion of cultural heritage may therefore be considered as one of the effects of so-called" globalization ", insofar as having aspects of its culture, perhaps hitherto considered by external looks such as coarse, primitive or exotic, recognized as World Heritage, contributes to the insertion of a country or social group in the international community, with benefits, not only political but also economic. "

As we can see, the transformations and social changes resulting from historical and cultural dynamism served as intangible elements for the new definition of cultural heritage, its concept and its tutelage. In this sense, Funari and Pelegrini (2006, pp. 24-25):

[...] societies have increasingly been interpreted as composed of various social groups, themselves fluid and constantly changing, with possibly conflicting interests. Therefore, the concepts of environment and culture have changed. The environment and culture were often valued for their unique and exceptional character. With the awakening to the importance of diversity, it no longer makes sense to value only, and in isolation, the most beautiful, the most precious or the rarest. On the contrary, the notion of preservation began to incorporate a set of goods that are repeated, which are in some sense common, but without which the exceptional can not exist. It is in this context that the notion of immateriality of the patrimony was developed.

Guided by the constitutional relevance, the Cultural Environment came to have legal protection established in article 216 of the Brazilian Federal Constitution of 1988, being considered material and immaterial assets, taken individually or together, bearers of reference to identity, action, to the memory of the different formative groups of Brazilian society, including forms of expression, ways of creating, doing and living; scientific, artistic and technological creations; the works, objects, documents, buildings and other spaces destined to the artistic-cultural manifestations; urban complexes and sites of historical, scenic, artistic, archaeological, paleontological, ecological and scientific value.

The Charter of 1988, when it attributed to the public power, to the society itself the promotion and protection of cultural heritage is inserting as "environmental good diffuse". Corroborating with this understanding, Marcos Paulo de Souza Miranda understands in his work Tutorship of the Brazilian cultural heritage:

"The protection of cultural heritage is undoubtedly part of the concept of a third generation fundamental right, and it is undisputed that the protection of this right satisfies humanity as a whole (diffuse right), insofar as it preserves its memory and its values, ensuring their transmission to future generations ". (MIRANDA 2006, p.16).

It is important to emphasize that the recognition of a cultural heritage and its preservation is not exclusive to the administrative function of the State and can also be exercised by the legislature, through appropriate laws and by the judiciary, ex officio or by provocation.

III. REGISTRY AS AN INSTRUMENT OF PROTECTION TO THE BRAZILIAN IMATERIAL CULTURAL HERITAGE

The Brazilian Law evolved to contemplate other cultural goods, the immaterial ones, that dispensed with other legal tutelages to the popular cultures, to the knowledge and knowledge, practices and places. Folkloric movements, national and international articulations coexisted to emphasize this view of appreciation of the valorization of popular cultures, in that bias the Public Power was broadening its conception of cultural heritage, of the plural character of identities.

Still under the aegis of Decree Law no. 25/1937, even if the legislation did not change. There was a milestone in

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this evolution of treatment of the legal concept of cultural heritage when in 1980, the Institute of National Historical and Artistic Heritage - IPHAN, by decision of its Consultative Council fell in Bahia, a terreiro of candomblé, in a more evolved view for translating the breadth of what constitutes Brazilian cultural heritage, decades later, of the aforementioned legislation, going against legal literality, but impressing upon that immovable property exceptional historical and artistic value.

Thus, a political decision representative of paradigm change in the IPHAN, which contributed to the evolution of the Law on the aggregate matter, the various demands of the different groups and movements experienced in the 1940s that defended the protection of the ways of creating, living and doing, forms of expression and celebrations, places, spaces, such as Intangible Cultural Heritage.

This new vision was wrapped up in the legal system, placing the Intangible Cultural Heritage at the same level as the Material Cultural Heritage, without hierarchical treatment, but with appropriate tutelage.

The Constitution of 1988 recognized the equality of legal protection of the Material and Intangible Cultural Patrimony, with the leveling of value of these categories and constitutional instruments for their effective protection.

Even so, the Registry that is an adequate instrument to protect the intangible or intangible assets, still remained dependent on the tipping, was relegated to oblivion. As we perceive the constitutional provision expressed in Article 216, which constitutes non-self-executable, norms of a programmatic nature, placing the Intangible Cultural Heritage without effective state protection by not regulating the legal instrument, important for adoption of public policies. However, more than a decade later, due to the pressures of traditional groups and intellectuals, Presidential Decree n. 3.551, published on August 4, 2000, regulating the constitutional provision.

Decree Law no. 3,551 / 2000 is an important norm that established the Register of Cultural Goods of Intangible Nature that constitute Brazilian cultural patrimony and created the National Program of Intangible Heritage.

The Registration of Cultural Goods of Intangible Nature that constitute Brazilian cultural heritage, will be done in one of the following books, as set forth in article 1. of the said Decree: I - Book of Knowledge Registry, where knowledge and ways of doing will be inscribed in the daily life of the communities; II - Book of Record of Celebrations, where they will be inscribed rituals and celebrations that mark the collective experience of work, religiousness, entertainment and other practices of social life; III - Book of Record of Forms of Expression, where literary, musical, plastic, scenic and playful manifestations will be inscribed; IV - Book of Registration of Places, where markets, fairs, shrines, squares and other spaces where they are concentrated and reproduce collective cultural practices will be registered.

As a cultural and political phenomenon, Law translated the ideal that prevailed at the time among intellectuals recognizing for the first time from a Decree-Law, that the national historical and artistic patrimony is constituted by all movable and immovable property existing in the country and whose preservation is of public interest, or because of its connection with memorable events in the history of Brazil, or because of its exceptional archaeological or ethnographic, bibliographic or artistic value.

It was essential to safeguard the intangible or intangible cultural heritage, or rather, the creation of a national identity, could not be restricted to the protection of material cultural goods, whose legal instrument of tipping was foreseen for the protection of these goods.

Advances brought by Decree Law no. 3.551 / 2000, were experimented with the publicity of the instrument for protection of intangible cultural goods, creation of an affection department for the conduct of the processes, implementation of programs, with well defined objectives for policies of Inventory, Registration and Safeguarding cultural goods of an intangible nature , preservation of ethnic and cultural diversity, encouragement and support to preservation initiatives and practices, among others.

It is the responsibility of the National Historical and Artistic Heritage Institute (IPHAN) to execute the National Program of Intangible Heritage - PNPI. In accordance with paragraph 1. of Article 216 of the Federal Constitution, while promoting the participation of groups and communities, promotes social inclusion and improvement of the quality of life of the agents involved in supporting the material conditions indispensable for the reproduction of cultural expressions and greater access to benefits generated by this preservation.

IV. THE PROTECTION OF IMMERSIAL HERITAGE IN THE STATE OF AMAZONAS AND POPULAR PARTICIPATION

In the State of Amazonas, following the guidelines of Decree-Law no. 3.551 / 2000, ways of promoting, protecting and encouraging the intangible part of cultural heritage is being carried out through the Culture Secretariat. Develops studies, edict and projects in the

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areas of popular culture and indigenous, characterizing the cultural experience of a community; Rescue of traditional urban toys: cloth doll (witch), top, wooden leg and the game of stone button of tucumã used in Largo de São Sebastião; Studies on the cultural and social use of tucumã; Studies on the Symbols of the Amazon; Announcement of research on saints and crendices in Amazonas; Search "Memory of the Largo de São Sebastião"; Collection of postcards from the series "Intangible Cultural Heritage"; Collection of postcards of the series: "Memória do Amazonas"; Coordinates the "Map of the Arts" project; Promotes the mapping of the cultural assets of the State; Promotes the registration of the culture of the Boi Bumbá de Parintins as Brazilian cultural heritage; Projects to safeguard the traditional expressions: traditional ox of Manaus, Gambá de Maués; Produces documentaries that express the richness and cultural diversity of the state; Traditional Medicine Saterê; Japanese immigration in the Amazon and Tukano rituals; Coordinates the implementation of Culture Points in the State; Promotes academic seminars and discussion forums on the themes of popular and indigenous cultures; It disseminates in Brazil and abroad the traditional cultural manifestations of the Amazon; Promotes the appreciation of local masters and local knowledge; It supports state policies aimed at traditional cultures.

Among its state competencies: I - Promote actions for knowledge and valuation of intangible assets; II - To propose and promote studies of mapping and inventory of intangible cultural heritage of the State; III - Develop activities to safeguard and disclose intangible assets; VI - To carry out projects with a view to valuing the popular traditional culture (Indians, blacks and caboclos); VII - Stimulate actions with groups or communities, valuing cultural identities; VIII - Maintain interinstitutional relations and articulation with private and non-governmental organizations in order to carry out intersectoral projects; IX - Propose projects that promote cultural citizenship; X - Perform other activities that are determined in your area of competence.

Cultural heritage has to be considered a valuable tool of human experiences, but popular participation can no longer be ignored by the public power. To individuals who are excluded from this process, heritage education must be a practice of social participation. And these political practices that involve the experience of sociability, require of all those involved an understanding of the social use of the convivial space between the individuals that make up that community (CERTEAU, 2007).

Throughout history, cultural rights allow the defense of social and ethnic minorities, this recognition of cultural identity passes through diversity, with constitutional support for Indians, Afro-Brazilians and Quilombola communities. It brings a certain reflection to these origins of struggle and resistance, to talk about immaterial heritage is to give meaning, to refer to belonging, to be recognized by the community and to be included in its sociocultural dynamics.

The Public Power has the duty to protect, promote and value the cultural assets and values of the different ethnic segments of society, as set forth in article 215, paragraph 1. of CF / 88. On the other hand, the extension of the concept of cultural heritage broke with an elitist vision of considering as object of legal protection the manifestations of the historically dominant class and recognized the importance of the participation of other ethnic segments for the construction and cultural valorization of a truly democratic and inclusive.

V. CONCLUSION

The theme of protection of intangible heritage is still little explored. The objective of this work was to address the means of safeguarding Brazilian immaterial cultural heritage, and in Amazonas, besides the need for popular participation in this process. In Brazil, the concern and effective legal protection was not very far, starting from the aegis of the Federal Constitution of 1988. After, the decree law n. 3,551 of August 4, 2000, which established the Register of Cultural Goods of Intangible Nature that constitute Brazilian cultural patrimony, and created the National Program of Intangible Heritage. The great challenge is the perpetuation of intangible assets, which by their nature and intangible dimension require public policies that involve all, not only the Public Power, but society. In Amazonas, the Secretariat of Culture has this competence to preserve, promote and safeguard intangible cultural heritage. This understanding of the culture, the roots, the traditions, and everything that constitutes intangible heritage with its profound significance for the people and place, the heritage education itself must be constant.

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Microbiological Analysis of Surface Waters in the "Igarapé Esperança" water Resources in Benjamin Constant-Am

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Abstract *— One concern that plagues the contemporary population is the pollution of water sources. When a water ecosystem is degraded and modified by anthropic actions, environmental and human survival is a risk. The release of freshwater effluents into water resources results in several socio-environmental problems, significant impacts on aquatic life and the environment as a whole. In this way, this work presents results of the analysis of the surface waters using Microbiological Parameters in 06 points of the Igarapé in the city of Benjamin Constant-AM, in order to know the levels of water pollution from microbiological agents such as the presence and quantity of Thermotolerant Bacteria, Total and Heterotrophic Coliforms. It was verified that in one of the Parameters analyzed the value exceeded the limit allowed by the Ministry of Health (2011) and Conama Resolution nº 357 of 03/17/2005 (CONAMA, 2011), returning the concern to some residents who still use the surface waters for domestic purposes, allowing the appearance of diseases characteristic of impacted water ecosystems. It is necessary to encourage and carry out actions aimed at the preservation and conservation of the Igarapé, enabling the formation of work centers to study ways of reversing and minimizing the Environmental Degradation framework.*

Keywords *— **Analyzes. Water Resource. Microbiological Parameters.***

I. INTRODUCTION

The Amazon Rainforest has the largest biodiversity, sociodiversity, and morphoclimatic and phytogeographic holder of the world, in an area of 6.3 million km2, being approximately 5 million only in Brazilian territory, covering most of the countries of South America, as Bolivia, Colombia, Ecuador and Peru "(HAFFER et al, 2002).

It has the largest drainage basin in the world, with about 700,000km² (URSZTYN, 2004). It is formed by a diversity of water bodies, not only large rivers and lakes, but also numerous small streams that constitute one of the densest water networks in the world (JUNK, 1983).

Water in this extensive forest is essential for the life and dynamics of living ecosystems and local populations. In the Amazon, the mainland streams, mostly, present acidic waters, due to the presence of humic and fulvic acids. They are one of the natural resources that most directly suffer from the impacts of urban growth. Until recently used abundantly, water resources in many regions of the Amazon have become increasingly scarce as population expansion occurs (FARIA, 2010).

According to the National Water Agency (ANA, 2012), the main causes of the poor quality of raw water are due to the lack of control of population growth in the surroundings of water bodies, accompanied by lack of investments in basic sanitation, contamination by domestic sources, industrial , agricultural activities and mining.

With the discharge of several pollutants in the water bodies, changes and modifications in their physical, chemical and biological characteristics occur. According to CONAMA Resolution 357 (Brazil, 2011), it establishes acceptable values for the different types of parameters in the raw waters, classifying these water resources according to their use. The classification standardizes the bodies of water and allows the establishment of goals to reach the level of quality desired (BRASIL, 2006).

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Detection of certain metals in surface waters according to IUPAC (2008) is of considerable importance because it establishes the levels of influences for natural ecosystems as well as monitor and control the critical sources through which they reach the hydrosphere.

Microbiological analysis is also considered relevant for monitoring studies of natural waters, as it is possible to verify the influence of some microorganisms on water quality. An example is the presence of bacteria typical of degraded sites such as the Coliformes group, formed by bacteria which include the genera Klebsiella, Escherichia, Serratia, Erwinia and Enterobacteria.

II. METHODOLOGY

The survey was carried out in Igarapé Esperança, a water body of greater scope, present in the urban area of the city of Benjamin Constant (1,116 km from Manaus), a city belonging to the sub-region of the Amazon Basin called the micro-region of Alto Solimões in the southwest of the state of Amazonas, between the coordinates: 4 ° 23'19.56 "S - 70 ° 1'31.99" W, in a triple border area razil, Colombia and Peru (IBGE, 2010), shown in figure 01.

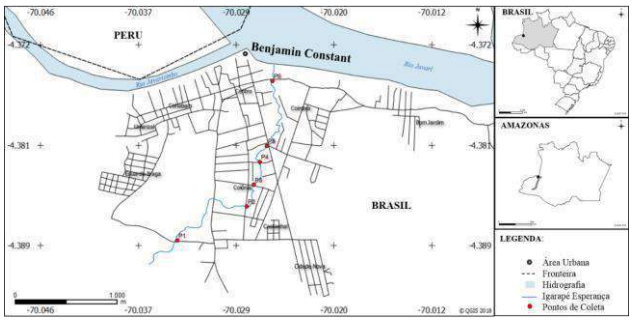

Fig. 01. Location of Collection points in the Municipality of Benjamin Constant-AM.

The research consisted in the sampling of surface waters and sediments at 06 points along the Igarapé Esperança, in the smaller and larger urbanization sections of the municipal district of Benjamin Constant-AM, distancing approximately 500 meters from each point. Surface water samples were collected against the stream in 500 mL polyethylene pots, approximately 10 cm from the surface, previously decontaminated after vigorous rinsing with distilled water.

The analysis was performed after the conclusion of the samples, as a way of minimizing and delaying the processes of chemical and biological changes of the water from the moment of withdrawal of the sample from the environment. The microbiological parameters analyzed were Heterotrophic Bacteria and Thermotolerant Bacteria and Total Coliforms.

For analyzes of Thermotolerant and Total Bacteria, the Collext reagent was added to the polyethylene pot containing the samples, shaking until the solution was diluted. The solution was poured into the analysis plate, taking it to the sealer to prevent spillage and external contamination in the sample. After this procedure, the 06 analysis plates corresponding to the collection points were taken to the Greenhouse for 24 hours of incubation.

The procedure for the analysis of the presence of Heterotrophic Bacteria is similar to that of Thermotolerant and Totals, but another reagent is used. 1 ml of the water sample was applied to the test dish and 5 ml of the Simplate for HPC reagent. Samples were taken to the greenhouse for 48 hours, as shown in figures 02 and 03.

III. INDENTATIONS AND EQUATIONS

The first paragraph under each heading or subheading should be flush left, and subsequent paragraphs should have a five-space indentation. A colon is inserted before an equation is presented, but there is no punctuation following the equation. All equations are numbered and referred to in the text solely by a number enclosed in a round bracket (i.e., (3) reads as "equation 3"). Ensure that any miscellaneous numbering system you use in your paper cannot be confused with a reference [4] or an equation (3) designation.

Fig. 02. Solutions poured into

Fig. 03. Plates with samples taken to

The analysis and reading of the bacteria occurred with the aid of the lantern of emission of ultraviolet radiation and with the data of references obtained from the Resolution Conama nº 357 of 03/17/2011 (CONAMA, 2011) and Reference Patterns: ordinance nº 2914 / 2011 of the Ministry of Health.

Data analysis was performed using quantitative and qualitative treatments, tabulated with the use of electronic spreadsheets for better quantification and interpretation of graphs and tables later submitted to statistical treatment using Microsoft Excel, version 2016.

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The dispersion charts used to demonstrate the relationship between sets of values obtained in the two collections, referring to the samples collected in the Amazon Summer and those collected in the winter, were used to explain the results. These procedures are performed upon receipt corresponding to all collections.

IV. RESULTS AND DISCUSSIONS

The determination of microorganisms indicative of water pollution is essential for the verification and monitoring of the level of environmental impact of a given object of study. The analysis of the thermotolerant coliforms, "organisms belonging to the subgroups of bacteria of the species Escherichia coli, made it possible to verify the presence in all points of this type of prokaryotic that originates mainly from human feces (BRASIL, 2011), indicating contamination in the water resource.

According to Figure 4, the quantity of thermotolerant coliforms at 4 collection points (points: P2, P3, P4 and P5) exceeded the value determined according to ordinance no. 2914/2011 of the Ministry of Health (Funasa, 2011), which establishes the measurement of drinking water for human use. In this evaluation it is possible to verify the presence of total and thermotolerant coliforms, preferably Escherichia coli. This same rule "establishes that the standard bacterial count should not exceed 500 colony forming units per 1 milliliter of sample (500 / CFU / ml)" (BRASIL, 2006).

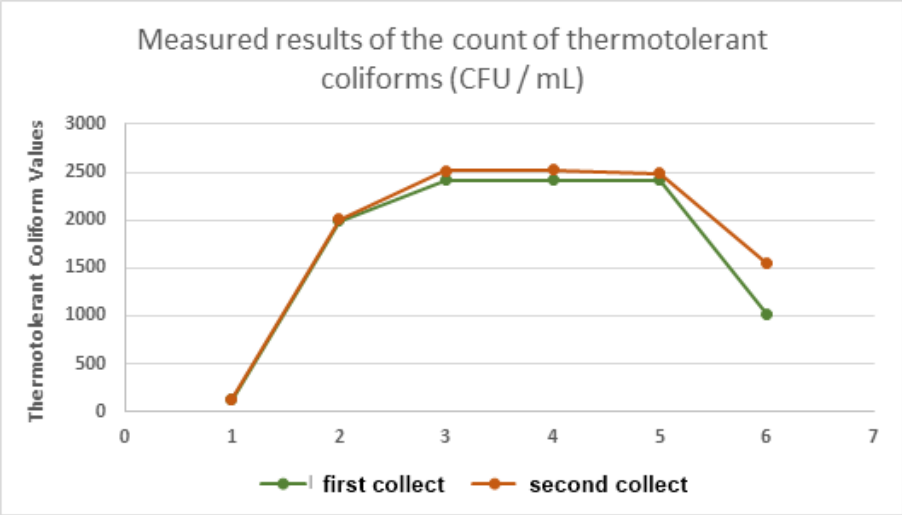

Fig. 04. Quantity of thermotolerant coliforms in the samples collected.

The indicated values of thermotolerant bacteria that reached 2,419.6 in 3 points, demonstrate the very high concentration of Escherichia coli in these areas. In a second collection, there was a slight increase in the measured values highlighting the point P4 (2,525 CFU / m), an increase caused by the beginning of the period of higher precipitations. The highest values would be due to the higher concentration of housing nuclei and consequently domestic discharges directly to Igarapé, causing problems related to public health, which are reflected in inadequate or almost nonexistent sanitation.

According to Brazil (2011), "the fecal origin of E. coli is unquestionable and its ubiquitous nature unlikely, which validates its more precise role as an organism indicating contamination in both natural and treated waters."

Another analysis was the determination of the total amount of Heterotrophic Bacteria. These bacteria are essences in water ecosystems because they "participate in the cycling of many inorganic substances used by other living beings, besides decomposing cellulose, lignin, keratin and other natural molecules difficult to decompose" (COSTERTON et al, 1995). high concentrations can affect water quality.

To determine the presence or absence of Heterotrophic Bacteria, we used the Ultraviolet emission Flashlight, observing the existence of blue fluorescence in the wells of the plates. Such staining indicates the possible presence of colonies of certain bacteria. Figure 05 shows the values determined by the most probable number (MPN) method in a sample.

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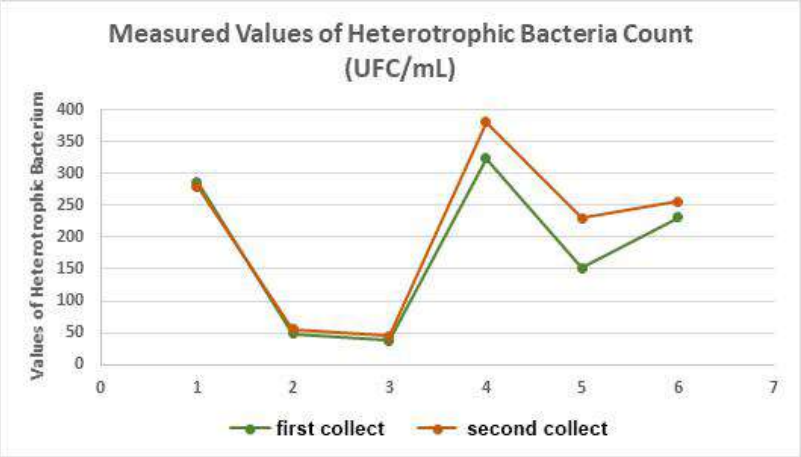

Fig. 05. Quantity of Heterotrophic Bacterium from the lake sample.

The highest concentration that presented an expressive value in relation to the other points was P4 (324 bacteria in a 10 mL sample of water), but did not exceed the allowed value of 500 CFU / mL indicated by ordinance 2914/2011. In the second collection, the points P4 (380 CFU / mL) and P5 (256 CFU / mL) were the most discharged sites.

Although this species of bacteria is not considered pathogenic, its excess may present risks to human health, deteriorating water quality, causing unpleasant odors and flavors (BRASIL, 2012).

Sabioni and Silva (2006) emphasize the importance of controlling their density, since in higher numbers they may present a certain risk to health and especially to the environment, and may act as secondary pathogens. According to Opas (1999), some of the major diseases caused by water pollution by pathogenic bacterial microorganisms.

Another microbiological parameter used was the measurement of total coliforms. Most of the bacteria in this group belong to the coliform genera Escherichia, Citrobacter, Klebsiella and Enterobacter, although there are other genera and species included in this group (BRASIL, 2011). The analysis found that the point with the highest incidence of total Coliforms was P5, with the result reaching the most probable number of 65 and the P4 with 45 units of this group in the first collection. In the second collection there was a change in the values corresponding to the points P5 (70) and P6 (42) units of total coliforms.

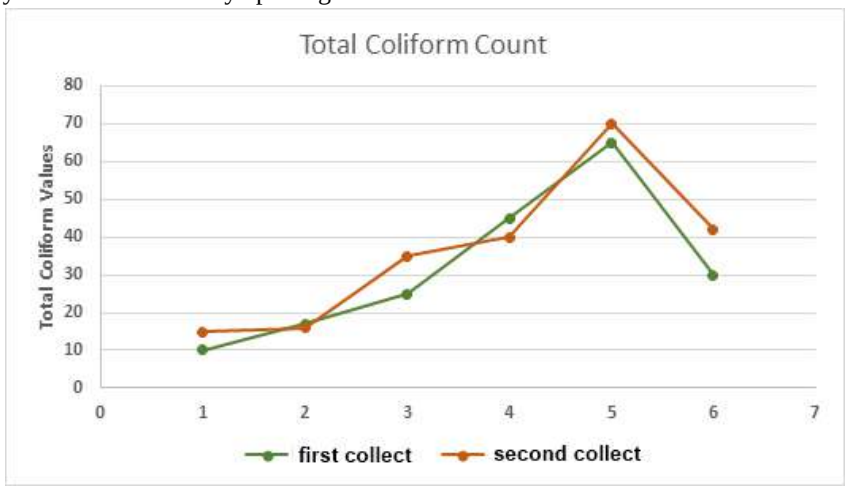

Fig. 06. Total Coliform values corresponding to the collection points of the lake.

Figure 6 shows a rise, which starts from P1, with the lowest number of total Coliforms, and as the water body enters the neighborhoods, the values increase, which can be explained by the greater influence of urbanization and lack of infra - structure and greater superficial flow of fecal material in the stretches, data shown in points P4 and P5.

This is explained by the fact that there are higher numbers of residences that discharge all kinds of matter (animal, vegetable, oils and greases) in their beds, representing a great indication that the waters of Igarapé

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are being contaminated by human feces, rendering it unusable for consumption. Effluents are released directly into water bodies, and there is no sewage treatment plant (STUDART, 2003).

According to the National Water Agency (ANA, 2012), the main causes of the poor quality of raw water occur due to the lack of control in the population growth around the bodies of water, accompanied by lack of investments in basic sanitation, contamination by domestic sources, industrial , agricultural activities and mining.

With the discharge of several pollutants in the water bodies, changes and modifications in their physical, chemical and biological characteristics occur. According to CONAMA Resolution 357 (Brazil, 2005), it establishes acceptable values for the different types of parameters in the raw waters, classifying these water resources according to their use. The classification standardizes the bodies of water and allows the establishment of goals to reach the level of quality desired (BRASIL, 2006).

The presence of this group of bacteria in the water resources of developing countries, according to the World Health Organization (WHO) 80% of diseases caused by contaminated water. Microbial contamination of urban systems has the potential to cause large outbreaks of waterborne diseases, so ensuring the quality of such systems is a priority (WHO, 2008). According to the report of the Pan American Conference on Health and Sustainable Human Environment, about 30% of the Brazilian population consumes water from unsafe sources, most of which are served by public water supply and do not always receive adequate quality and quantity of water (COPASAD , 1995).

V. CONCLUSION

The analysis of the microbiological parameters of the surface water of the analyzed water body made possible the analysis of the water quality of one of the main water ecosystems of the urban area of the city of Benjamin Constant-AM, being possible to correlate the results obtained with the anthropogenic activities visualized at the time of collection, demonstrating and confirming that the increase of housing centers around the body of water causes environmental degradation, a strong threat to the health of the local population and biota.

It was possible to classify according to the norms, that the analyzed water ecosystem was evaluated in Class III, because they presented values, standards and microbiological conditions qualifiable by resolution of CONAMA No. 357 of 2011,

The results suggest that the Igarapé needs an intervention for supposed recoveries in its physical structures, reallocations of domiciles located around the water body that periodically release household waste, organic residues and solids that allow the proliferation of microorganisms that directly affect the local population.

ACKNOWLEDGEMENTS

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Of Prescribility in the Environmental Administrative Process

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Abstract*— *It is undeniable that environmental protection is of increasing importance to society as a whole, given its vital importance for the survival of man on planet earth. In this way, the State adopted a rigid posture that reflected through governmental actions, due to the exercise of its legal function, elaborating laws and regulations that aim at the protection and conscious use of natural resources, as well as the mechanisms of reprimand to the violators. Thus, in spite of environmental law, the present work seeks to highlight and discuss the incidence of prescribed under the environmental administrative processes established from the practices of acts considered illegal the legal norms attached to the environment, reflected by reason of the processing time, intercurrent prescription, due to the eternalization of these processes, considering that this administrative position is unbearable for the administered, because, the same results in embargoes and interferences in the legal relations between the pairs - Administrators and Public Administration, since the administrative inertia unjustifiably harms the delay in the regular progress of the process.

***Keywords*— *Environmental Law, Social Relationships, Prescriptibility*.**

I. INTRODUCTION

The objective of this study is to analyze the incidence of intercurrent prescription in the course of the environmental administrative procedure due to the extensive time taken to process its procedures, which often extend over a period of more than five (5) years, and thus , end up hampering their pedagogical and punitive function, as regards the imposition of penalties and pecuniary sanctions for the practice of conduct contrary to the environment, in addition to giving absolute legal uncertainty in the relations between the parties involved, where environmental damage ends up being succumbed by deadline.

It is essential to record that the Public Administration has control of all procedural procedures despite its optional acts, resulting from its exercise of police power derived from Law No. 6.938 / 81, which establishes the National Environmental Policy - PNMA, which was received by art. 225, of the Federal Constitution, where such administrative position is regulated by Decree No. 6,514 / 08, which provides for infractions, penalties and administrative sanctions in favor of the environment, where the latter, however, is destined to processes in the federal jurisdiction is also applied, by analogy the demands reflected in the States, Federal District and Municipalities.

Thus, from an overall view, it is undeniable that administrative procedures, within the scope of the Public Administration must observe the legal term of process, under penalty of losing the right to promote the proper application of administrative penalty, which often ends in the application of fine due to the investigation of infraction practices against the environment. In this sense, the term is also dealt with by Law No. 9.873 / 99, which establishes the five-year prescriptive period for the exercise of punitive action by the Federal Public Administration, either Direct or Indirect, as of the date of practice of the act or, in in case of permanent or continuous infringement, of the day on which it ceased.

In order to do so, it is perfectly possible and due to the application of the intercurrent prescription in environmental administrative proceedings due to extensive processing, above all, because it is timid that the paralysis of the same does not operate, because of the taxpayer, that in turn, is subject to the timeliness of its acts, but rather by the inertia of the Public Administration regarding the practice of acts essential to the regular progress of the process.

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II. OF ENVIRONMENTAL LAW

Initially, it should be clarified that Environmental Law is a public order norm, whose purpose is to promote the protection of the environment, through the exercise of its legal function, by elaborating laws and regulations aimed at the protection and conscious use of natural resources, as well as such as mechanisms for reprimanding offenders, through principles and coercive norms that regulate human activities that, directly or indirectly, may affect the health of the environment in its global dimension, aiming at its sustainability for present and future generations, under the terms of Art. 225, of the current Constitution,

"Art. 225. Everyone has the right to an ecologically balanced environment, a common use of the people and essential to a healthy quality of life, imposing on the Government and the community the duty to defend and preserve it for present and future generations . "

Thus Environmental Law, therefore, a set of norms and legal instruments established by the country's legislator whose foundation is the protection of the environment, against human behavior, whose main tool is coercive action by the Public Administration that has pillar, the provisions of the caput , of art. 37, of the Constitution Patria, in verbis:

Art. 37. The direct and indirect public administration of any of the Powers of the Union, of the States, of the Federal District and of the Municipalities shall obey the principles of legality, impersonality, morality, publicity and efficiency and also the following ...

In line with the constitutional conception referred to above, the alignment of Environmental Law with other branches of law, such as: criminal, tax and, above all, Administrative Law is observed, especially with the advent of Law 6.938 / 81, which provides for the application of penalties and administrative sanctions due to the occurrence of conducts and activities harmful to the environment. The correct exegesis of this law is indicated in the provisions of its art. 70, which defines what becomes an environmental infraction, let us see:

Art. 70 - It is considered an environmental administrative infraction any action or omission that violates the legal rules of use, enjoyment, promotion, protection and recovery of the environment.

Therefore, Environmental Law regulates any action or omission that violates the legal rules of use, enjoyment, protection and recovery of the environment, where once the infraction is established, this will be processed in an environmental administrative process, which will seek the promotion of punishment of the offender with the application of Law No. 9605/98, which deals with environmental crimes, provides for harmful conduct against the environment and its sanctions, with a view to conscientizing society and punishing those who degrade it, without prejudice of the application of other penalties provided for in the legislation attached to Decree No. 6,514 / 08.

III. OF THE ENVIRONMENTAL ADMINISTRATIVE PROCESS - OF THE INCIDENCE OF INTERCHANGEABLE PRESCRIPTION

The environmental administrative process, like any administrative process, is a means by which the State, in the exercise of its police power, promotes the investigation of conduct understood as infringing on the environment as a result of the action or omission of the person or entity . Thus, the environmental administrative process, despite administrative legislation, will have as its basis the constitutional principles of legality, due process of law, legal certainty, motivation; proportionality and, with greater emphasis, the principle of reasonable length of the process, because it is inadmissible in the legal system the eternalization of administrative processes at any level of performance.

For this, the prescription, besides being a mechanism of legal security is a regulator of stability of social relations, either determining the initial term and also the deadline for its establishment and satisfaction of what is determined after regular administrative process, either or to avoid the unjustified suspension of the procedural movement.

In order to do so, the State's judicial protection in defense of the environment begins with the assessment of the alleged offender, with due observation of the principle of ample defense and contradiction, which eschew the principles of probation, motivation, reversibility and of the right represented, all based on art. 5º, LV of the Federal Constitution, which thus stipulates: "The litigants, in an administrative proceeding, and the accused in general are assured the contradictory and ample defense, with the means and resources inherent therein."

In this way, the environmental administrative process, besides being based on the police power of the Direct and indirect Public Administration, is also supported by the general principles of law, determined by art. 37, of the Constitution of the Nation, as previously mentioned, whose interpretation in the scope of Environmental Law plays a role of integration and harmonization of the legal system and stability of social relations, by means of normative acts focused, mainly, to the protection of the environment before the environmental infringements,

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characterized not only by the occurrence of damage, but also, by non-observance of legal rules, that may or may not have harmful consequences for the environment.

Therefore, any conduct considered harmful to the environment derived from the practice of an unlawful act practiced by a natural or legal person, whether by action or omission, will be determined through an administrative process of its own, imposing a penalty in the manner determined in Decree No. 6,514 / 08 c / c Law No. 9,605 / 98, which can not be extended indefinitely in order to lose its purpose and cause significant instability in the relations between peers, thus giving rise to the possibility of intercurrent prescription due to the provisions of Law no. 9,873 / 99, with the additions of Law 11,941 / 09.

Thus, once the practice of an act harmful to the environment is verified, or, in the case of permanent or continuous infraction, when the illegal activity ceases, the initial frame of the administrative process is established, with the parameter, also, of the initial frame of the period of 05 (five) years for the Public Administration to promote the determination of unlawful conduct, under penalty of losing the right of action, as well as the possibility of imposing penalties and penalties, which is why the prescription in the pursuant to Decree No. 6,514 / 08 c / c Law No. 6.938 / 81.

With regard to Decree No. 6,514 / 08, which, among its provisions, establishes the federal administrative procedure for the determination of administrative infractions to the environment and the applicable sanctions, which is inaugurated by the drawing up of the notice of infraction by the enforcement agent, which shall contain the identification of the assessee, a clear and objective description of the environmental infractions found and the indication of the respective legal and regulatory devices infringed, as determined by arts. 96 and 97.

In this way, in the approach regarding the starting point of the counting of the term to determine environmental damage and its consequences, the comment of the eminent Cut Trennepohl, in work: Infractions Against the Environment: fines, sanctions and administrative proceeding: comments to Decree No. 6,514, dated July 22, 2008, which reads as follows:

"... Before deciding whether an illegal activity that has occurred for more than five years is still possible punishment should be checked whether the negative effects of it persist because of other anthropogenic action or not. In the event of an action or omission that prevents the adverse effects from ceasing, or that the environment returns to its original equilibrium, the five-year prescription for the determination and punishment is removed, since it characterizes the continued negative effect. "

Therefore, once the environmental administrative process has been instituted, it is important to observe the five-year period for its determination and application of the applicable sanction, avoiding, for its consequence, the perpetuation of these processes, causing eminent and undeniable instability in the relations, besides violating the principle of due process of law, legal certainty and other principles inscribed in Article 37 of the Constitution. In this context, notwithstanding the exercise of the environmental police power conferred on all the organs that are members of SISNAMA, in the light of art. 6, of Law 6.938 / 81, it is necessary to observe the legal term, under penalty of loss of the right of action to investigate the practice of infractions against the environment and, consequently, the possibility of imposing sanctions. In the strict legality of the principle of legal certainty, it is impossible for the administrative process to be perpetuated, despite Law No. 9.873 / 99, which establishes the five-year prescriptive period for the punitive action of the Federal, State or Federal Public Administration. Indirect, counted from the date of practice of the act or, in case of permanent or continuous infraction, of the day in which it ceased.

It is therefore important to note that the perpetuation of administrative processes due to the deprivation of the Public Administration is eminently harmful to the legal system, since it necessarily implies the primary function of the protection of the environment by the State, where the Administration and its agents has the duty to act in the confirmation of the principles of efficiency and ethics, under penalty of violation of the law itself, configuring unlawfulness revealed by a flawed and invalid conduct. Therefore, under the terms of Law No. 9,783 / 99 and Decree No. 6,514, of 2008, it remains the understanding that intercurrent prescription has as its main purpose to curb the inertia of public agents - responsible for expressing the will of the State - in promote the necessary actions to boost the process, finalizing it in a reasonable time. This follows the provisions of art. 21, of Decree No. 6,514 / 08:

Art. 21.

§ 2º. The statute of limitations in the procedure for the determination of the notice of infringement paralyzed for more than three years, awaiting judgment or order, whose records shall be filed ex officio or at the request of the interested party, without prejudice to the determination of the functional liability resulting from the stoppage.

As can be seen, the incidence of intercurrent prescription is perfectly applicable in cases of

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proceedings that have been carried out for more than 03 (three) years without the proper apuratorial movements pertinent to the infraction dealt with in the administrative process. The unjustified procedural inertia, for more than three years, is undoubtedly a determining factor for determining intercurrent prescription.

Finally, in spite of several doctrinal and jurisprudential currents, it is important to recognize that in light of the guiding principles of Public Administration - art. 37, of the CF / 88 - the incidence of intercurrent prescription in the administrative sphere, is fully applicable, whenever, due to its own defect, acts are not practiced that is mainly responsible after the administration promotes challenge or recourse, as a way of safeguarding legal certainty and the stability of relations related to due process of law.

IV. OF THE PRESCRIPTION OF EXECUTIVE PREDICTION IN THE ENVIRONMENTAL ADMINISTRATIVE PROCESS

The administrative protection of the environment develops the specific legislation, where, it is the right of the administration of a reasonable length of the processes and their respective procedures, which highlights the possibility of the incidence of intercurrent prescription because the said process is processed "Ad eterno", considering that it is unbearable for the administered this eternalization, which results in embargoes and interferences in the legal relations between the pairs - Administrators and Public Administration, since the inertia of the administrative one harms, eminently, the regular progress of the process.

Consistent, environmental damage is a generic and comprehensive damage that reaches the legal good that is close to it, which is the social community of its surroundings, thus affecting social, economic and political life, given the irreversibility of the evil occasioned.

Since the environment is a diffuse right, civil reparation assumes great breadth, with profound implications on the species of responsibility of the degrading / polluting agent that is objective, based on the simple risk or the simple fact of the harmful activity, regardless of its fault.

Thus, based on the rule of art. 21, Decree No. 6,514 / 08, it is impossible to perpetuate the proceedings instituted with the purpose of promoting compensation for environmental damages, notwithstanding, the legal hermeneutics of imprescritibility, which attributes to the environment the same inherent right to life and its reflexes. In this sense, it is impossible to ignore the fact that the regular procedural environment is closely linked to the institutes of estoppel, decadence and prescription, which are rules of public order, covering various biases of our legal system and governed by the principles of legality, security legal, motivation, isonomy, reasonable length of the process, ample defense, administrative efficiency among other principles that manage the functions and prerogatives of Public Administration.

Thus, much more than the police power of the public entity in the face of the administered, is the protection of the constitutional rights of social relations between peers - public and private / private, where the application of the prescription proves to be an effective instrument of activity control administrative, thus avoiding the preponderance of administrative deities in comparison with the efficiency of the public service.

Respectful opinions of others, it is observed, that the environmental administrative process is submitted, yes, the incidence of the institute of the prescription is punitive, which starts from the date of the practice of the infraction or the cessation of the permanent or continuous infraction, by the intercurrent prescription, which may occur while the administrative proceeding is continuing, unless it is unjustifiably left paralyzed, without any movement, for more than three years.

In order to do so, we maintain the position that the pre-eminent environmental administrative process is subject to the prescriptive period established in civil-administrative legislation, or else, rely on the quinquennial prescription of the CTN and other sparse laws such as Decree No. 20.910 / 32 as the Law Decree No. 6,514 / 08, inasmuch as intercurrent prescription is intended to restrain the inertia of public agents in promoting the acts necessary for the regular progress of the process, a fact that prompts the perpetuation of these processes and, consequently, the time limit foreseen by law exceeds the deadline, so it must be borne in mind that all are due to the correct filing of proceedings and their respective procedures until finalization, in a timely manner, that must be developed by the mantle of item LIV, 5 of the Charter, which prescribes that no one shall be deprived of liberty or property without due process of law.

In this context, therefore, the principle application of due process, whose extension reaches the incidence of intercurrent prescription in the sense that the Public Administration can not extrapolate its exercise of police power and perpetuate the processes under its responsibility, under penalty of violating the principle of legal certainty and isonomy, in the form of art. 1 of Law No. 9.873 / 99, which establishes:

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Art. It prescribes in five years the punitive action of the Federal Public Administration, directly and indirectly, in the exercise of police power, aiming to establish violation of the legislation in force, counted from the date of practice of the act or, in case of permanent or continuous infraction, of the day where it has ceased.

§ 1 - The limitation period in the administrative procedure paralyzed for more than three years, pending judgment or order, whose records shall be filed ex officio or at the request of the interested party, without prejudice to the determination of the functional liability resulting from the stoppage, as the case may be.

In spite of the above legal norm, it should be emphasized that mere internal acts of simple procedural movement, without any usefulness to elucidate the facts, do not have the power to rule out intercurrent prescription, since such practices only serve to perpetuate processes, that environmental procedural rules have been violated, since the process is inherent in the task of concluding the investigation of the practice of conduct harmful to the environment perpetrated by the natural or juridical person. Failure to comply with the provisions of Law 9,873 / 98, as amended by Law No. 11,941 / 09 and Decree No. 6,514 / 08, is an absolute cause of the incidence of intercurrent prescription, especially since the unjustified suspension of the lawsuit for more than three years will cause the recognition of the intercurrent prescription and will demand the determination of functional responsibility.

Following the above position, comes the STF, with the following understanding: "the remedy for damages to the Public Treasury arising from a civil offense" is mandatory, at the time of judgment of the Extraordinary Appeal (RE) 669069. In this sense, one has that this binding norm reaches the administrative environmental proceedings instituted for the purpose of promoting the adequate reparation of environmental damage, being therefore susceptible to the limitation period the right and true duty-power to propose the public civil action to be handled by the legitimate ones.

In addition, it must be noted that the Brazilian legal system does not admit any imprescriptibility, except those that are clearly and expressly already regulated in the Constitution. In the present case, as reparations for environmental damage end in fines for the public purse, such condition is subject to the limitation period. Therefore, it is not for the infraconstitutional legislator or for the applicator of the norm to create the possibility of perpetuating the possibility of an environmental civil litigation being brought to the attention of the Judiciary at any time, even more when this inertia derives from omission of the Public Power, which , as a principle, has the duty to act efficiently and promote the reasonable duration of proceedings.

Thus, with due respect to contrary positions, pertinent to non-prescribability in environmental administrative processes, it is necessary to conclude that the intercurrent prescription is recognized in the general repercussion 666 of the STF, which also reaches the issues and matters that deal with the determination of responsibilities civil and environmental issues.

In the same line of case-law updates regarding this issue, the STJ has already acknowledged the incidence of intercurrent prescription in environmental administrative proceedings paralyzed in a higher term and 03 (three) years - Law 9,783 / 99 c / c Law 9,784 / 99 , in refusing to accept the Regime filed in REsp 1,401,371 / PE, maintained the TRF's understanding of the 5th Region, albeit due to the impossibility of reanalysis of evidence, due to the prescription of the administrative process paralyzed for more than 03 (three) years.

It is noteworthy that the aforementioned decision is aimed at inhibiting the inertia of public administration, which can not leave the taxpayer at the mercy of endless administrative processes, waiting for a decision that will directly influence the management of their businesses and their assets.

The High and Supreme Courts have already signaled for their understanding to restrain the inertia of the public administration regarding the practice of administrative procedures and procedures capable of promoting regular progress in the process, regardless of their respective legal nature, under penalty of offense to the principles provided for in art. 37, of the Federal Constitution, which guide the activities of the Public Administration as a whole, such as REsp. 1.115.078-RS - Rel. Min. Castro Meira, judged on 24.03.2010. In this respect, new judicial decisions on prescriptibility in administrative proceedings also seek to guarantee the principle of legal certainty, since the administered / offender can not remain for too long for the uncertainty of a conviction or not, since such a response will have a direct impact on the their assets.

Thus, the environmental administrative process in all its follow-ups and procedures, because it is based on the principles of Public Administration can not perish because of the inertia of the Public Administration, despite its prerogative, especially when provoked by the offender, that to his turn, presents, in a timely manner, manifestation by means of challenge and appeal. In such situations, the application of intercurrent administrative prescription as a means of guaranteeing legal certainty and stability of social relations, regulating the initial and

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final period, thus avoiding that the processes last longer than normal, as well as avoiding the standstill unjustified from the procedural iter, the maximum of which reflects the scope of Paragraph 1 of Law 9.73 / 99, which reads:

"... The statute of limitation in the administrative procedure suspended for more than three years, pending judgment or an order, shall be subject to a statute of limitation, the proceedings of which shall be filed ex officio or at the request of the interested party, without prejudice to the determination of functional liability arising from the stoppage, case."

In fact, since administrative intercurrent prescription has the function of avoiding the perpetuation of administrative procedures, especially in the application of administrative penalty and penalty, therefore, in the case of enforceable collection, the prescription is accompanied by the institute of decay, which are modalities of extinguishment of the tax credit, as foreseen in its art. 156, of the CTN, where the development of the process finds limitations in the provisions in arts. 173 and 174 of the same statute. These commands are fluent in procedural courses, especially regarding the application of fines related to infractions of environmental damages, which, can not be understood as imprescriptible, since the inertia of the Public Administration can not be perpetuated, under penalty loss of the right to demand the collection of its alleged non-tax credit, due to the analogous application of art. 1 of Decree No. 20.910 / 32.

In order to do so, the intercurrent prescription, under the light of the domestic legislation, emphasizes the efficiency of the public service, the officiality and morality and the security of the relations between the pairs, and thus the prescriptive rules, when they are intended to deal with liability for environmental damage, must also be seen through the eyes of prescribilidad, according to the art. 108, of the CTN c / c 178, of the CCB, whose understanding is pacified by Eg. STJ, by refusing to grant the Regime filed in REsp 1,401,371 / PE, for which it maintained the understanding of the TRF of the 5th Region, even though it was impossible to reanalyse evidence, due to the limitation of the administrative process paralyzed by more than 03 (three) years, which is contrary to the rule of paragraph 1 of art. 1, of Law No. 9.873 / 99, which is why it is noted that administrative disregard, above all, entails the loss of the right to impose administrative penalties and penalties corresponding to acts and acts harmful to the environment.

The aforementioned decision, while inhibiting the inertia of the public administration, protects the manager / offender from the eternalization of environmental administrative processes, in relation to the awaited decision that will directly influence the management of their businesses and their assets. In addition, it can not be denied that the non-observation of the application of the rule of § 1º, of art. 1 of Law No. 9.873 / 99, in the environmental administrative process, it is in total disrespect for the guiding principles of the Public Administration itself, which are imperative to its proper functioning, under penalty of invalidating its acts, rendering them illegal and even unconstitutional, since the inattention to the principles implies a clear offense to the primacy of the public function enshrined in art. 37, of the Brazilian Constitution.

Hodiernamente, have been faced with judicial decisions that take into account the incidence of intercurrent prescription, under the abovementioned rules, which aim to inhibit the inertia of the public administration, giving shelter to the principle of efficiency, foreseen in the Federal Constitution, which should guide the activities, since both the Public Administration and its agents have to act in accordance with the ethical precepts, under penalty of eminent affront to the law itself, thus constituting an unlawful, unmotivated and deviant act of its function, the which, finally, translates into nullity of the administrative act.

It is essential to emphasize that the positions of our Country Courts, which are in line with the most up-to-date doctrine regarding the incidence of intercurrent prescription in environmental administrative proceedings, are intended to guarantee the principle of legal certainty, since the taxpayer can not remain for too long in the uncertainty of imposition of penalties pecuniary penalties whose collections of alleged credit will directly impact their operations and planning, in addition to their work activity.

It should be noted, in due course, that it is the duty of the Public Administration to guarantee and act in accordance with the principles described in art. 37, of the Constitution of the Nation, which is why it is necessary to recognize in the legal world intercurrent prescription in the administrative sphere whenever, due to the deference of the administration, the acts in question are not practiced within a period of up to a maximum of 03 from the constitution of the fact, or from the challenge and / or administrative appeal.

Accordingly, it is important that, in reference to the limitation of the enforceable environmental claim, the term a quo is given for the non-payment of the penalty imposed on the offender by a final administrative final decision that ratifies the infraction notice and imposes the pecuniary sanction . It should be emphasized, as

https://dx.doi.org/10.22161/ijaers.6773 *ISSN: 2349-6495(P) | 2456-1908(O)*

appropriate, that the final decision should comply with the command Law No. 9.873 / 98, with wording given by Law 11,941 / 09 c / c Decree No. 6,514 / 08.

Therefore, once the voluntary payment has not been made in the scope of the Public Administration, the period of five years begins for the taking of measures to promote the collection of the debit constituted in the final administrative decision, being allowed the adoption of restrictive measures, among the the most important of which are the registration of the Defaulters Registry - CADIN (Law No. 10,522, of 2002) and the active debt.

Law No. 9.873 of 1998, with wording given by Law No. 11,941 of 2009, expressly provides for the incidence of the statute of limitations:

Art. 1º-A. Once a non-tax credit has been definitively established, after a regular administrative process has been completed, a five (5) year period of execution of the federal public administration regarding credit arising from the application of a fine for violation of the legislation in force.

It is essential to point out that the Superior Court of Justice recognizes as the initial term of the enforceable environmental claim the necessary definitive constitution of the credit in the administrative scope, so the theory of imprescritibility falls by land, since the counting of the term for the collection of the amount due by title is insurged of fine. To that end, STF's Summary 467 has the following document: "It prescribes in five years, from the end of the administrative process, the Public Administration's intention to promote the execution of the fine for environmental infraction."

According to the STJ, prescribilidade is accepted and affects training, enforceability and procedural procedure, as evidenced by repeated decisions of the Superior Court in order to apply to the execution of fines imposed by regular environmental administrative proceedings the provisions of Decree No. 20.910 / 32 according to the principle of symmetry, as set out in the following judgments:

CIVIL AND ADMINISTRATIVE PROCEDURE - FINE CHARGES FOR THE STATE - PRESCRIPTION - RELATIONSHIP OF PUBLIC LAW - CREDIT OF ADMINISTRATIVE NATURE - INAPPLICABILITY OF THE CC AND OF THE CTN - DECREE 20.910 / 32 - PRINCIPLE OF THE SYMMETRY.

1. If the relationship that gave rise to the collection credit is based on Public Law, there is no application to the prescription contained in the Civil Code.

2. Since the requirement of the amounts collected by way of a fine is born in a tie of an administrative nature, and therefore does not represent the requirement of a tax credit, the legal discipline of the CTN is removed from the treatment of the matter.

3. Incidence, in kind, of Decree 20.910 / 32, because the Public Administration, in the collection of its credits, must impose the same restriction applied to the administered with respect to the passive debts of that one. Application of the principle of equality, corollary of the principle of symmetry.

3. Special appeal inadmissible. [9]

ADMINISTRATIVE. FISCAL EXECUTION. ADMINISTRATIVE FINE. INFRINGEMENT TO THE LEGISLATION OF THE ENVIRONMENT. PRESCRIPTION. LEGISLATIVE SUCCESSION. Law 9,873 / 99. DEADLINE. OBSERVANCE. SPECIAL APPEAL SUBMITTED TO THE RITE OF ART. 543-C OF THE CPC AND TO RESOLUTION STJ No. 08/2008.

1. Ibama filed an indictment against the defendant, imposing a fine of R $ 3,628.80 (three thousand, six hundred and twenty-eight reais and eighty cents), in violation of the rules of environmental protection. The infraction was committed in the year 2000 and, in that same year, precisely on October 18, 00, was the credit inscribed in Active Debt, and the execution was proposed on May 21, 2007.

2. The issue discussed in the case file is, in part, coincident with that contained in REsp 1.112.577 / SP, also from my report and already judged under the regime of art. 543-C of the CPC and STJ Resolution No. 08/2008. In this particular case, the fine was applied by Ibama, a federal entity for environmental control and control, and it is possible to discuss the incidence of Law 9,873, dated November 23, 1999, with the additions of Law 11,941, dated May 27, 2009 In the other case, the fine was derived from the environmental police power exercised by an entity linked to the State of São Paulo, in which it would not be pertinent to discuss these two federal laws.

3. The jurisprudence of this Court recommends that the period for the collection of the fine imposed by virtue of administrative infraction to the environment is five years, under the terms of Decree No. 20.910 / 32, applicable by isonomy for lack of specific rule to regulate this time limit.

4. Although it is settled that the prescriptive term of art. 1 of Decree 20.910 / 32 - and not those of the Civil Code - apply to relations governed by Public Law, the case of the case involves examination in light of the provisions contained in Law 9.873 of November 23, 1999, with the additions of Law 11.941, of May 27, 2009.

https://dx.doi.org/10.22161/ijaers.6773 *ISSN: 2349-6495(P) | 2456-1908(O)*

5. Law 9.873 / 99, in art. 1º, established a period of five years for the Federal Public Administration, directly or indirectly, in the exercise of Police Power, to investigate the violation of the legislation in force, a period that must be counted from the date of practice of the act or, in the case of permanent or continuous infringement, of the day on which the infraction has ceased.

6. That provision established, in fact, the time-limit for the lodging of the claim, and not for the judicial recovery of the defaulted claim. In fact, Law 11.941, of May 27, 2009, added art. 1º-A to Law 9,873 / 99, expressly providing for a period of five years for the collection of the credit arising from breach of current legislation, in addition to the five-year term provided for in art. 1 of this Law for the determination of the infraction and constitution of the respective credit.

7. Prior to Provisional Measure 1,708, dated June 30, 1998, later converted into Law 9.873 / 99, there was no decadential period for the exercise of police power by the Federal Public Administration. Thus, the applied penalty was subject only to the five-year prescriptive period, according to the jurisprudence of this Court, due to the analogous application of article 1 of Decree 20.910 / 32.

8. The infraction under examination was committed in the year 2000, when Law 9.873 / 99 was already in force, and art. 1, which sets a deadline for the Federal Public Administration to establish, in the exercise of police power, the violation of the legislation in force and constitute the credit arising from the fine imposed, which was done, since the credit was registered in Active Debt in October 18, 2000.

9. As of the definitive constitution of the credit, occurred in the same year of 2000, a further five years are calculated for its judicial collection. This period therefore matured in 2005, but execution was only proposed on May 21, 2007, when the prescription was already in effect. The contested judgment must therefore be upheld, albeit on different grounds.

10. Special appeal not provided. Judgment subject to art. 543-C of the CPC and to STJ Resolution No. 08/2008. [10].

On the other hand, it is important to note that Law No. 9.873 / 99, covers the hypotheses that interrupt the prescription, let us see:

Art. 2º-A. The statute of limitations of the enforcement action is interrupted:

I - by the order of the judge ordering the summons in tax execution;

II - by judicial protest;

III - by any judicial act that constitutes in default the debtor;

IV - by any unequivocal act, even if extrajudicial, that it imports in recognition of the debit by the debtor;

V - by any unequivocal act that it imports in express manifestation of attempt of conciliatory solution in the internal scope of the federal public administration.

It should be noted that in none of the cases mentioned above in the scope of the environmental administrative proceeding, intercurrent prescription will prevail, as Minister Castro Meira teaches us, who pronounced in the judgment of Resp 1.112.577: "the initial term of the prescription coincides with the moment of the occurrence of the right injury ". Thus, in the case of an administrative fine, the prescription of the collection action begins only with the expiration of the credit without payment, when the offender becomes defaulted. "Before that, and as long as the administrative process of imposition of the penalty does not end, there is no statutory time limit, because the credit is not yet definitively constituted and simply can not be charged," said the minister. Therefore, prescritibilidade is evident as regulator the effectiveness of the Public Administration before its own inertia and interest of the taxpayer.

V. CONCLUSION

In spite of all the foregoing regarding the prescriptibility of the environmental administrative process, it is concluded that intercurrent prescription is fully possible, due to the lack of public administration when it remains inert in not proceeding with practices of internal acts that truly promote regular process , since such an institute is supported by Law No. 9.783 / 99, which states: "... it prescribes in five years the punitive action of the Federal Public Administration, directly and indirectly, in the exercise of police power, aiming to establish infraction of legislation in force, counted from the date of practice of the act or, in the case of a permanent or continued violation, of the day on which it ceased. " Loss of the right to impose administrative penalties must be established in the light of Decree No. 6,514 / 08, which states: "... it prescribes in five years the action of the administration aiming at ascertaining the practice of infractions against the environment, counted from the date of the practice of the act, or, in the case of a permanent or continuous infraction, on the day on which it ceased ", it is not justified that the administrator be at the mercy of the conduct of public agents, since this represents a clear offense to the guiding principles of

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administrative activity established in art. 37, of the Brazilian Constitution.

It should be emphasized in due course that the preponderant objective of the intercurrent prescription in the administrative procedure is to restrict the inertia of the public agents, who in charge of the process, are responsible for expressing the will of the State, and it is not acceptable that the regular , lasts for more than 03 (three) years, in an unjustified way, leaving, therefore, the one administered at the mercy of its impresteza ..

The occurrence of the intercurrent prescription in the administrative procedure entails the necessary determination of the functional responsibility of the dehydrating server, under the terms of Law no. 8.112 / 91, since the administrative proceeding follows the principle of officiality, and therefore "the initiation and of the administrative procedure is the responsibility of the Administration itself. Furthermore, it is reiterated that it is the duty of the Administration to complete the processes for verifying the conduct to be adopted, thus satisfying the interest of the collectivity, in terms of art. 225, of the Magna Carta.

In the final round, due to the fact that the environmental administrative process is governed by the norms of administrative law, with bias in other branches of law, such as criminal and tax, it has to be that intercurrent prescription is made viable and legally applied with objective of curbing the unjustified paralyzation of the process for more than three years will bring about, making it "ad eternal", a fact that violates the peculiar principles of Public Administration attached to art. 37, of the Constitution, even though the constitutionally guaranteed right to an ecologically balanced environment is taken into account (Article 225). This right in fact is imprescriptible, however, the administrative and prescriptable conduct, ensuring, of course, its submission to the incidence of intercurrent prescription as a legal, constitutional and legal rule.

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Survey of current and potential soil erosion through the Universal Soil Loss Equation (USLE) for the municipality of Castelo-ES, Brazil

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Abstract *— Studies related to soil erosion are extremely important as they help to determine areas with greater environmental vulnerability and assist in territorial management. The objective of this work was to evaluate the current erosion and potential of the soil from the Universal Soil Loss Equation (USLE) for the municipality of Castelo, state of Espirito Santo, Brazil, as a way to subsidize improvements in the area. The procedures were performed in the ArcGIS® program, having as digital cartographic bases the Integrated System of Geospatial Bases of Espírito Santo, the National Water Agency and the Jones dos Santos Neves Institute. The Digital Elevation Model of the area was generated to then obtain the direction and accumulated water flow. The maps of potential and current soil erosion were generated from the data of: erosivity, erodibility, land use, conservation practices and topographic factor. Erosion was mapped and quantified, and potential erosion was quantified by local community. To assist in the studies, photographic records were made depicting some local environmental problems. The municipality has a large area (83,77%) vulnerable to potential erosion due to its physical characteristics, while there are communities that have most of their area with high risk of soil loss. As for the current erosion, which considers land use and conservation practices, most of the municipality (43,64%) has a low risk of soil loss. However, there are degraded areas of agriculture, harming water courses, for example. Government action and the implementation of conservation practices are some suggestions to minimize environmental problems.*

Keywords *— **Soil Erosion, Geoprocessing, Environmental Impacts, Territorial Planning, Mitigation Measures.***

I. INTRODUCTION

The lack of planning in the use and occupation of geographic spaces, as well as investments in equipment and services to meet the needs created by the population, induced the imbalance of the environment [28]. In the state of Espírito Santo, the lack of planning and environmental imbalance originated in two important cycles of the Espírito Santo economy: the 1st cycle (from the 19th century until the 1950s), which was centered on coffee, and the 2nd cycle. (1950-2000), characterized by industrialization [5].

Changes in vegetation cover and management by agricultural and livestock activities affect hydrology, dynamics and carbon stocks in the ecosystem and lead to loss of environmental services such as biodiversity maintenance, water cycling and stocks. that prevent the aggravation of the greenhouse effect [6].

Soil erosion is a process that consists in the separation of isolated particles from the soil mass and their transport by erosive agents such as runoff and wind incidence. When available energy is no longer sufficient for particle transport, so-called deposition occurs [30] [39].

Water erosion is one of the main forms of degradation of agricultural soils in Brazil. It means the process of runoff by runoff water, in which there is disintegration, transport and deposition of soil particles, nutrients and organic matter. The occurrence of erosive processes is determined, among other factors, by rainfall erosivity, soil erodibility and soil cover, which is a very relevant factor in the control of water erosion [10].

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In this sense, soil erosion occurs in urban and rural spaces and with different types (laminar or linear) and intensities (appearance of furrows, ravines and gullies). Management and conservation practices act on the temporal rhythm of erosive processes [16]. Agricultural areas in Brazil suffer annual losses of 822.7 million tons of soil, with erosion causing a loss of $ 2.9 billion annually on land ownership. The external costs to the rural property resulting from the erosion process add another $ 1.3 billion. Thus, erosion causes a total loss of approximately US $ 4.2 billion to Brazil [19].

Geoprocessing is the discipline of knowledge that uses mathematical and computational techniques for the treatment of geographic information and has increasingly influenced the areas of cartography, natural resource analysis, transportation, communications, energy and urban and regional planning. Computational geoprocessing tools, called Geographic Information Systems (GIS), allow you to perform complex analyzes by integrating data from multiple sources and creating georeferenced databases. They also make it possible to automate the production of cartographic documents [40] [37] [38].

An important tool in data geospatialization is ArcGis, which is a set of computational applications of Geographic Information Systems developed by the company Environmental Systems Research Institute, which has advanced tools for spatial analysis, data manipulation and cartography [36]. The use of a GIS becomes an important tool to be used in environmental control and monitoring, since it can provide, in addition to the storage of images and information, the crossing of them, allowing a broader and more accurate view of the environment. study site [32].

Although Espírito Santo is a small state, it has prominence in some productive sectors, making it important for the Brazilian economy, such as pulp production, which represents 28.3% of the national production, papaya (40, 2%), coffee (19.8%), iron ore (28%), coal (29.9%), roasted coffee (18.7%), non-metallic mineral products (20.3%) and steel (14.2%) [34]. However, this production affects the existence of forest fragments and soil use, being a major cause for concern when done in a disorderly manner.

Given the above, the objective of this work was to conduct a survey of the current erosion and potential of the soils of the municipality of Castelo (ES), from geotechnologies, with a view to offering subsidies for improvements in the studied area.

II. MATERIALS AND METHODS

The study site adopted was the municipality of Castelo, located in the south mesoregion of the state of Espirito Santo. With an area of 66307,58 hectares, its economic base is agriculture and coffee is the main agricultural activity. It has altitudes ranging from 92 to 2082 meters and covers 1.45% of the state territory [20]. Fig 1 shows the location of the municipality of Castelo.

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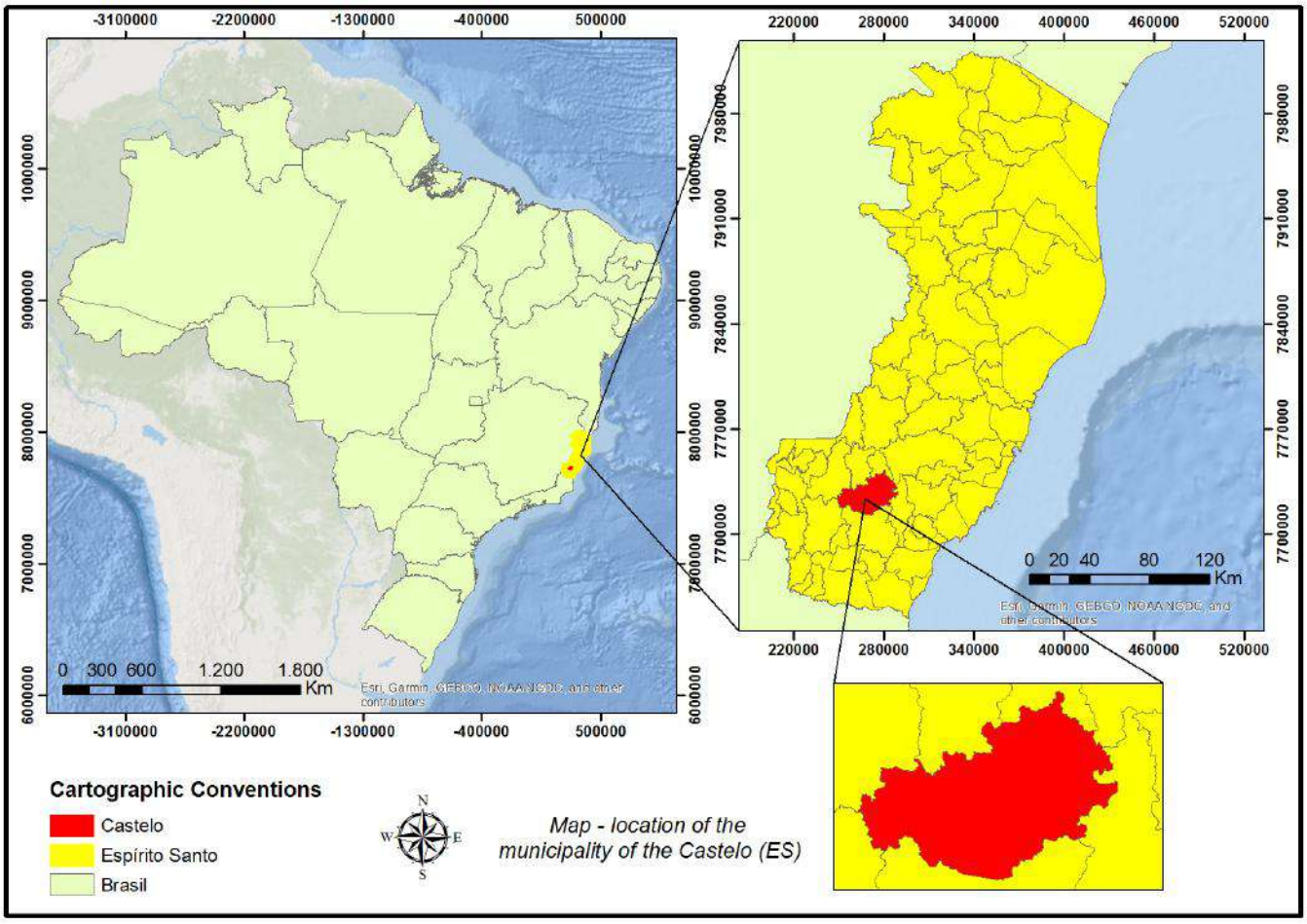

Fig. 1: Location of the municipaliy of Castelo, in the state of Espírito Santo, Brazil

The procedures were performed using the computer program ArcGIS® 10.2. All data collection operations were based on annual rainfall series extracted from the National Water Agency database [31], land use and occupation data, soil types and contours available at the base of digital data from the Integrated System of Geospatial Bases of the State of Espirito Santo [17] and archives related to the mapping of the cities of the State of Espírito Santo [21], aiming to favor the subsequent statistical interpolations of the data.

In ArcGIS®, the file referring to the municipalities of the state of Espírito Santo was added, and subsequently edited, considering only the area covered by the municipality of Castelo / ES. From data of contour lines acquired in GEOBASES, it was possible to generate the so-called Digital Elevation Model (MDE) of the municipality, through the interpolation of contour lines and the subsequent conversion of the generated file to raster format. MDE is one of the most important data for geospatial analysis, and it means a digital representation of a section of the surface, given by a matrix of planimetric (x, y) coordinates and a pixel intensity value, corresponding to the elevation [24]. For this work, it was adopted the value of 25 for the pixel size, thus having high resolution for the considered area.

From the MDE, it was possible to define the direction and the accumulated drainage flow of the municipality, through the items "flow direction" and "flow accumulation", contained in the program attributes table. The estimation of the average soil loss rate was performed by the universal soil loss equation (USLE). The equation was elaborated aiming to predict the average soil losses over long periods and specific conditions. It expresses the action of the main factors that affect water erosion, being expressed as a function of six environmental and management variables [8]. The USLE is expressed by equation:

$$A = R \times K \times L \times S \times C \times P$$

At where:"A": is soil loss in ton / ha.year; "R": is the erosivity factor of rain, in MJ.mm/(ha.h); "K": is the soil erodibility factor in ton. ha.h. / ha (MJ.mm); "L": is the ramp length factor (dimensionless); "S": is the slope factor, based on% slope; "C": is the land use and management factor (dimensionless); "P" is the practical conservation factor.

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The ability of rain to erode an unprotected area in a given locality is expressed by the numerical factor R [41], and is calculated from monthly erosion indices obtained by equation [23]:

$$EI\,i = 67{,}355 \times \left(\frac{ri^2}{Pi}\right)^{0{,}85}$$

Being: "EI i": monthly average erosion index (MJ ha^{-1} mm^{-1}); "ri": monthly average rainfall (mm); "Pi": mean annual rainfall (mm) ($1 \leq i \leq 12$).

The factor R corresponds to the sum of the monthly erosion indices [2].

Some soils are more prone to erosion than others, even when vegetation cover, rainfall, slope and erosion control practices are the same. This difference is called soil erodibility, and is due to the inherent properties of the soil [2]. From the MDE of the studied area, a local slope map was generated to determine the so-called topographic factor. (LS) of the equation from the generation of two maps. The L factor map was obtained using the the following expressions [26], [27], [32] [11]:

$$F = \frac{\sin C / 0{,}0896}{0{,}56 + 3(\sin C)^{0{,}8}}$$

$$m = \frac{F}{1+F}$$

$$L = \frac{\left[\left[A + D^2\right]\right]^{(m+1)} - A^{m+1}}{x^m D^{m+2} (22{,}13)^m}$$

Where: D = pixel size (determined by the file properties icon); A = accumulated drainage flow (determined through the flow accumulation icon in ArcGIS®); C = slope (expressed and converted to radians); x = shape coefficient (adopted x = 1 for pixel systems).

Then, the S factor map was generated by an algorithm consulted in the literature [26], [27], starting from the following mathematical conditions, considering the slope: when tan C <0.09, adopt S = 10.8 sin (C) + 0.03 e; when tan C ≥ 0.09, adopt S = 16.8 sin (C) + 0.5.

The equations were inserted in the raster calculator tool, also known as map algebra, which allows working the maps from the equations inserted in the program. Subsequently, the LS factor map was plotted and interpreted according to the data contained in the literature consulted. Ramp length and slope factors have been researched separately, however, it is more convenient to consider them together as an LS factor [3].

Some soils are more prone to erosion than others, even when vegetation cover, rainfall, slope and erosion control practices are the same. This difference is called soil erodibility (factor K), and occurs due to the inherent properties of the soil [2]. The K factor was initially determined by mapping the soil types of BHCP and then by consulting the data in the literature.

After obtaining all components of the equation, the maps of potential erosion (EP) and current erosion (EA) were generated. For this, the erosion classes were classified for the municipality of Castelo through the methodology consultation in the literature [12]. The area was also quantified in percentage (%) and in hectares (ha) for each current and potential erosion class.

In order to evaluate the potential erosion for each community in the municipality of Castelo, initially, with the Jones dos Santos Neves Institute [21], a file referring to the communities of the municipality to later evaluate the potential erosion for each community. This step was of fundamental importance in order to identify the regions with the greatest potential or not to soil erosion considering only their physical factors.

To justify the results achieved, some rural areas of the municipality were covered, recording images referring to visualized forms of soil erosion, when there is no proper management and planning of land occupation. For each photographed image, the location coordinate and community name were also recorded to provide more accurate results. Possessing the maps of potential erosion and current erosion, in addition to the photographs, mitigation measures were proposed according to the vulnerability to soil erosion for the referred municipality.

III. RESULTS AND DISCUSSIONS

According to the data from the historical series acquired from the National Water Agency and, from the equation that estimates the monthly erosion rates [41], the R factor obtained was 6454,68 MJ ha^{-1}. mm^{-1}. Based on data edited in the layout of the ArcGIS® program, it was possible to determine the predominant soil types in the municipality of Castelo, supporting further work.

Table 1 presents the description of the soil types and their respective K (soil erodibility) values, consulted in the literature. And table 2 contains the values adopted for the product of multiplying the CP factor (conservationist practices and land use) [44], [38], [45], [22], [39], [38], [25].

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Table 1: Erodibility factor (K) data for each soil type determined.

Soil type	Factor K
Cambissolo háplico	0,037
Latossolo amarelo	0,041
Chernossolo argilúvico	0,028
Argissolo vermelho-amarelo	0,034
Argissolo vermelho	0,044
Neossolo litólico	0,048

Table 2: CP factor data for each land use and occupation of the municipality of Castelo (ES).

Class (land use and occupation)	Factor CP
Rock outcrop	0
Built area	0
Marsh	0
Rock Field/Altitude	0,01
Agricultural prodution – banana	0,25
Agricultural prodution – cofee	0,25
Agricultural prodution – sugar cane	0,05
Agricultural prodution – coconut tree	0,25
Other permanent crops	0,25
Other temporary crops	0,20
Mineral extraction	0
Macega	0,01
Body of water	0
Native forest	0,00013
Native forest at na early stage of regeneration	0,00013
Other classes	0
Pasture	0,025
Reforestation – Eucalyptus	0,0026
Reforestation – Pine	0,0026
Reforestation – Rubber tree	0,0026
Soil exposed	1

Therefore, the study area covers 6 different soil types and 20 identified land use and occupation classes. Numerical information was considered for the USLE estimate of current and potential erosion. Fig 2 presents the slope (S) and topographic maps of the factors (product of slope length by slope).

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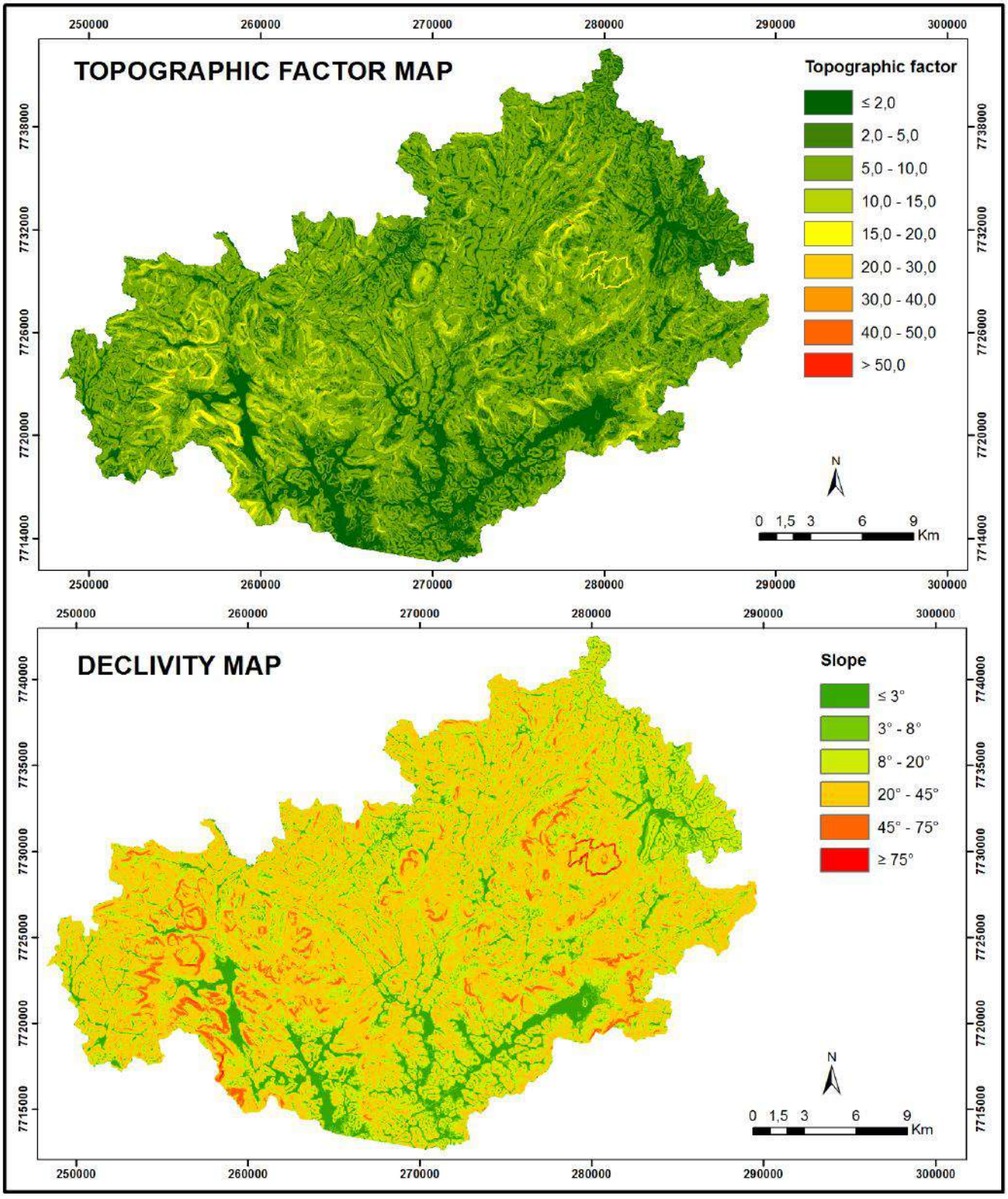

Fig. 2: LS factor maps and slope of the municipality of Castelo (ES)

Topographic factor values above 1,5 are significant [35]. Therefore, the topographic factor is high in most of the municipality of Castelo, with the predominant values being from 0 to 20,0.

High values for the topographic factor, as seen in this paper, indicate areas with greater sediment transport capacity, that is, with greater vulnerability to erosive processes [7], due to the higher surface runoff velocity [3].

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Therefore, the municipality of Castelo, according to the LS factor data, is vulnerable to erosive processes of water occurrence for the most part, which can be attributed mainly to the steep slope in its territory. In the case of the slope, it has greater influence than the ramp length in the calculation of the topographic factor [33].

Table 3 presents the area data, in hectares (ha) and percentage (%), according to the current soil erosion classes.

Table 3: Area data for each current soil erosion class for Castelo municipality.

Soil type	Area (ha)	Area (%)
Slight	28935,44	43,64
Mild to moderate	2604,00	3,93
Moderate	2123,63	3,20
Moderate to high	1936,20	2,92
High	4374,28	6,60
Very high	14857,11	22,41
Extremely high	11525,77	17,30

Therefore, according to current erosion data, about 43,64% of the municipality's area has mild erosion, which is a positive factor for maintaining the quality of local soil and water resources. However, approximately 42,40% of the area corresponds to erosion rates classified as high or extremely high. Considering the "mild" and "mild to moderate" and moderate classes, about 47,6% of the municipality is prone to acceptable soil loss.

The values found are mainly influenced by the forms of use and occupation of local soils. Inadequate forms of land use trigger various processes that degrade environmental conditions, such as increased runoff and, consequently, greater sediment transport [1]. Another relevant factor is related to planning and territorial planning. The presence, for example, of high slope agricultural crops (considered as Permanent Preservation Area - APP) favors the loss of soils.

Given this scenario, to control soil erosion, land use readjustment is necessary, which can be accomplished in the following ways: the first one is through readjustment of use, adopting covers that are capable of protecting the soil. soil properly; and another is the adoption of mechanical conservation practices that fragment the ramp length and reduce the surface runoff space [14], linked to a correct planning of land use and occupation. These measures are fundamental for the areas of the municipality of Castelo with high incidence of soil loss, considering the influence of the CP factor.

Table 4 contains the area, in hectares (ha) and percentage (%), for each potential erosion class.

Table 4: Area data for each class of potential soil erosion for the municipality of Castelo.

Class	Area (ha)	Area (%)
Weak	7915,66	11,94
Moderate	2842,33	4,29
Moderate to strong	25037,08	37,76
Strong	18043,67	27,21
Very strong	12465,25	18,80

Most of the municipality (37,76%) is vulnerable to moderate to strong classified soil losses, while only around 16.40% have a low to moderate framed soil loss incidence. Approximately 83,77% of the municipality has an incidence of soil loss ranging from "moderate to strong" to "very strong", which is a matter of concern for preserving the quality and structure of most local soils. The potential of a soil to water erosion can be an important indicator of environmental vulnerability in a given location [30].

Thus, disregarding the CP factor, most of the municipality of Castelo has a tendency to soil loss, attributed to local physical characteristics such as slope and soil type.

Therefore, they are areas of high environmental vulnerability that need conservationist measures to minimize soil loss. With regard to measures for greater soil protection in these locations, environmental planning actions can be considered to discipline use and occupation by matching the use classes to the environmental conditions of the site [29].

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For the municipality of Castelo, the need for erosion control is essential, given the characteristics of the relief (mainly), soil erosivity and erodibility.

Fig 3 and Fig 4 show, respectively, the current and potential erosion maps for the municipality of Castelo (ES).

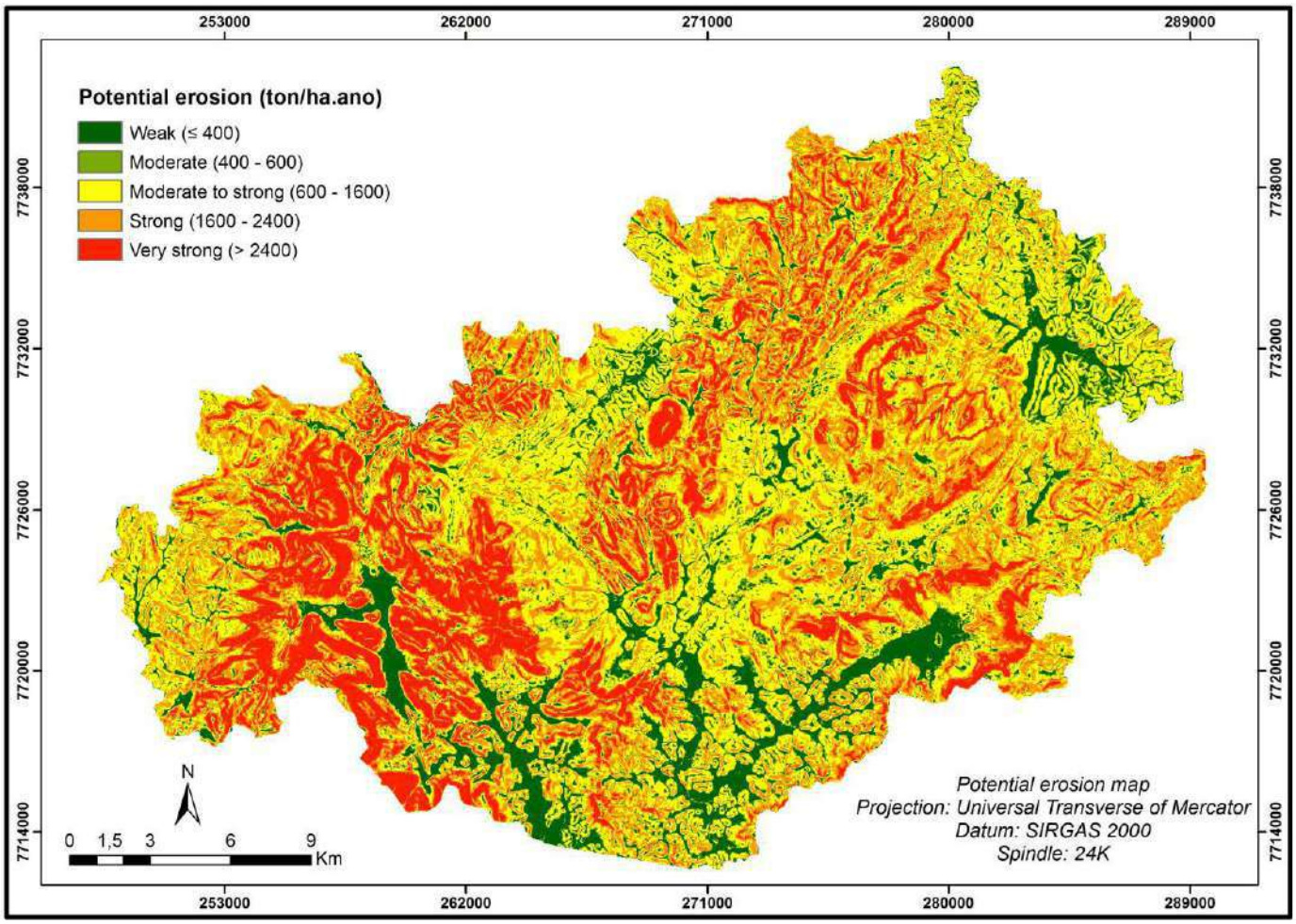

Fig. 3: Potential erosion map of the municipality of Castelo (ES).

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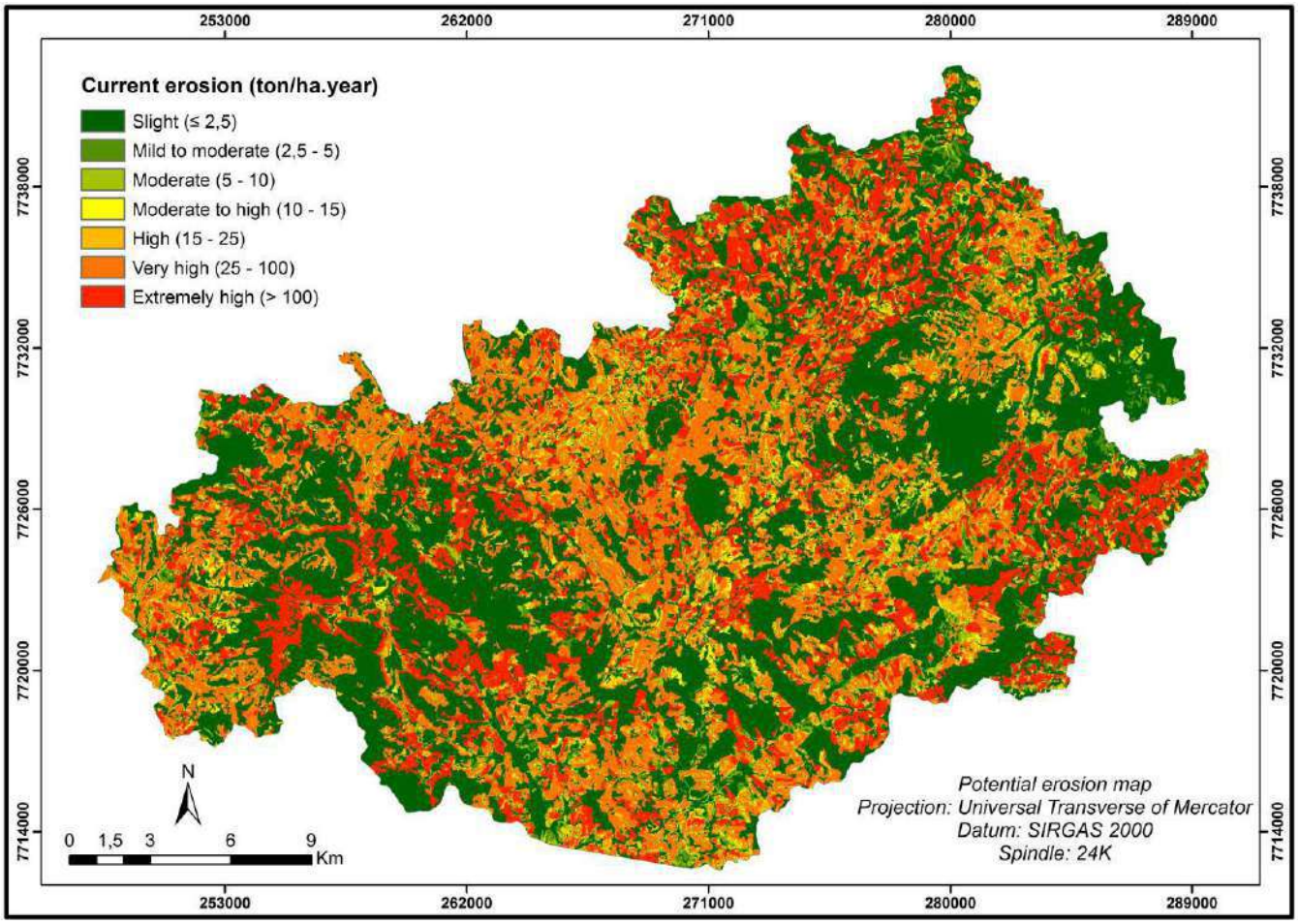

Fig. 4: Current erosion map of the municipality of Castelo (ES).

In the current erosion map, it is noted that there are large areas with a high incidence of erosion, whereas areas with erosion classified as "mild" were clustered in most of the municipality, which can be attributed to the forms of use and occupation. of the soils. As for potential erosion, the highest incidence of soil loss is in the western portion of the municipality, which may be justified by the steep slope and soil type of these sites.

However, comparing the two figures, it is clear that there are areas with high potential for soil loss due to physical characteristics and, however, present low current soil loss. This fact can be attributed to land use and land cover, such as the occupation of native vegetation and rocky outcrops. In the case of native vegetation, it has a relevant factor in the protection of soil and water resources, regardless of local physical conditions, contributing to the improvement of the environmental quality as a whole.

However, in less clarity, there are places with low tendency to soil loss and that, due to the CP factor, have high soil loss. Given this scenario, it is essential the action of the local government and other authorities, with a view to orienting the population on areas with a greater tendency to erosive processes and, mainly, to subsidize better planning in the forms of land occupation.

In addition, the importance of geotechnologies in environmental studies is highlighted, as this paper approaches, in order to serve as an instrument for planning and management of areas [44], such as the municipality of Castelo.

In this case, the mapping of current and potential erosion allowed a clearer and more dynamic visualization of the situation of soil loss in the municipality, in order to prioritize mitigation and mitigation actions of environmental impacts from anthropic action to specific regions and regions. contribute to improving the management of areas less vulnerable to erosion.

Table 5 presents the area data for potential erosion classes by community of Castelo municipality.

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Table 5: Area data (%) for each class of potential soil erosion for the communities of Castelo municipality.

Communities	Weak	Moderate	Moderate to strong	Strong	Very strong
Aparecida	23,44%	6,04%	39,83%	25,52%	5,17%
Apeninos	8,66%	3,96%	47,19%	31,07%	9,12%
Aracuí	20,72%	4,48%	33,98%	26,93%	13,89%
Arapoca	16,61%	2,83%	20,99%	21,78%	37,79%
Bateia	10,98%	4,60%	48,04%	30,86%	5,52%
Campestre	3,59%	2,87%	36,00%	32,50%	25,04%
Castelo (cidade)	22,57%	6,01%	42,70%	17,42%	11,30%
Caxixe Quente	7,85%	4,66%	46,25%	31,85%	9,39%
Cedro	8,70%	4,87%	55,96%	25,33%	5,14%
Conduru	22,58%	6,72%	40,23%	25,87%	4,60%
Córrego da Prata	4,68%	3,73%	40,92%	41,82%	8,85%
Corumbá	7,00%	4,84%	48,14%	32,23%	7,79%
Crimeia	8,85%	7,15%	55,02%	20,87%	8,11%
Estrela do Norte	13,31%	1,51%	13,44%	18,25%	53,49%
Fazenda da Prata	19,52%	3,80%	27,74%	22,94%	26,00%
Fazenda das Flores	10,37%	3,70%	40,42%	23,88%	21,63%
Fazenda do Centro	11,79%	4,21%	41,59%	30,25%	12,16%
Fazenda Velha	8,47%	2,79%	34,12%	32,90%	21,72%
Forno Grande	21,40%	9,28%	52,46%	14,57%	2,29%
Grécia	3,62%	1,33%	14,89%	28,03%	52,13%
Jabuticabeira	6,02%	4,00%	41,53%	30,50%	17,95%
Lembrança	4,21%	2,14%	26,00%	32,26%	35,39%
Limoeiro	4,70%	2,42%	24,43%	41,08%	27,37%
Mamona	7,47%	8,48%	56,43%	23,09%	4,53%
Mata das Flores	28,52%	7,18%	43,36%	17,98%	2,96%
Monte Alverne	4,75%	3,02%	28,65%	39,71%	23,87%
Monte Pio	24,15%	4,21%	32,79%	23,09%	15,76%
Mundo Novo	23,82%	3,08%	24,76%	22,53%	25,81%
Nogueira	13,67%	5,17%	36,42%	23,06%	21,68%
Pati	5,48%	2,33%	28,78%	34,78%	28,63%
Patrimônio do Ouro	3,70%	3,10%	44,63%	32,75%	15,82%
Pedra Lisa	9,09%	3,95%	51,05%	31,42%	4,49%
Pedregulho	4,23%	3,23%	40,21%	38,78%	13,55%
Pico do Forno Grande	1,02%	1,29%	33,80%	42,15%	21,74%
Pontãozinho	4,68%	3,74%	46,36%	27,88%	17,34%
Pontões	5,01%	3,21%	43,29%	26,47%	22,02%
Quilombo	5,50%	2,52%	26,23%	30,90%	34,85%
Santa Clara	7,21%	1,56%	15,56%	20,97%	54,70%
Santa Helena	11,42%	4,79%	70,69%	12,00%	1,10%
Santa Justa	4,88%	2,25%	28,90%	39,80%	24,17%
Santa Maria de Baixo	10,48%	4,55%	44,26%	26,54%	14,17%
Santa Maria de Cima	7,51%	3,56%	42,45%	39,03%	7,45%
São Cristóvão	10,38%	4,40%	42,90%	28,48%	13,84%
São José	32,18%	7,07%	37,55%	15,55%	7,65%
São Manoel	9,84%	5,16%	45,04%	23,58%	16,38%
São Pedro	12,52%	6,66%	58,30%	20,62%	1,90%
Seleta	4,13%	1,42%	17,96%	32,19%	44,30%

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Taquaral	23,61%	4,56%	34,33%	29,90%	7,60%
Ubá	5,44%	3,75%	39,16%	37,98%	13,67%
Vai e Vem	13,86%	8,12%	59,57%	17,37%	1,08%

Regarding the quantification of the area and respective descriptions of vulnerability to potential soil erosion by community, most of the communities of the studied municipality presented moderate to strong soil loss index. However, in the fifty communities considered, eight of them had the highest predominance of the "very strong" soil loss class, and three of these communities (Grécia, Estrela do Norte and Santa Clara) have more than half of their territory with classified soil loss. as very strong.

The communities that presented the most satisfactory results were: Mata das Flores, São José, Monte Pio and Taquaral. Both, due to their physical characteristics, have the highest percentage of land with low soil loss linked to low percentage with very strong soil loss. Thus, the planning and management of local soils must be done correctly, in order to minimize the occurrence of erosive processes of water occurrence.

The occupation of areas, without prior knowledge of their susceptibilities and restrictions of use, can generate imbalances to the natural environment, often resulting in environmental and social damages [44].

Another relevant factor is the adoption of necessary soil conservation and protection measures in communities with higher erosive potential, with a view to mitigating the erosion caused by agriculture and eucalyptus, pine and rubber forest, present in the municipality.

Non-conservationist land use has numerous impacts on the environment, including biodiversity reduction, soil disaggregation, siltation of watercourses, among others [9]. Regarding pasture, agriculture and eucalyptus, both with a strong predominance in rural areas, if not properly managed, can present relevant erosive processes [45]. During the recording of the photographs, it was found that there are several places, such as those located in communities with a high potential erosion index, that suffer from intense erosion processes due to the non-consideration of conservationist practices and the incorrect planning of the forms of use and occupation. as shown in Fig 5 to Fig 7.

Fig. 5: Erosion in pasture area, in Estrela do Norte community.

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Fig. 6: Erosion in pasture area, in São José community.

Fig. 7: Eutrophic water resource in the community of Jabuticabeira.

As seen in figure 5, there is a strong erosive process in a pasture area, due to the physical characteristics of the site and the incorrect management of the areas. This is most often due to the adoption of the extensive livestock system, as it is characterized by low investment in formation (especially when the land already has some kind of pasture) and the maintenance of pasture. However, this system can have the following consequences: destruction of natural ecosystems (due to depletion or low productivity, which encourages the rancher to expand production on natural biomes and, consequently, to destroy them), soil degradation (causing erosion forms such as furrows and gullies) and pollution of water resources through the loading of nutrients, hormones, heavy metals and pathogens carried to the riverbed by leaching [13], as shown in the figure 7.

Given this scenario, to minimize erosion, the adoption of paddocks is of utmost importance in order to avoid overgrazing, to safeguard more forest preservation areas on farms and to assist in the restoration of grass, which in turn contributes to the protection of of the soil [15].

Other examples include: the adoption of pasture management systems (continuous grazing, for example), soil remediation and fertilization prior to grazing, mountain top protection and slope revegetation. These measures are essential to make production more sustainable and, especially, to minimize erosive processes in these areas [18]. Of great predominance in the municipality, coffee farming, if not handled correctly, can

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cause negative environmental impacts. One is the change in physical properties of surface water as a result of the surface runoff of rainwater, as shown in Fig 8.

Fig. 8: Water resource with high sediment content, in a seletion devoid of ciliary vegetation and with coffee vegetation.

A relevant factor contributing to the contamination of water resources is the absence of riparian vegetation due to non-compliance with legislation, which in turn requires a minimum of 30 meters in relation to a water course for the implementation of rural anthropogenic activities and, mainly protect the springs.

Given this scenario, some techniques are of great importance in the installation and maintenance of coffee crops, especially in areas with considerable potential for soil loss. Some of them are: using green manure, rotating crops, cultivating contour lines, adopting the practice of vegetative management called "alternating weeding" (contributes to the retention of land removed in the surface runoff), presence of cover dead soil (attenuates the impact of water droplets on the soil constitutes a physical barrier to runoff and provides organic matter to the soil) and adoption of no-tillage system (soil tillage is not necessary, maintaining its quality). Another relevant issue is the adoption of agroforestry systems to the detriment of coffee monocultures, bringing greater soil protection linked to greater economic and ecological gains [18].

In general, agricultural and livestock activities in the municipality need to be adapted to local relief, since, without proper care, they can cause high soil loss and, as a consequence, severe environmental damage to water resources, fauna and flora. Regardless of the potential erosion level of the communities studied, mitigation and mitigation of negative impacts from anthropic action should be implemented, along with other forms of subsidies for improvements in the environmental quality of the study space.

IV. CONCLUSION

The municipality of Castelo has a high vulnerability to soil loss considering the physical aspects of its relief, erodibility and erosivity. The high values of topographic factor and slope indicate irregularities in the relief, which requires even more attention in the execution of human activities, such as agriculture. As for current erosion, dictated by land use and conservation practices, the municipality has low soil loss in much of its area, which indicates a positive factor for soil preservation. However, in some communities such as North Star, Santa Clara and Grécia, there is a great tendency for soil loss, meaning the need for proper management of anthropic activities to avoid causing environmental problems, as seen in the photographic records.

Given this scenario, the action of local public authorities through territorial planning and management, together with the adoption of mitigation measures and mitigation of environmental impacts are extremely important, in addition to the expansion of vegetation cover near water courses, in order to minimize soil loss

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especially in communities where there is a high tendency to this phenomenon.

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Germination of Soybean Seeds treated with Sources and doses of Lithium for Agronomic Biofortification

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Abstract**—***Lithium is a chemical element, symbol Li, this element can be new strand of world agriculture. The agronomic Biofortification of soybeans can be beneficial to the entire production chain that involves, because this practice can lead to an increase in the average productivity of culture in soils naturally poor, reversing the current picture of stagnation in productivity the last 10 years. Additionally, the producer of grains will benefit from adding value to the final product and the consumer will benefit by purchasing a product with higher Li content. Treatments were arranged in a completely randomized design (DIC), with three repetitions. The twelve treatments were arranged in a factorial scheme 2 x6. The first factor is regarding the two lithium sources (Li2SO4 e LiOH) and the second factor refers to five doses of lithium in their fonts used (0; 20; 40; 60; 80 and 100 mg dm^{-3}). Soybeans have had a positive effect on germination with the use of doses and sources of lithium compared with the witness, but the germination percentage was less than 65% well below the expected, which shows that the lithium in large doses can be harmful for the germination of seeds.*

Keywords**—Glycine max, trace element, food security**

I. INTRODUCTION

Lithium (Li), is a metal found in magmatic rocks. Like the other alkali metals of your group, the lithium is chemically very active and never occurs as a pure element in nature. Of 131 minerals known from lithium, the larger quantities of this element in your composition are found in the minerals: spodumene (Li_2O - 6 to 9%), petalite (Li_2O - 4.73%), lepidolite (Li_2O - 4.19%), Zinwa- limited (Li_2O - 2 to 5%), amblygonite (Li_2O - 7.4%), among these mineral spodumene is the principal mineral source of lithium due to your high content and deposits in the Earth's crust (LOSEY; JOHN, 2004; BRAGA; SAMPAIO, 2008; MINERALOGY DATABASE, 2012; CHOUBEY et al., 2016). [1–4]

In Brazil, the extraction of lithium is made from pegmatites (species of rocks) located in the Southeast and northeast regions, the most important being the ore spodumene (Li_2O - 6 a 9%) (BRAGA, 2008) [4]

In the midst of the lithium industry dispute is increasing the interest of medicine for this mineral, especially for your effectiveness in treating mental disorders, especially bipolar disorder, as well as in the treatment of cancer, high blood pressure, balance hormonal, leukemia, diabetes and immune functions. Recent studies show that this element can also be used in lower levels in some blood diseases, in the prevention of Alzheimer's disease, amyotrophic lateral sclerosis, and Parkinson's disease. (YOUNG, 2011; FORLENZA et al., 2014). [5, 6]

In addition to the use of lithium as a raw material in

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pharmaceuticals, this can be used in preventive actions like your addition to drinking water and food through your release for fertilization. These measures are being adopted, with success, to control the expression of behavioral diseases on population, in which modified behavior, showing signs of improvement, decreasing the aggression, increasing the level of socialization and regularization of sleep (SCHRAUZER, 2002). [7]

This element can be a new strand of world agriculture, and therefore should be treated as a key issue, to have food security (GUILHERME et al., 2013), [8] and in the not too distant future, the food will have as much importance as remedies, however, unlike these, acting preventively (GUÉRIN et al., 2011). [9]

One of the various crops, soybeans (Glycine Max L.) is one of the world's largest food consumption, animal and human, for being one of the most important sources of vegetable protein, in addition to the fat used for biofuel production. This culture also presents photochemical characteristics beneficial for all these features taken as the reference culture in the development of this work (MARTINEZ, 2013) [10]. Thus, the use of the technique of agronomic Biofortification becomes of great importance to introduce lithium levels in grain in sufficient quantities to prevent various diseases caused by a deficiency of this element.

The Biofortification is the enrichment of foods with nutrients, vitamins, and protein and can be accomplished through genetic improvement or an agronomist. The agronomic practice consists in addition, before and during cultivation, of one or more elements, with the goal of obtaining a food enriched with essential nutrients to the man (WHITE; BROADLEY, 2009). [11]

The introduction of these nutrients, micronutrients or trace element, and/or vitamins in basic crops seeds and one of the aspects of Biofortification. The Biofortification process begins with a seed that is seen through a multidisciplinary lens. This technique aims to make the Biofortification in seeds that will lead to a fully developed plant whose seeds have high concentrations of nutrients and that will later be consumed by the population in the world (HarvestPlus, 2017). [12]

On the above, the objective of this work is to evaluate the effects of the application of doses and sources of lithium on the seed germination of soybean cultivar M8808 IPRO to agronomic Biofortification.

II. MATERIALS AND METHODS

The experiment was conducted in the laboratory of Analysis of seed plant science and plant health department, Federal University of Tocantins, Gurupi, TO. The University is located in the southern region of Tocantins, the 280 m of altitude and coordinates 11° 43 ' 45 " south latitude and 49° 04 ' 07" west longitude. Treatments were arranged in completely randomized design s (DIC), with three replications of 50 seeds, totaling 150 seeds so for treatment. The twelve treatments were arranged in a factorial scheme 2 x 6. The first factor is regarding the two sources of lithium (Li_2SO_4 and LiOH) and the second factor refers to five doses of lithium in their fonts used (0; 20; 40; 60; 80 e 100 mg dm^{-3}).

For the test of germination from seeds were used to cultivate M8808 IPRO. The 50 seeds of each repetition were placed in plastic bags identified and separated is added 1.5 ml of the solution prepared earlier by bags of seeds after constant stirring to homogeneity, were left for 40 minutes on the solution and then dried in the Sun. The witness received no treatment of solutions containing lithiumFigure 1.

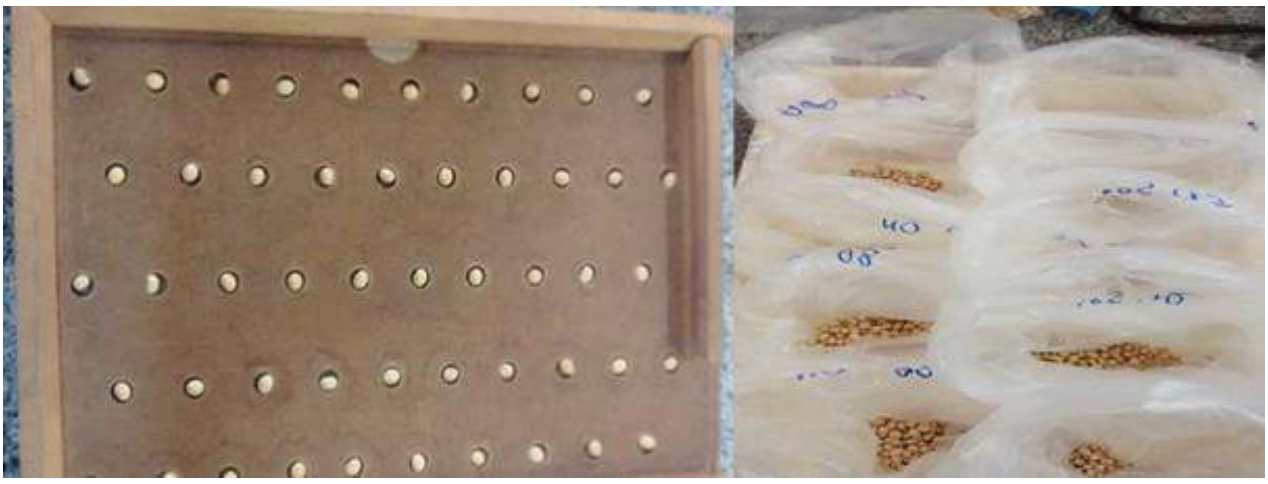

Fig. 1: Separateness for the application of doses and sources of lithium. Gurupi-TO, 2017.

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Soon after the seeds were placed in blotting paper moistened with distilled water and subjected to the germination test being later taken to germination Chamber type BOD with constant temperature adjusted to 25 ºC as methodology advocated byFigure 2 [13].

Fig. 2: Seeds separated into blotting paper in 3 repetitions per treatment, taken the germination Chamber type BOD. Gurupi-TO, 2017.

III. RESULTS AND DISCUSSION

The results showed that the application via lithium seed showed a significant difference in seed germination of soybeans. Among the sources observed that the maximum dose of lithium sulfate reduction in the germination of normal seedlings and consequently increase in the germination of abnormal plants. The source Lithium hydroxide presented opposite effect on germination of normal and abnormal plants.

The normal seedlings showed quadratic response as a function of increasing doses applied via lithium sulfate and Lithium hydroxide Figure 3. The maximum estimated germination percentage will occur in use above 100 mg dm-3 Lithium hydroxide, which represents a gain of 9.4 percent compared to treatment witness. For the lithium sulfate source, maximum germination occurred with 40 mg dm-3 representing a gain of 12.4% compared to treatment without application of lithium, however as increasing the dosages noted a decrease in the percentage of germination.

According to Nascimento (2014) [14] Lithium when at doses above 71 mg dm^{-3} affected the development of lettuce plants, thereby reducing the total absorbed and accumulated by the plants. As observed in larger doses of LiSO4 treatments (Figure 4), where the highest doses were also had a smaller percentage of normal plants. This result that differed from finding by [15] in the study of Li absorption by plants of lettuce, cotton, and sunflower, in Poland, using doses of Li-like 0; 2,5; 20; 50 e 100 mg dm^{-3}, in hydroponic cultivation. These authors observed that high amounts of Li provided decreased dry mass of root, shoot and leaf area and presented signs of toxicity as necrosis in older leaves. However, in smaller doses, it was observed that there was positive development of these cultures, as well as accumulation of this element in the parts considered to be agricultural importance.

Already about the abnormal seedlings, quadratic response noted in light of increasing doses applied via lithium and Lithium hydroxide sulfate (Figure 5). The highest percentage of germination of abnormal plants was observed in the use of 60 mg dm-3 using lithium as a source of Lithium hydroxide, which represents an increase of 8% over the witness.

For lithium sulfate, the highest germination of abnormal plants happened on the application of 100 mg dm-3 lithium representing an increase of more than 8% in relation to the treatment without application of lithium.

Significant interference sources and doses of lithium in seed germination, agree with the results reported by Kalinowska et al. (2013) [16] in your work evaluating the influence chloride and Lithium hydroxide on growth, l-Ascorbic acid content and Lithium accumulation in lettuce plants in nutrient solution, lithium deposits found in plant tissues, reducing the development of plants, as well as typical symptoms of toxicity, the use of doses ranging from 20 to 100 mg dm-3 independent of source Used lithium, which demonstrates a negative effect and a loss in productivity of plants.

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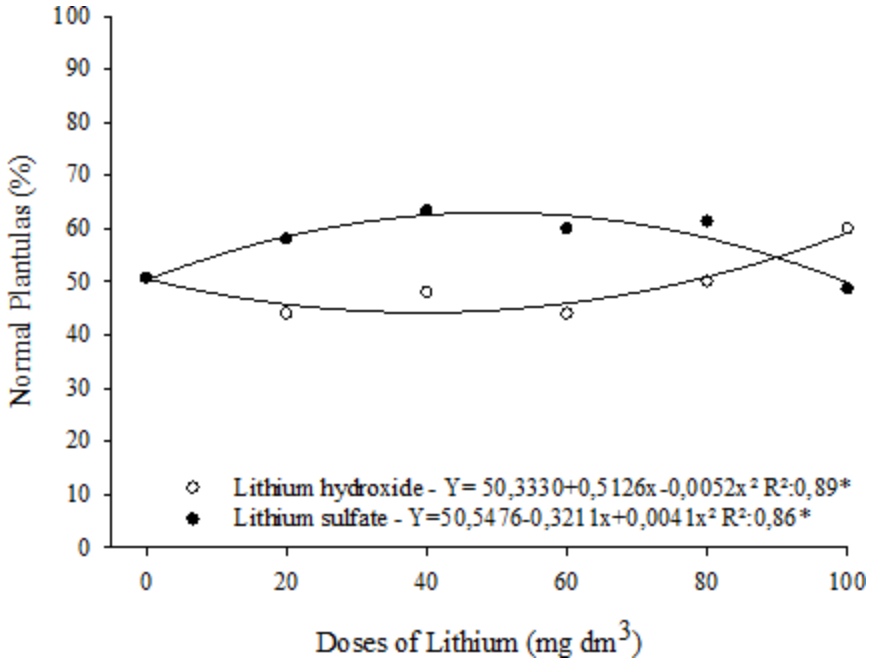

Fig. 3: Normal Seedlings (%) of soybean seeds (Glycine max) on the basis of different sources (sulfate and hydroxide) and doses (0; 20; 40; 60; 80 e 100 mg dm^{-3}) de Lítio. Gurupi-TO, 2017

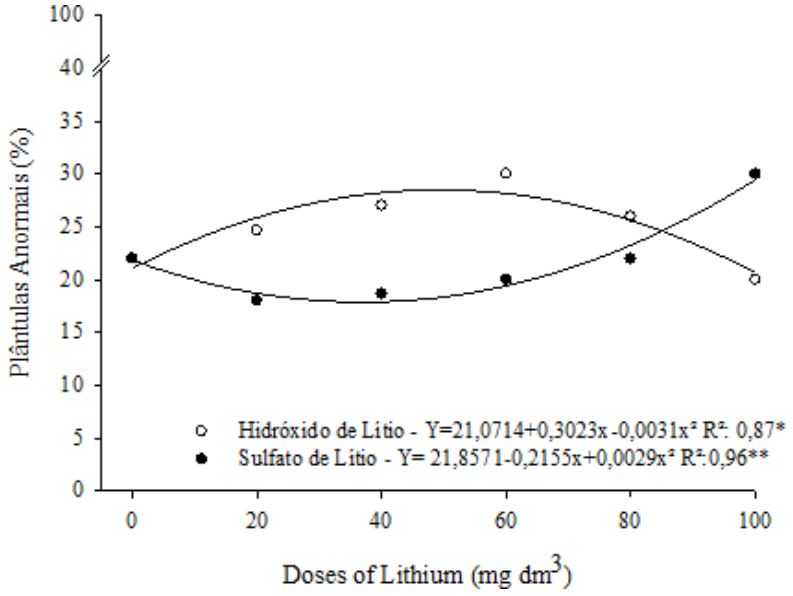

Fig. 4: Abnormal Seedlings (%) of soybean seeds (Glycine max) on the basis of different sources (sulfate and hydroxide) and shots (0; 20; 40; 60; 80 and 100 mg dm^{-3}). Gurupi-TO, 2017.

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One of the evaluations carried out, can be observed during the count of the source Lithium hydroxide has restricted growth of seedlings, in the shoot and root, as well as in the formation of secondary roots, considered of great importance for the establishment of a normal plant to be a limitation to the use of this source in agronomic Biofortification. Already the seedlings subjected to lithium sulfate source appeared larger in length of shoots and roots showing as much by roots in relation to Lithium hydroxide source (Figure 5).

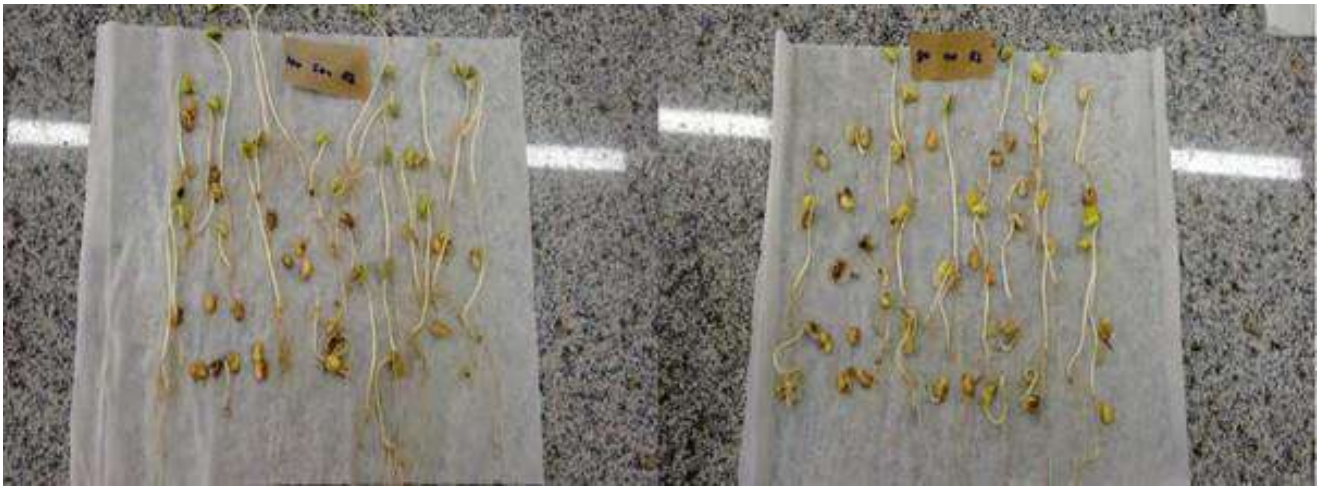

Fig. 5: Seedlings of soybean seeds (Glycine max) with high doses of lithium. Gurupi-TO, 2017

IV. CONCLUSION

1- sources and lithium doses provided a significant effect on seed germination of soybeans.

2-the lithium Sulfate source obtained the highest percentage of germination of normal plants in comparison with Lithium hydroxide.

3 – the number of abnormal plants increased when used as a source of Lithium hydroxide.

4 – For Biofortification of soybean seeds using lithium, it is recommended the use of sulfates source, with a view to your highest percentage of germination of normal plants, without any damage harmful to the development of culture.

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Scope of sustainability in ecological cities

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Abstract *— Sustainable urban development is an indispensable advance due to the growth of cities initially formed in a disorderly way and without care of the preservation of the environment. The relationship between man and the environment has been reframed, maintaining capitalist and progressive thinking, but with recognition of the awareness of a healthy environment and restrictive measures that guarantee environmental protection. The exercise of the joint evolution of society and nature, working in an intelligent way, using the technologies available to the population, aiming for future well-being, will ensure that there are conditions of use for a future society that will succeed the current one. Its purpose is to specifically address the extent and importance that cities that care about sustainability have, acting and caring locally, to make their impacts globally possible, as well as to address how unbridled and with no organization involved in cities that were created without the necessary care with the preservation of the environment. In the various phases of the Research, the Referent Techniques, the Category, the Operational Concept and the Bibliographic Research were activated.*

Keywords *— **Sustainable development. Sustainable Cities. Environment.***

I. INTRODUCTION

This article aims to address the importance of sustainable development as a social requirement of all cities and countries, with a view to ensuring that future generations can enjoy a healthy and safe environment.

Its purpose is to specifically address the extent and importance that sustainability-minded cities possess, by acting and caring locally, to be able to counter their impacts globally, as well as to address how unbridled development and without organization implied in the cities that were created without the necessary care with the preservation of the environment.

This article is divided into three topics. In the first, it will be discussed about Sustainable Development, drawing a general line about its meaning and its implication throughout the world.

In the second item we will consider reflections about sustainable cities, creative and innovative practices that become necessary for the advancement of society, and the use of applicable technologies as a way of seeking development, concomitantly to a preserved environment.

Regarding the third point, it will be portrayed, regarding the reach of sustainability through sustainable cities.

As for the Methodology used, it is recorded that in the Investigation Phase the Inductive Method was used, in the Data Treatment Phase the Cartesian Method, and, the Results Report expressed in this article is composed on the inductive logic basis.

In the various phases of the Research, the Referent Techniques, the Category, the Operational Concept and the Bibliographic Research were activated.

II. SUSTAINABLE DEVELOPMENT

Sustainable development is found when the economic and social growth of a society is marked with corresponding attention also to environmental preservation, both for this generation and for future generations, guaranteeing them a healthy and lively environment.

Consciousness about the degradation of the environment is a recognized theme around the world, because it will be at a critical moment in the history of planet Earth, since much has been extracted from nature to advance growth, while the ecosystem does not regenerate at the same speed.

Thus, having reached levels of urbanization and development, all countries are more attentive to the fragility of nature, seeking to reconcile social and economic development with environmental preservation.

In addition to the collective consciousness that arises regarding the preservation of nature, the orders are

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attentive to the establishment of rules for the maintenance of natural resources.

In this sense, DERANI clarifies that "environmental law is a right for man. It is a right that man must see in all dimensions of his humanity, "that is, they are regulations that benefit the very human being, maintaining the planet where he lives.

Clarifying about environmental law and sustainability, FENSTERSEIFER points out that:

> Communication between fundamental social rights and the fundamental right to the environment is also one of the central objectives of the concept of sustainable development on the horizon constituted by the Socio-environmental State of Law, since, together with the idea of environmental protection, the central objective is to meet the basic needs of the world's parts and the equitable distribution of natural resources (eg access to water, food, etc.).

Concerning Environmental Law, DERANI says:

> They are factors that make up the quality of life, the quantity of natural resources for the production, as well as the hygiene of the environment and the availability of nature destined to leisure.

Thus, sustainability is the most adequate way for a civilization to progress but considering that transformations occur not only with attention to the needs that are present in the daily life of society, but also in guaranteeing the maintenance of nature.

Although greed motivates the enterprise at all costs, laws that are pertinent to the use of natural resources are growing, with societies, institutions, government, scholars and sympathizers in constant vigilance, so that the Law on the environment is fulfilled, and cases of distortion have the necessary punishment and reprimand.

Regarding the internationally required care in the face of nature and its conservation, VEIGA emphasizes:

> The international community's understanding of the care required for environmental conservation has been much more intense than is commonly assumed. A few indicators are enough to realize that the global political process with this focus is frantic.

Sustainable development is a way of maintaining a balanced relationship between the progress of man and the maintenance of nature by carefully regulating all activities that may adversely affect the environment.

In this sense, they clarify BODNAR and CRUZ:

> The concern of the present generation should not be to guarantee future generations the same amount of environmental goods and resources. The insufficiency of this objective is manifest. This is because the irresponsibility of the human being generated a historically unsustainable development and has already led the present generation to the verge of collapse by the manifest limitation of many primordial goods for the full life. Thus, it is fundamental that all collective intelligence and that all accumulated scientific knowledge is also in the service of improving the conditions of the whole community of future life and not only in the service of the human being.

Thus, the adequate one is the advance allied to the creation and application of methods that conciliate social and technological development with the conservation of the natural resources.

Emphasizing that nature is part of a collective right to be maintained and preserved, says Fensterseifer:

> In environmental matters, the democratic process must always be present, in view of the repercussion and collective nature of environmental degradation for the whole of society.

And yet, FENSTERSEIFER, complements:

> The very transindividual nature of the issues surrounding the ecological theme imposes a democratic and transparent process for the political decisions taken to have legitimacy and constitutional foundation. Any activity that is harmful or potentially harmful to the environment, before being implemented, must be subordinated to a democratic decision-making process, giving voice to all representatives of social groups interested in the issue.

DERANI notes that "environmental economics focuses on the role of nature as a supplier of raw materials or as recipient of harmful materials," and asserts:

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> Determining price to nature is the same as privatizing it, imputing to the user of this resource a monetary consideration. The appropriation of a natural resource for production or production waste depends on the availability of the individual to bear the price charged to the parcel of nature that is intended to be used.

Thus, it is well-known that the concern with the environment is a constant matter, since with the advancement of technology and access to information, consumption is increased every day, and all are in constant movement, and consequently, the preservation of natural resources is imperative.

III. SUSTAINABLE CITIES

In the specific case of Brazil, urbanization occurred as a result of the Industrial Revolution.

Since then the consequences of unbridled and irresponsible development have been evident, since the price of social, technological and cultural development has been realized at the expense of great wear and tear on nature.

Without concern for natural sources, cities began to develop in a disorderly way, without organization and without attention to the environment and to sustainability, since natural resources seemed inexhaustible.

The development of a community that transforms into a city demands an extensive and complicated sequence of actions, and in practically the integrality of development in Brazil, practically the entirety of the spaces already have a consolidated occupation, in the way they were naturally developing.

Along these lines, BOFF points out:

> The concept of sustainability can not be reductionist and applies only to growth / development, as it is prevalent in our times. It must cover all the territories of reality, ranging from people, taken individually, to communities, culture, politics, industry, cities and especially to Planet Earth with its ecosystems. Sustainability is a way of being and living that requires aligning human practices with the limited potentialities of each biome and the needs of present and future generations.

There is no more possibility of reorganizing the formation of cities, which simply came into existence and developed.

However, it is possible to create strategies to maintain nature and natural resources, seeking to minimize the degradation of the environment.

As an example, driving cars that cause great pollution are mentioned, and new forms of fuels that are less harmful to the environment, manufacture of vehicles in better quality material, and electric ones are already being explored, not to mention the great incentive the use of bicycles, public transport, hiking, etc.

Therefore, even in the face of advances that do not go down in any way, a collective conscience about sustainability is gradually being created, and minimizing damages to nature becomes an interest of all.

Considering that most cities have already been formed with the natural progress of their development, consequently, there is still an expressive number of Brazilian municipalities that have not yet properly implemented an organized master plan.

It is worth noting that the City Statute (Law No. 10,257 / 2001), which regulates articles 182 and 183 of the Federal Constitution, establishes general guidelines for urban policy and other measures.

The City Statute establishes rules of public order and social interest that regulate the use of urban property for the collective good, security and well-being of citizens, as well as environmental balance.

Thus, even though most cities are already structured in every country, it is increasingly recognized the importance of sustainable actions as a source of citizenship promotion, preventing this growth of cities too much to destroy the balanced environments in these urban spaces.

Still, in Brazil there are few cities that can be considered as sustainable cities, although many have isolated actions and private and governmental measures to combat environmental degradation.

This is because in the past the great interest in the growth of infrastructure, technologies, economy, modernity, has caused an acceleration in growth without care with the sustainability of cities.

However, practices of preserving the environment and creating ways to minimize the use of technology with reduction of environmental degradation are growing every day.

As an example, the search for greater urban mobility with the use of collective transportation, energy saving, water saving, waste recycling, energy sources and sustainable fuels is indicated.

GONÇALVES presents other examples of cooperation related to sustainability:

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> Standardization issues such as radio frequencies, electrical outlet models and customs classification can be considered as situations requiring coordination, without necessarily having an underlying conflict. Absent temptations to change the behavioral pattern, we can, once again, speak in cooperation in the weak sense.

These are individual and community attitudes in a city that, when viewed as habits, can improve the quality of life of citizens in an equitable way and guarantee the use of nature by future generations.

Urban growth without environmental awareness leads to territorial, economic, cultural, environmental and social changes that will take years to be minimized.

For this reason, the great importance of environmental protection, as FENSTERSEIFER says:

> Environmental protection is directly related to the guarantee of social rights, since the enjoyment of these rights (such as health, housing, food, education, etc.), at levels constitutionally desirable, is necessarily linked to favorable environmental conditions, such as , for example, access to drinking water (through basic sanitation, which is also a fundamental social right that is part of the content of the existential minimum), (...).

FENSTERSEIFER also contends that the accelerated development of cities and the search for sustainable urban environments is an idea that cannot go back, clarifying:

> The prohibition of environmental retrogression, as with the prohibition of social retrogression, is related to the principle of legal certainty, the protection of trust or even predictability in the normative framework of legal relations (the constitutional guarantees of the acquired right, the act perfect legal and res judicata, as well as the limits matters to the constitutional reform are expression of the constitutional principle of legal security), which presents itself as a characteristic feature of the conformation of the State of Right.

Therefore, it is necessary that this approach of the government with the population in the quest to manage and maintain the cities in a sustainable way is so necessary, that even urban planning and environmental sustainability are issues regulated in the Maximum Charter of our country.

IV. SCOPE OF SUSTAINABILITY THROUGH SUSTAINABLE CITIES

Today the world has more urbanized and populated areas than preserved natural areas.

The urban densities are marked by occupation of space and soil without appropriate prior organization and without maintenance of the natural space and environmental balance.

As seen, a city that is considered sustainable must work in a smart way, using the technologies available to the population, but that works projected for the future, having as ideals and projects thought about the years to come, ensuring that there are conditions of use for a future society that will succeed it.

Sustainability is a theme that affects all residents of planet Earth, not just Brazilian cities, because any degradation or environmental preservation, in one way or another, interferes and impacts in every country in the world.

So, everyone must be united and concerned about sustainability on our planet.

In this respect, pointed out GARCIA:

> Thus, sustainability consists in the thought of global empowerment for the preservation of balanced human life, and consequently of environmental protection, but not only this, also the extinction or diminution of other social ills that act contrary to the hope of delaying the survival of man on Earth.

In this line, on global civil society, GONÇALVES points out that they are individuals who, regardless of the border, care about these public affairs:

> It consists of "groups, individuals and institutions that are independent of states and state borders, but which are at the same time preoccupied with public affairs."

GONÇALVES complements:

> The construction of Global Environmental Governance is fundamentally aimed at enabling cooperation and consensus to be achieved in negotiating to solve major environmental problems, with increasing participation.

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In fact, it is a great challenge to ensure a decent quality of life for the population of your cities when the infrastructure is already completely geared towards environmental degradation, without concern for nature.

However, the improvement in the quality of natural resources and maintenance of nature bring clear benefits in all aspects of the city and its inhabitants: for housing, education, health, availability and generation of employment and income, among many other aspects.

It is worth pondering that the lack of structure, knowledge, social development, implies the unregulated advance of community life, not paying attention to environmental issues, since in a poor people, the search for survival is already difficult and it is very costly to think, still, in care with the preservation of the environment.

On the distinction of environmental degradation in countries of different economies, VEIGA says:

> In an economy that favors competition for value production, where the constant pressure for modernization and consequent technological efficiency require not only better but greater appropriation of nature and energy, it is necessary to adapt to more broad purposes, embraced by the expression quality of life and welfare, producing a social change of values (gesellschaftlichen Wertwandel) based on another ethical consensus on the objectives of the economy.

Countries with low economic power tend to grow in a disorderly way and the increase of the urban population without the figure of rule and of a public power accompanying this natural urbanization, has as unalterable consequences without adequate structure of security, unregulated use of sources of energy, in short, a naturally disorganized growth.

If in these countries there is little investment for education, health, food, culture, still less can investments in social and urban structure for environmental maintenance.

These relations cannot be isolated particularities, because, as seen, in the natural environment there are no boundaries, since degradation damages the planet.

On the need for solidarity in this coexistence of the human being on this planet, FENSTERSEIFER says:

> Solidarity expresses the fundamental need for the coexistence of the human being in a social body, formatting the web of intersubjective and social relations that are drawn in the space of the state community. But here, in addition to a moral duty or obligation of solidarity, it is necessary to transpose to the legal and normative level such an understanding, as a fundamental pillar for the construction of a society and a rule of law, guardians of the fundamental rights of all its members, without exclusions.

Thus, a sustainable city becomes a reference for quality of use of natural resources, influencing positively around the world, being that locality where the well-being of all citizens, with concern for nature, is sought.

It is a projected or adequate city, thinking about the well-being of the population, longevity with quality of life, healthy environment, ensuring that all contribute and are part of this sustainable development.

In the words of ROMERO:

> (...) sustainable city is the human settlement constituted by a society with awareness of its role of agent transforming spaces and whose relationship is not given by the nature-object reason but by a synergistic action between ecological prudence, energy efficiency and equity socio-spatial.

Regarding environmental citizenship, geared towards a larger dimension of the collectivity, of the planet, FENSTERSEIFER indicates:

> Environmental citizenship is increasingly turning towards a planetary dimension. It is necessary the local action of the environmental citizen, but always with a vision focused on the reflections that environmental degradation brings to the entire planetary ecosystem. As an example, atmospheric pollution and global warming generated largely by developed countries have a direct impact on the environmental quality and living conditions of developing countries. Therefore, a new conception of citizenship is necessary, recognizing the role and the importance that everyone has in the defense of Planet Earth.

As said, a new conception of citizenship is necessary, where each one recognizes its importance in Planet Earth.

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Despite the existence of several practical and theoretical obstacles, the number of groups, cities, governments, scholars and citizens dedicated to implementing committed actions with present and future generations grows daily.

In this context, it is concluded that it is a fundamental Community right to live in an ecologically balanced environment, in which everyone must be aware of their role on the planet, contributing to the necessary integration between policies of urban development and protection of the environment, that is to say , each doing his part.

V. CONCLUSION

The advance of civilization and urbanization of cities has led to environmental disasters so severe that it has become essential to create regulations to minimize environmental degradation.

The relationship between man and the environment has been reframed, maintaining capitalist and progressive thinking, but with recognition of the awareness about the maintenance of a healthy environment and restrictive measures that guarantee environmental protection.

Throughout the development of cities, the process of occupation and use of space was used with a focus on progress, based on growth and improvements, without appropriate maintenance of the natural space and the environmental balance.

Reflections on urban environments and sustainable cities have grown as population concentration in urban space brings degrading variables to the environment, that is, when the development of the city has already greatly damaged nature.

However, individual and collective practices can minimize non-retrofitting advances, such as pollution from car use that can be minimized using public transport, accessibility for bicycle riding, use of new sources of fuel, etc.

Sustainable development should not be a goal to be pursued, but viewed as a fundamental condition for guiding the advancement of civilizations with the guarantee of already damaged environmental conditions.

Thus, the result of practices in sustainable cities inspires other places in the world to work intelligently, using the technologies available to the population, aiming for future well-being, ensuring that conditions exist for use by a future society that will happen.

The theme is of great importance, so much so that UN Brazil, in partnership with UN-HABITAT, launched on 05/06/2018 in Maceió / AL, the Glossary of Sustainable Development Objective 11, with the slogan Sustainable Cities and Communities , which will be discussed in Agenda 2030.

Finally, the fact that the UN is debating sustainable development through sustainable cities demonstrates, in addition to all the above, the sensitivity and importance of the theme, which must inevitably be discussed by the world.

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Study of the Application of Glass Waste in Concrete Production

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Abstract *— Aiming at sustainable development and preservation of the environment, many governments and NGOs are questioning the high volume of recyclable waste in landfills from the construction industry that are not reused by the industry. In this research, the use of the glass residue in the production of concrete in partial replacement to the aggregate was studied, with the objective in applications in the construction of non -structural parts and components such as the execution of gutters, half-wire and sidewalks. This research sought to analyze the behavior of the compressive strength of the concrete produced with partial replacement of the mineral aggregate by glass residues. The results showed that the compressive strength is strongly influenced by the variation of the amount of glass replacing the mineral aggregate, possibly by the interface between the glass surface and the cement matrix. However, concrete with glass residues partially replacing the mineral aggregate can be a viable alternative in our region, for several applications, especially those that do not require structural function, contributing to more sustainable constructions with use of discarded glasses and reduction of consumption , and consequent mineral exploration, of the pebble dredged from riverb eds.*

Keywords *— **Glass, Concrete, Aggregate.***

I. INTRODUCTION

The construction industry, over the decades, has suffered several advent and its constructive techniques have been improved in parallel. Concrete is one of the materials most used in engineering works and is in constant study. Its great application is due to its durability, ease of taking on different forms and versatility, being therefore used in various forms, whether in structural or non structural parts. The possibility of incorporation of residues into cement-based mixtures is a contribution of the construction industry to the recycling of environmentally harmful waste, and may also improve the performance of the materials with their addition [1].

The incorporation of waste into concrete is a subject that has been studied quite frequently throughout the world. Firstly, because of the need to dispose of the waste, since environmental laws are more stringent every day, and also because concrete is a material that has high "packer" potential, that is, it has a facility to incorporate several types of waste without damage to the environment, in addition to improving some properties.

Glass is one of the most consumed building materials in the world, only in Brazil, according to data from the Business Commitment for Recycling [2]. 54% of the glass produced, about 500,000 tons / year, are incorrectly destined.

In the city of Manaus, with the increase of inhabitants, the capital also saw jump the volume of domestic and industrial waste. At least 72 thousand tons of household waste are generated each month. Incorrect disposal threatens streams, rivers and groundwater, and the municipal landfill, where proper disposal is made, moves to the maximum limit and can only receive garbage for another 4 years. However, there is no definition for building a new landfill to meet demand.

In view of the above, the present work has the objective of presenting a bibliographical review of the technical feasibility of the use of glass waste as a large aggregate in concretes.

II. LITERATURE REVIEW

A brief bibliographic review will be presented, containing the historical context of the civil engineering, concrete of portland cement, constituent materials and properties, concrete resistance, use of glass in concrete.

2.1 HISTORICAL CONTEXT OF CIVIL ENGINEERING

Civil engineering is the branch of engineering that encompasses the design, design, construction and

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maintenance of all types of infrastructure necessary for the well-being and development of society, as well as the preservation of the natural environment. In this way, this area is dedicated to the creation of buildings, bridges, tunnels, power plants, industries and countless other types of structure.

From the beginning of history, humans have started to build their own shelters using the natural elements around them. Subsequently, the structures acquired increasingly complex characteristics reflecting the development of the techniques. It was then used to use scientific knowledge in this area, so that the dimensions, resistance and other attributes of a given work could be estimated. New materials came to be used, especially iron and cement, that allowed the emergence of the great structures that today make up the scenario of the modern world.

When we look for a definition of Engineering we will find: Engineering is the art of applying scientific and empirical knowledge and certain specific qualifications to the creation of structures, devices and processes that are used to convert natural resources into forms adapted to meet human needs.

When defined as art this concept is as old as man, but when considered as a set of knowledge with a strong scientific basis, organized in an organized way, engineering appeared in the eighteenth century. In this way, engineering, whatever it is, consists of the performance of a qualified and qualified professional, who has a diploma and a legal ability to practice the profession [4].

When there were only two civil and military engineering, civil engineering was one of the first to stand out. Military engineering was developed by the people who served the military as civil engineering was exercised by the citizens. Over time civil engineering has been improving and subdividing itself, among the ramifications, today you can find subdivisions like electrical engineering, mechanics, chemistry, naval, mechatronics among others.

According to [5], the English engineer John Smeaton, one of the discoverers of Portland cement (eighteenth century), was the one who first used the term civil engineer as a professional characterization, to distinguish from engineers [6].

The civil engineer is the only one who is qualified to handle projects and constructions of buildings, roads, tunnels, subways, dams, ports, airports and even power generation plants, as well as being able to choose the most appropriate places for a construction, to verify if the terrain and the material are really suitable for the work, supervising the construction progress [4].

2.2 PORTLAND CEMENT CONCRETE

Portland cement concrete is a product that results from the hardening of the mixture of Portland cement, large aggregate and water, in suitable proportions.

According to [6], the heterogeneity of the materials composing the concretes and the complexity of their behavior, both fresh and in the hardened state, always represents a challenge to the technicians responsible for the elaboration and use of concretes.

2.2.1 Constituent materials and properties

Portland cement concrete consists of two phases: the cement paste, composed of portland cement and water, and the aggregates. The cement, upon contact with the water reacts and acquires some binding properties, resulting from its hydration. The blend hardens to become a solid and strong material.

2.2.2 Portland cement

Portland cement is by definition according to [7] "the product obtained by the pulverization of clinker consisting essentially of hydraulic calcium silicates with a certain proportion of natural calcium sulphate, possibly containing additions of certain substances which modify their properties or facilitate your job ". When mixed with water they moisturize and produce dough hardening, which can offer high strength.

Table 1: Composition of Portland cement.

Name	Initials	Composition	Abbreviation
Tricalcium Silicate	CaO	3CaO.SiO2	C3S
Dicalcium silicate	SiO2	2CaO.SiO2	C2S
Tricalcium aluminate	Al2O3	3CaO.Al2O3	C3A
Tetracalcium aluminate iron	Fe2O3	4CaO. Al2O3. Fe2O3	C4AF

Source: Adapted from [3].

2.2.3 Water

Second [8] impurities contained in water can negatively influence the strength of the concrete, cause stains on its surface, or even result in corrosion of the reinforcement. For these reasons, attention should be paid to the quality of the water for kneading and for curing the concrete. As a rule the water should have a pH of 6.0 to 9.0.

2.2.4 Aggregates

Granular material of varying shape and volume, generally inert and having compatible dimensions and properties for use in construction, is known as aggregate.

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According to [9], natural aggregates are found in nature (sand, pebbles) and artificial ones that are obtained by the action of man through industrial processes or the tailings of these.

Until recently, the aggregate was regarded as an inert granular material, dispersed in the cement paste, used primarily for economic reasons. However, this concept has been reformulated and today the aggregate can be considered as a building material connected in a cohesive whole by means of a paste of cement. In fact, the aggregate can not be considered an inert material because its physical, thermal and sometimes also chemical properties influence the performance of the concrete [10].

The concrete can be defined as stone and cement paste, the paste being the bonding element of the stones. There are many voids between the stones to be filled only with the cement paste. For this reason, the small aggregate (sand) is used to reduce the consumption of cement and water, which in excess is harmful to the concrete, as it causes shrinkage, as well as compromising the workability of the concrete. In order to obtain a satisfactory result, the aggregate dimensions must be gradually distributed, promoting the best use of the cement, that is, keeping the resistance constant with the lowest possible cement consumption, which is the most expensive concrete input.

The terminology of the aggregates is defined according to the norm of [11], which classify aggregates as to nature. This standard defines the terms for aggregates most commonly used in concrete and cement mortar:

• Aggregate: granular material, generally inert with dimensions and properties suitable for the preparation of mortar and concrete.

• Natural aggregate: stone material that can be used as it is found in nature and can be subjected to washing, grading or crushing.

• Artificial aggregate: material resulting from industrial process, for use as aggregate in concrete and mortar.

• Recycled aggregate: material obtained from tailings, by-products from industrial production, mining, the process of construction or demolition of civil construction, including aggregates recovered from fresh concrete per wash.

• Special aggregate: aggregate whose properties can give the concrete or mortar a performance that allows or assists in the attendance of specific requests in unusual structures.

• Sand: small aggregate originated through natural or artificial processes of rock disintegration or from other industrial processes. It is called natural sand if it results from the action of agents of nature, from artificial sand when coming from industrial processes, from recycled sand when coming from recycling processes, and sand from crushing when coming from the process of mechanical fragmentation of rock, according to specific rules.

We must keep in mind that a good concrete is not the most resistant, but the one that meets the needs of the work with respect to the piece that will be shaped. Therefore, the consistency and the mode of application accompany the resistance as being factors that define the choice of suitable materials to compose the mixture, which should associate workability with the most economical dosage [12].

The aggregates, within this cost-benefit philosophy, must have a varied granulometric curve and must come from deposits near the dosage site. This implies a regionalization in the types of crushed stones, sands and pebbles that can be part of the composition of the trace.

Regarding grain size, the aggregates can be divided into adults and children, being considered as large, the whole aggregate that is retained in the number 4 sieve (square mesh with 4.8 mm side) and small which can get through this sieve [13].

They can also be classified as artificial or natural, being artificial sands and stones from the rock crushing, as they require the man to act to modify the size of his grains. As an example of natural, we have the sands extracted from rivers or ravines and the pebbles rolled, stones from the river bed.

Due to the importance of the aggregates within the mixture, several tests are required for their use and serve to define their granulometry, actual and apparent specific mass, modulus of fineness, clay lumps, organic impurities, pulverulent materials, etc.

Fig. 1: Aggregate metering bay,

Source:[13.]

2.3 CONCRETE DOSAGE

The general purpose of concrete dosing can be summarized in selecting the appropriate components from the available materials and determining the most

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economical combination that concrete will produce with certain minimum performance characteristics [14].

Still, according to the author, the most important performance requirements are the workability of the concrete in the fresh state, and the strength of the concrete in the hardened state. The workability that is responsible for the ease with which the mixture can be launched, compacted and finished and the resistance, which when reached as needed is related to the durability of the concrete.

The dosage based on previous experiments is called non-experimental dosing, since the experimental dosage is based on scientific studies [15].

2.4 CONCRETE RESISTANCE

One of the main properties of concrete is resistance to mechanical stresses of various types.

2.4.1 Resistance to axial compression

In most structures, the concrete is subjected to stresses that transmit compressive stresses. This fact, together with the fact that the assay is relatively simple and precise, makes the axial resistance the most evaluated property to verify the quality of a concrete, both for the control of the work and for laboratory studies [16].

Several factors may affect the mechanical strength of the concrete, eg water / cement ratio, age, shape and grade of aggregates, type of cement, shape and size of specimens, curing conditions, etc.

2.4.2 Water / cement ratio

Several factors may affect the mechanical strength of the concrete, eg water / cement ratio, age, shape and grade of aggregates, type of cement, shape and size of specimens, curing conditions, etc.

2.4.3 Evidence

For rupture of specimens to compression, the recommendations of [17] should be followed.

Generally, the compressive strength is measured in standard cylindrical specimens measuring 15cm in diameter by 30cm in height, cured in a humid chamber at 20º C.

2.4.4 Age of concrete

The reactions between cement and water progress with time, being, however, asymptotic [18]. Normally 28 days are considered as the standard age, the material being tested at 3 and 7 days, to obtain information about the quality of the concrete more quickly [18].

2.4.5 Specific mass

According to [19], uncoated concrete structures are, to a greater or lesser degree, subject to the action of aggressive agents such as carbon dioxide in the air, sea salt, sulfur gases from a sewage network, etc. , the more porous the concrete, the faster these agents impair the integrity of the part.

• Lightweight concrete is normally between 1440 and 1800 kg / m3

• Structural concretes have a specific mass of the order of 2300 to 2800 kg / m3

• Heavy concrete, used in radiation shielding, has a specific mass around 3360 to 3840 kg / m3.

2.5 USE OF GLASS IN CONCRETE

The historical context and the fundamental elements of the use of glass in concrete will be presented.

2.5.1 The History of Glass

According to [20], it is not known for certain the period and the people who discovered the glass. It is known, however, that Egyptians, Syrians, Phoenicians, Assyrians, Babylonians, Greeks and Romans, already realized works with the glass. Because of this it is not possible to attribute the discovery of glass to a single people and to a single epoch. However, the Roman historian Pliny attributes to the Phoenicians the accidental discovery of glass. The origin would have been casual: preparing a campfire on a beach on the shores of Syria to warm their meals, improvised stoves using blocks of saltpeter and soda. After a while, they noticed that a shiny substance was dripping from the fire, which solidified immediately. The glass would then be discovered

Still in Egypt, Mesopotamia, Syria, or Greece, the production of glass in antiquity required great efforts of artists and workers, mostly slaves. The basic elements of its composition: silica, calcium, lime, barrel and potassium, were basically the same as today, but produced opaque and sandy glass. The small ovens, the clay pot, the difficulty in achieving high temperatures and reaching the required degree of melting made the tasks difficult. With the bellows technique applied to the oven, introduced in Egypt, it was possible to increase the heat and thus to make the glassy mass more pliable, but the glass until the century. VI BC was produced on a reduced scale for use and exclusive adornment of the nobles.

The discovery of the technique of blowing (hollow glassware: bottles, pots, cups, bulbs, etc.) in Syria and Alexandria, when Rome already extended its hold on the Middle East, marks a great moment in the history of glass. Around the year 100 BCE the Romans began to produce glass by blowing it into pressed molds, greatly increasing the possibility of manufacturing in series of manufactures (simple vessels and exquisite objects of art). They were the first to invent and use window glass.

According to [20] the history of the glass industry in Brazil began with the Dutch invasions (1624/35), in Olinda and Recife (PE), where the first glass workshop

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was assembled by four artisans who accompanied Prince Maurício de Nassau. The workshop made windows for windows, glasses and jars. With the departure of the Dutch the factory closed.

he glass returned to enter the economic map of the country from 1810, when on January 12 of that year, Portuguese Francisco Ignacio da Siqueira Nobre received a royal license authorizing the installation of a glass industry in Brazil. The factory installed in Bahia produced smooth glass, white glass, bottles, bottles and bottles. It came into operation in 1812. In 1825 closed due to major financial, bureaucratic, labor and competition, foreign competition and the ire of the Portuguese.

In 1895, it was founded in São Paulo the Vidraria Santa Marina, today one of the great industrial groups of the country. By 1900, the plant already produced 20,000 bottles of green glass per day. In 1903, Santa Marina became a joint-stock company and five years later produced one million bottles a month, 2 m² of glass for glass in 24 hours and employed 650 workers. High productivity for a factory that only in 1921 would install automatic machines with daily capacity of 460 thousand bottles.

2.5.2 Definition

Glass is an inorganic, homogeneous and amorphous substance, obtained by cooling a melt. Its main qualities are transparency and hardness. Glass is distinguished from other materials by several characteristics: it is neither porous nor absorbent and is a good insulator (dielectric). It has low index of expansion and thermal conductivity, supports pressures from 5,800 to 10,800 kg / cm2.

In general, the glasses have as main constituent the silica or silicon oxide - SiO2 (Table 3). According to [21] the glass in the amorphous state consists essentially of silica (SiO2 - 72.5%) and a lower percentage of sodium (Na2O - 13.2%) and calcium (CaO - 9.18%).

Table 2: Chemical composition of glass.

COMPOUND	(%)
SiO_2	72
Na_2O	14
CaO	9
Al_2O_3	0,7
MgO	4
K_2O	0,3

Source: [23].

In Table 2 it is possible to visualize some chemical compositions of glass investigated by different authors, in studies with application of the glass residue in the production of other materials.

Table 3: Compositions of glass residue used in research.

Compound (%)	TOPÇU e CANBAZ (2004)	SHAYAN e XU (2006)	FEDERICO e CHIDIAC (2009)
SiO_2(%)	70-75	72,4	63,79
Na_2O(%)	12-18	13	11,72
CaO(%)	5-14	11,5	13,01
Al_2O_3(%)	0,5-2,5	1,45	3,02
Fe_2O_3(%)	-	0,48	1,57
MgO(%)	-	0,65	0,89
K_2O(%)	0-1	0,43	0,54
SO_3(%)	-	0,09	0,165

Source: [23].

Table 3 shows the chemical composition of the cements used in some researches focusing on the use of glass residues in order to compare them with the chemical composition of the glass residue.

With the Tables presented, an initial comparison of the main components of the composition of the glass residue and the cement can be made. The oxides SiO2, Al2O3 and CaO are part of the ternary system of the chemical composition of the main cements found in the Brazilian market and when analyzing the chemical compositions of the glass residue presented in Table 4, it is verified that the added oxides exceed 70% of the total, which indicates this residue as a cementitious material. In this way, it is possible to conclude that the substitution of glass residue by cement in mortar and concrete has a high probability of being viable.

According to [20] the glass can be classified in three types as to the variation of the chemical composition:

• Sodium-calcium glass whose application is in general packaging, bottles, pots, automobile industry, civil construction and household appliances;

• Boron-Silicate glass, whose application is in the manufacture of household utensils (Ex. Pans), has the characteristic of resisting thermal shock besides presenting an attractive beauty;

• Lead glass for the manufacture of glasses, cups, chalices and handmade pieces.

As regards its physical characteristics, glass has [22]:

• Dilation coefficient = 9x10-6 ° C-1;

• Modulus of Elasticity = 75 GPa;

• Breakdown Voltage = 1,800 Kgf / cm²;

• Compression Voltage (Tempered Glass) = 1000 Kgf / cm².

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2.6 RULES APPLICABLE TO GLASS

The publication of two new standards in Brazil intends to move the glass market to buildings. This is the NBR 16,023 - coated glass for solar control (Requirements, classification and test methods) and NBR 16015 - Insulating Glass (characteristics, requirements and test methods), both in force since the first half of 2012.

Until then, the two products, already used in architectural projects, did not have national technical parameters for their evaluation. With both texts, the sector intends to guarantee the manufacture of quality products and their correct and safe use.

The expectation is that companies have the standards as a reference for the quality of their products, while consumers also have safe parameters for evaluation, the technical manager of the Brazilian Association of Flat Glass Processors and Distributors (Abravidro) and coordinator of the Brazilian Glassware Committee Plans (CB-37) of the Brazilian Association of Technical Standards (ABNT).

Some Brazilian standards applicable to glass are listed in Table 4, mainly those related to glass requirements and specifications.

Table 4: Standards applicable to glass in Brazil.

Standard	Description
NBR 11706 - Glass in construction (ABNT, 1992)	It sets the required conditions for flat glass applied in civil construction.
NBR14207- Bathroom cabinets made of safety glass (ABNT, 2009)	Specifies the minimum safety requirements for materials used in the design and installation of bathroom boxes made from safety glass panels for use in apartments, houses, hotels and other residences.
NBR14564: Glass for shelving systems - Requisitos e métodos de ensaios (ABNT, 2000)	Specifies the performance requirements and linear measurements required to ensure the safety of the flat glass application used in the composition of shelving systems that have the glass as a component of use applied to their use.
NBR14697 - Laminated glass (ABNT, 2001)	Specifies the general requirements, test methods and care required to ensure the safety and durability of laminated glass in its applications in the civil construction and furniture industry, as well as the methodology of classification of this product as safety glass.
NBR14698 - Tempered glass (ABNT, 2001)	It specifies the general requirements, test methods and care required to ensure the safety, durability and quality of flat tempered glass in its applications in civil construction, the furniture industry and white goods appliances.
NBR NM293 - Terminology of flat glass and accessories to your application (ABNT, 2004)	Establishes the terms applicable to flat glass products in plates and accessories used in construction.
NBR NM294 - Float glass (ABNT, 2004)	It establishes the dimensions and quality requirements (in relation to optical and appearance defects) of colorless and colored float flat glass for the architecture and decoration markets.
NBR NM298 - Classification of flat glass for impact (ABNT, 2006)	Establishes classification of flat glass products, requirements and test methods for flat glass to be considered as safety glass.

Source: Authors, (2019).

2.7 THE RECYCLING OF THE GLASS

The growth of the population and the world economy has led to a considerable increase in material consumption. The generation of waste becomes inevitable and the search for alternatives of disposal of this waste becomes increasingly common among the industries.

The concern with waste in general is relatively small in Brazil when compared to other countries in Europe. There are many studies in Brazil about the use of waste in the production of new materials, but there is no government policy to encourage the purchase of environmentally sound products that favor products containing residues. Table 5 shows the recycling rates of glass containers in several countries, in which Brazil is one of the countries where recycling is very low.

Table 5: Recycling of glass packaging in the world in 2011.

Countries	Index (%)
Belgium	96
Sweden	91
Netherlands	91
Germany	81
Czech republic	78

https://dx.doi.org/10.22161/ijaers.6777 ISSN: 2349-6495(P) | 2456-1908(O)

Italy	74
Brazil	47
France	68
Lithuania	67
UK	61
Portugal	57
Estonia	41
Slovakia	37
Bulgaria	34
Hungary	34

Source: adapted from [24].

As a rule, waste should be treated and deposited at the place where it was generated. However, this rarely happens due to the lack of planning of the industries at the time of project design. Such weakness leads industries to seek final disposal for waste generated away from the place of shipment.

2.8 APPLICATIONS IN CIVIL ENGAGEMENT

2.8.1 Applications

Currently, glass is widely used in civil construction because it is a high-tech, multifunctional and aesthetic material. It is a material that does not require finishing and the necessary maintenance consists only of periodic cleaning [25].

The glass can be applied in: facades, coverings, guardrails, floors, shop windows, partitions, shields, viewers of swimming pools, boxing for bathrooms, wall cladding, among others.

2.8.2 Glass in the production of concrete

Concrete is one of the most used materials in civil construction, in Brazil and in the world. It consists, basically, of a mixture of binder, large aggregates, small aggregates and water. Additives and additions are used when different properties are required in their properties. Its basic constituents, besides being cheap products, are easily found throughout the world market.

The recycling process needs to be managed properly. This process can generate environmental hazards that are much more aggravating than the waste itself prior to recycling, depending on variable factors such as the type of waste, technology used and the proposed use of the recycled waste [26].

The lack of correct and judicious management of Civil Construction Waste (RCC) can generate several kinds of contamination, which can cause serious risks to man and the environment, both in the recycling process and in its post-recycling use, as well as in the deposition irregular and large volume generation. But it is the deposition in irregular areas and the immense generation of waste that will lead to the greatest and main environmental risks, the problems of basic sanitation and health to the man. Thus, residues can cause blockage of pathways, floods, proliferation of diseases and vectors, environmental degradation, etc.

According to [27], construction activities generate great impacts to the environment, such as the proliferation of disease vectors, which will increase the deficiency of urban local sanitation, because the RCCs do not receive adequate solutions.

Researches related to the replacement of some concrete elements by small aggregates of glass have been carried out, with the main objective being the reuse of discarded glass in the construction industry and those coming from the garbage, which help to solve the environmental impact caused by this material, in the reduction consumption of natural resources, reduction of environmental pollution, among others. Brazil produces an average of 800 thousand tons of glass a year, of which 220 thousand tons are recycled [28]. Of the total, 40% come from the packaging industry, 40% from the diffuse market, 10% from the "cold channel" (bars, restaurants, etc.) and 10% from industry refuse.

One of the factors that makes this process limited is the high cost of glass waste, the most feasible landfill option, and the waste mix, taking into account that different staining glass also has different properties. The insertion of these wastes in civil construction has been applied in order to give destination to this material that is most often discarded incorrectly, since the landfills are already with reduced capacity and in the next years tends to stay home more overloaded. Taking into consideration all the materials deposited in nature, the villain among them is the glass, which takes 4,000 years to decompose [29].

The glass has in its composition a mixture of silica or silicon oxide (SiO 2) and calcium oxide. Being the same, composed of 72% of silica (SiO2), predominant compound in the sand, and that is one of the most abundant elements in the planet. It possesses in its chemical property high melting point 1830ºC and specific high mass of 2200 Kg / m³.

2.8.3 Replacement of the natural heavy aggregate by glass

Initially, it is necessary to clean the material, by removing labels and immersing in water to remove waste. Then, these glass residues are milled by hand, acquiring different grain sizes [30].

Cylindrical specimens measuring 15 x 30 cm, of Portland cement concrete, with a conventional trace composition and with different glass proportions, are used. As shown in figure 2 below.

https://dx.doi.org/10.22161/ijaers.6777 *ISSN: 2349-6495(P) | 2456-1908(O)*

Fig. 2: Materials used for test specimens

In figure 2 are the materials in the form, where each of the materials were separated by volume.

The molding and curing of the specimens used in the simple compression test have to be in accordance with the recommendations of [17]. Table 6 shows results obtained from the substitution of the natural aggregate by glass, in percentages 0%, 33% and 67%.

Table 6: Results obtained by the compression test.

Ordem	Ensaio	Moldagem		Corpo de Prova		Slump	Ensaio de Compressão			
		Data	hora	Número	Vidro	(mm)	Data	Idade	Carga (N)	Tensão (MPa)
1	01220-B/18	04/05	11:03	1	0%	10	11/05	7	264.938	15,00
2	01220-B/18	04/05	11:25	2	0%	11	11/05	7	280.834	15,90
3	01220-B/18	04/05	11:36	3	0%	10	11/05	7	298.496	16,90
4	01221-B/18	04/05	12:22	4	33%	12	11/05	7	310.860	17,60
5	01221-B/18	04/05	12:31	5	33%	12	11/05	7	305.561	17,30
6	01221-B/18	04/05	12:34	6	33%	13	11/05	7	309.094	17,50
7	01222-B/18	04/05	13:04	7	67%	14	11/05	7	284.366	16,10
8	01222-B/18	04/05	13:23	8	67%	13	11/05	7	287.899	16,30
9	01222-B/18	04/05	13:26	9	67%	14	11/05	7	286.133	16,20

Source: Authors, (2019).

2.8.4 Use of glass in mortars

The glass residue was used as a partial substitute for the small aggregate and / or cementitious material. The criterion for choosing which substitution would be made was mainly due to the size of the particles of the glass residue. Sometimes a milling process was necessary in order for the glass particles to have the desired size. According to [31], particle size plays a very important role since it influences possible alkali-silica (RAS) reactions, thus impairing the mechanical performance and durability of the cementitious matrix.

In their work [32] they used the ground glass residue (pass through sieve # 200) in percentages of 5 and 10% in substitution of Portland cement and of the small aggregates in mortars. It was found that only the sand substitutions by the ground glass showed a gain in the considerable compressive strength and that they exceed the results of the reference samples as shown in Table 7.

Table 7: Results of the tests of compressive strength (in MPa) at the different ages of rupture.

TRACE OF MORTAR – (Cement and Sand- CS) Replacing	BREAKING TIME		
	07 days	28 days	58 days
REF – CS	57,08	59,77	65,17
CIM5 - CS and 5% glass rep. the cement.	47,13	53,54	64,59
CIM10 - CS and 10% glass rep. the cement.	41,01	49,63	60,76
ARE5 - CS and 5% glass rep. sand.	51,06	57,50	73,77
ARE10 - CS and 10% glass rep. sand.	49,52	55,74	78,07

Source: Authors, (2019).

III. APPLICATION METHODOLOGY

The study was developed according to the design of a bibliographical research with a qualitative approach. The bibliographic research is developed based on material already elaborated, consisting mainly of books, scientific articles, theses and dissertations. The main advantage of this type of research is that it allows the researcher to cover a much wider range of phenomena than could be investigated directly.

The qualitative approach consists of analyzing the data working with all the material acquired during the research. This analysis must be present in the various stages of the research, becoming more systematic and formal after the finalization of the data collection.

3.1 SOURCES OF DATA

The sources should provide the appropriate answers to the resolution and/or understanding of the proposed problem.

In this study, a bibliographic survey of the subject was carried out to identify possible uses of glass as a substitution of raw materials for concrete production. According to the flowchart in Figure 3 below.

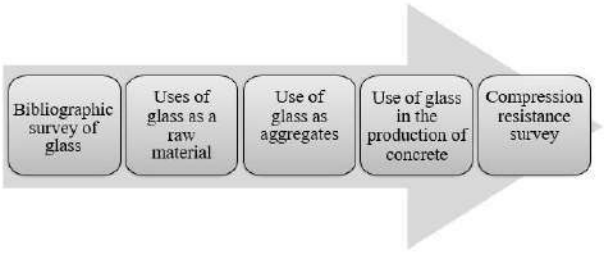

Fig.3: Study Flow Chart.

Source: Authors, (2019).

According to the literature analyzed, the authors in Table 8 investigated the use of glass in concrete production:

https://dx.doi.org/10.22161/ijaers.6777 *ISSN: 2349-6495(P) | 2456-1908(O)*

Table 8: Glass studies in the production of concrete.

Author	Title
LORENA, 2013	Study of the application of laminated glass waste in concrete production
ARTUR,2016	Evaluation of the use of common glass as Pozolana and evaluation of the use of tempered glass juice as aggregated graft in concrete.
LAYS,2018	Study of resistance to concrete compression produced with tempered glass residue

Source: Authors, (2019).

According to [33] the concrete used in the experimental program contemplated the partial substitution of the aggregate (grit) for ground glass, in proportions 0%, 33% and 67%. The glass used was tempered, and this material was chosen because of its abundance and because it does not have a suitable destination in the region. The methodology used to evaluate the possibility of using the glass in obtaining the concrete is demonstrated in the flowchart shown in Figure 4 below.

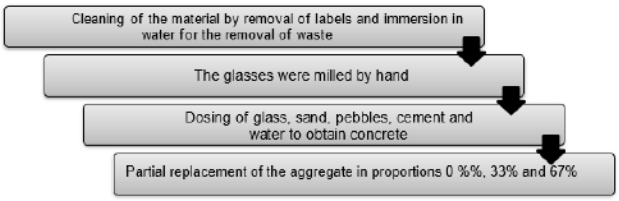

Fig.4: Flowchart of the use of glass methodology in obtaining concrete.

Source: Authors, (2019).

For this review we verified the studies performed by [33], using test bodies molded according to [36], as well as curing and determination of the compressive rupture load. The results, individual compression strength, mean compressive strength of cylindrical specimens and maximum standard deviation were in accordance with [36], the study used the methodology in figure 5 below.

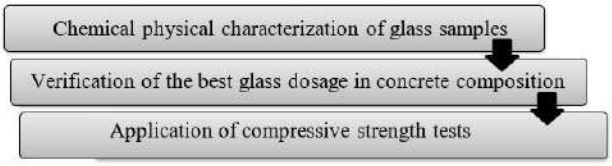

Fig.5: Flow diagram of the use of glass in the production of concrete.

Source: Authors, (2019).

IV. RESULTS AND DISCUSSIONS

The results of the research on the use of glass in concrete will be presented.

4.1 USE OF GLASS IN CONCRETE PRODUCTION.

The results indicate the possibility of replacing the large aggregate with the glass, however, it is necessary to test the best glass dosage for the substitution. According to [32], after analyzing the obtained results, it was verified the great potential of use of glass residue in partial replacement of the large aggregate as shown in figure 6, which in our region replaces the rolled pebble dredged river, with this combination of a more suitable solution for the disposal of glass, as well as the reduction of environmental impact with the exploitation of the pebble.

Fig.6: Glass as a large aggregate.

Source: [32.]

According to the same author we can analyze that the substitutions 0%, 33% and 67% predict that for a percentage replacement tempered glass, we will get a maximum resistance that can reach the value of 17.53Mpa.

According to [33] Tempered glass chips have an advantage over common gravel, which has its actual specific gravity value around 2.98 g / cm³, which shows a difference of 21.81% in the mass of these aggregates . Therefore a structure using as a large aggregate the glass shard would have its own reduced weight.

However, for [34] it was observed that the partial replacement of the cement by the laminated glass residue in proportions of 0, 5, 10 and 15% in the prepared concretes did not produce a considerable improvement in the properties analyzed. However, it also did not generate significant losses in the physical and mechanical properties in relation to the reference trait that in the case was the conventional one.

According to the studies of [33] the specimens were molded with the 1: 2: 3 trace in volume, and replacement

https://dx.doi.org/10.22161/ijaers.6777 ISSN: 2349-6495(P) | 2456-1908(O)

occurred by volume withdrawal of gravel and the same volume of glass scrap was added. The obtained resistance can be verified next. The water cement ratio was 0.5.

In this respect [33], the use of heavy aggregate concrete from tempered glass scrap is likely to be suitable for non-structural purposes. The concrete produced with 20% of glass scrap replacing the brittle, due to its resistance and decrease of density and 100% of substitution, although it was not the best replacement percentage, nevertheless, presented resistance close to 20 Mpa.

According to [33] and [34], the concrete having partial replacement of the large aggregate by the glass can be used for non-structural purposes, since for structures it needs to reach more than 20 MPa.

In practice according to [33] the use of this material would also occur in the production of pavers or sidewalks, as it would be easy to measure a concrete in which the necessary resistances are met, in addition to the fact that a recycled material is being used. Figure 7 shows possible occasions where glass as a bulk aggregate in concrete can be applied.

Fig.7: Concrete paving.
Source: Authors, (2019).

Another option for using concrete using glass as an aggregate is the pavers. According to [35], the name given to precast concrete or parallelepiped blocks is available in different thicknesses for use in various design types. The blocks are docked and there is no need for anything to make them stick or stick to the surface. What holds them to the ground is the friction between the pieces.

V. CONCLUSION

Sustainable actions are practiced in the civil construction, but still in considerably reduced volumes, in addition it is an environment in which there is a constant collection by lower costs and wastes, greater uses, turned all more for the financial economy of the enterprises than for the environmental question.

Considering that concrete is one of the most consumed products in the world, and that its composition is composed of materials extracted from nature in a non-renewable way, any alternative that allows saving of natural or financial resources, is of extreme value, especially when can combine a possible reduction of the extraction of such natural resources with a convenient and efficient destination of waste such as glass, which in the form of waste would be deposited in nature in an inefficient and polluting manner.

The literature review showed that the glass residue generated is a serious environmental problem, and it is necessary to seek alternatives for its use, in order to minimize the impacts caused by its disposal in an incorrect way.

This literature review has shown that for the determination of possible uses of glass from discards it is necessary, first, to characterize the glass, studies using molded test bodies as well as curing and determination of the compressive rupture load.

Another important factor for deliberation of possible uses of glass for concrete is the determination of the best dosage of glass to be used as an input to ensure the quality and durability required for the final product and the performance of technological tests that guarantee the quality of use.

Concrete with glass residue can be a viable alternative for several applications, especially those that do not require structural function.

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Diagnosis of the use and occupation of the lands of the hydrographic bowl of the Ribeirão São João-ES, Brazil

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Abstract *— Studies related to the use of soil in river basins are of extreme importance to, for example, assist in the evaluation of the environmental impacts of human activities. The objective of this work was to evaluate soil use in the Ribeirão São João river basin in the state of Espírito Santo, Brazil, as a way to subsidize actions of environmental improvements in the area. The geographic databases used were: the Integrated System of Geospatial Bases of the State of Espírito Santo, the Jones dos Santos Neves Institute and the National Water Agency. The procedures were performed in the ArcGis program. The basin was delimited to then, based on two land use files referring to the mappings of the years 2007-2008 and 2012-2015, determine and quantify the classes of land use. A thematic map was prepared in order to evaluate the distribution of classes. Pasture was the most predominant class (approximately 40%), followed by coffee farming (20%), arranged under small monocultures. The native vegetation presented low percentages (15,5%), although they did not decrease in this period. The high representativeness of the macega (approximately 5%), predominant alongside native forest fragments, indicates a problem regarding the management and use of local lands. Eucalyptus silviculture presented great growth during this period, together with the expansion of exposed soil areas. The basin of Ribeirão São João presents problems arising from human action, requiring actions such as the creation of ecological corridors, expansion of native forest cover and environmental education with local residents.*

Keywords *— **Hydrographic Basins, Vegetation Cover, Environmental Impacts, Territorial Planning, Geographic Information Systems.***

I. INTRODUCTION

Historically, the relationship between society and nature has become more complex as a result of the use of space, with currently seen effects, seen for example in the substitution of vegetation cover, in the implantation of industrial enterprises, urbanization and influences on water resources [4]. The landscapes on the terrestrial surface live in constant transformations, since this scenario is linked to the natural changes and, mainly, of the society [20].

Changes in soil use and land cover from anthropogenic action have provided major impacts in these landscapes, which can be mitigated through monitoring using spatiotemporal information on local landscape modifications [3]. Activities such as agriculture and livestock are responsible for changes in land use and occupation, increasing the exploitation of natural resources, directly influencing the quality and quantity of water available [21].

Disordered land occupation associated with deforestation and pollution caused by the use of pesticides, fertilizers, domestic / industrial effluents and garbage, can have serious consequences for the survival of several species [9], both terrestrial and aquatic. Other losses are related to losses of soil organic matter and nutrients, compaction and waterproofing of soils, sedimentation of fluvial channels and losses with floods, causing damage to the equilibrium of water systems in watersheds [11].

Knowing the dynamics of land use and occupation is of fundamental importance in assisting planning and territorial management. Studies with this approach constitute an excellent tool for environmental analysis, helping to identify and locate the factors responsible for the environmental conditions of a given area [17]. In addition, analyzing the soil situation may provide support for the elaboration of other studies, such as monitoring and mapping of fire risks and eradication of erosion in

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places where activities such as agriculture and livestock predominate [13].

A river basin can be defined as the region of the terrestrial surface surrounded by its topographic dividers and drained by a set of water bodies distributed according to the predominance of water and sediments and flowing to a single outlet [10]. The hydrographic basin is adopted as a relevant unit in the development of several studies, such as those that deal with land use, since it constitutes a systemic unit in studies involving fragilities and potentialities of a given landscape, covering the biotic, abiotic and anthropic factors [16].

The problems involved in environmental studies at river basin level can be easily evaluated with the help of geotechnologies, especially in thematic mapping, diagnosis and environmental prognosis and land use planning [8]. Through the so-called Geographic Information Systems (GIS), it is possible to detail the occurrence of conflicts in the use of land in a given river basin, strengthening environmental monitoring actions and assistance to the legal instruments of control and inspection of these sites, of a diagnosis crossing spatial information [24].

With the help of geoprocessing techniques, the objective of this work was to study the use and occupation of the lands of the Ribeirão São João river basin as ways of subsidizing measures to mitigate and mitigate possible environmental impacts.

II. MATERIALS AND METHODS

This study was based on the Ribeirão São João river basin. With an area of 91,88 km² and perimeter of 57,82 km, it covers the rural area of part of the municipalities of Castelo and Conceição do Castelo, having its mouth in the river Castelo. It is characterized by the fact that there are no urban agglomerates, however, the study of the dynamics of land occupation is justified by the predominance of activities such as cattle raising and agriculture (mainly coffee), which, when handled incorrectly, can lead to serious environmental problems. Fig. 1 shows the location of the studied area.

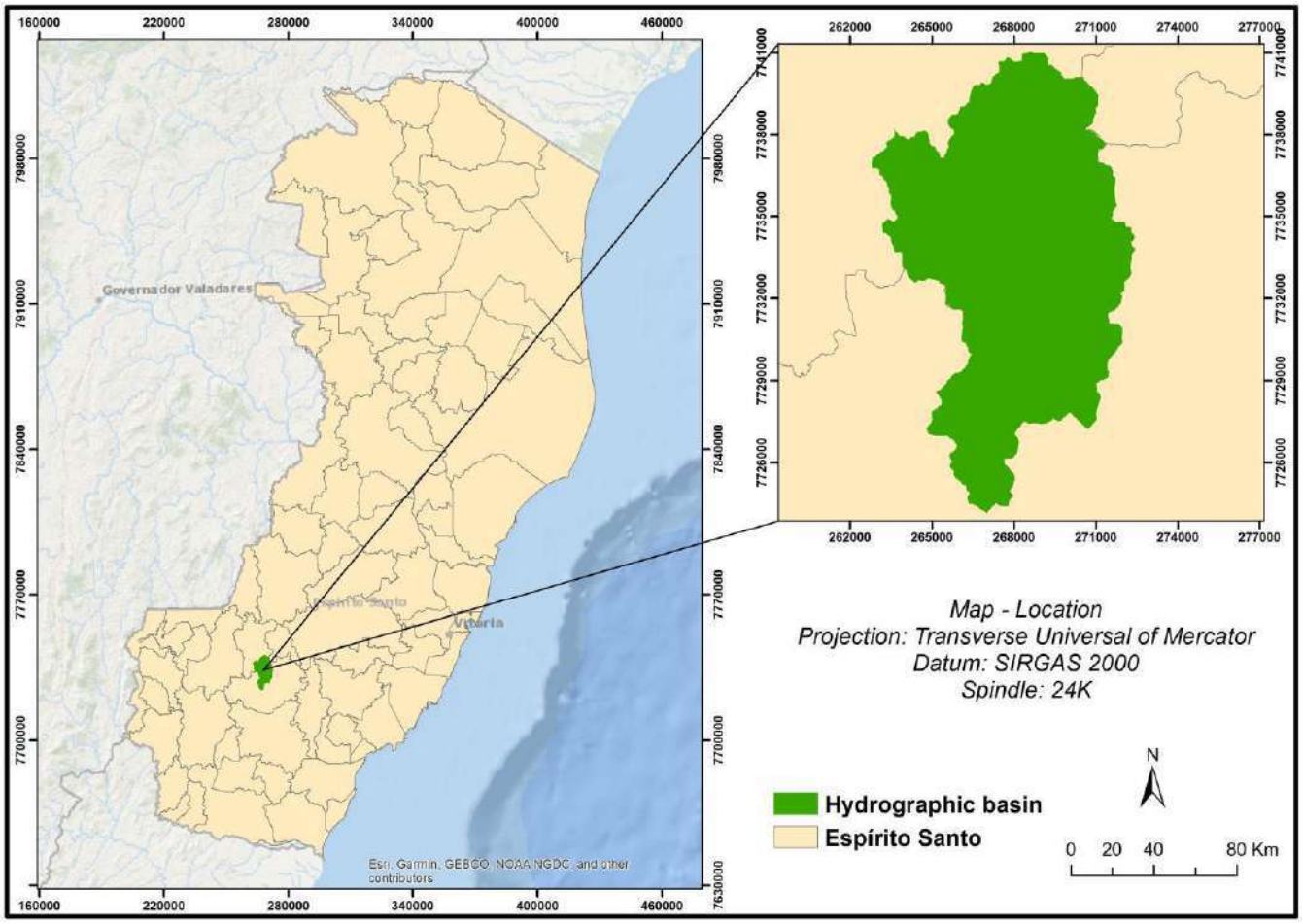

Fig. 1: Location of the sub-basin of Ribeirão São João, in the state of Espírito Santo, Brazil

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The ArcGIS® version 10.2 program was used for the basic execution of the procedures. The cartographic databases considered were the Integrated System of Geospatial Bases of the State of Espírito Santo (GEOBASES) [27] and the electronic sites of the Instituto Jones dos Santos Neves (IJSN) [28] and the National Water Agency (NWA) [26].

In GEOBASES, two shapefile (shp) files were collected on land use mappings from 2007 to 2008 and from 2012 to 2015, both handled in a scale equal to or better than 1: 25000, and a file referring to curves of the region studied. Together with the IJSN and NWA, a file containing the boundaries of the municipalities of the state of Espírito Santo and a feature representing the water courses and their respective identifications were acquired.

In ArcGIS®, the Digital Elevation Model (DEM) was initially generated from the contours of the region covered by the Ribeirão São João river basin, and then delimited this basin by means of the following procedures, in the attribute table: DEM correction generated; determination of the accumulated flow; determination of flow direction; definition of the drainage network and water courses; vectorization of the drainage network by converting the feature into raster format obtained for line format (shapefile); demarcation of a point by means of the creation of file shapefile representing the exutório of the basin and; delimitation of the river basin. In order to assist in the identification of the basin, it was added the archive of watercourses, thus making it possible to identify the main water flow line (in this case, Ribeirão São João) and its mouth at the Castelo River.

After the conversion of the file to polygon format obtained about the hydrographic basin, the information regarding the soil use collected in GEOBASES was added. With the help of the clip tool, the soil use was delimited for the BHRSJ.

The identification of the classes occurred through the table of attributes and the respective legend established. The quantification of each class, in square meter (m²), was possible through the creation of a new field in the attribute table and, later, the calculation through the geometric calculator.

III. RESULTS AND DISCUSSIONS

The hydrographic basins were consolidated as geographic compartments to achieve the integrated planning of land use and occupation, in which economic activities are associated with environmental quality. Rural producers use natural resources (mainly water, soil and vegetation), so that all the beneficial and harmful effects affecting rural areas and other sectors of society are influenced by them [17].

Table 1 presents the description and quantification of soil use and occupation classes of the Ribeirão São João basin for the mapping of the years 2007 to 2008 and 2012 to 2015.

Table 1: Representation and quantification of land use classes for the mappings carried out.

Classes	Mapping 2007-2008		Mapping 2012-2015	
	Area (m²)	Area (%)	Area (m²)	Area (%)
Rock outcrop	4.786.139,85	5,21	5.019.683,09	5,46
Marsh	27.341,97	0,03	32.745,76	0,04
Rock Field/Altitude	81.557,06	0,09	0,00	0,00
Agricultural prodution – banana	0,00	0,00	15.758,21	0,02
Agricultural prodution – cofee	19.070.481,90	20,76	20.190.048,54	21,97
Agricultural prodution – coconut tree	0,00	0,00	4.763,39	0,01
Other permanent crops	405.448,71	0,44	584.426,96	0,64
Other temporary crops	1.311.016,55	1,43	645.983,26	0,70
Mineral extraction	22.491,02	0,02	26.888,20	0,03
Macega	3700029,56	4,03	3.955.715,98	4,31
Body of water	78.462,80	0,09	93.516,12	0,10
Native forest	14.209.741,51	15,47	14.235.669,15	15,49
Native forest at na early stage of regeneration	5.680.998,65	6,18	5.326.507,48	5,80
Other classes	2.294.371,70	2,50	2.331.438,98	2,54
Pasture	38.337.495,61	41,73	36.711.624,74	39,96
Reforestation – Eucalyptus	1.527.055,36	1,66	2.235.366,46	2,43
Soil exposed	346.395,31	0,38	468.711,07	0,51

In both mappings, there was a greater predominance of pastures and coffee cultivation, thus indicating that coffee cultivation and dairy farming and cutting are the basic economic activities carried out in this river basin.

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However, in the analyzed period, there was a small reduction of pasture areas linked to the increase of coffee cultivation, mainly under monocultures.

Agriculture, when improperly managed and disposed of in monocultures, contributes to soil impoverishment by modifying its physical, chemical and biological characteristics [19]. At the same time that dairy farming is widespread in Brazil, a phenomenon seen also in the São João river basin, sustainability must be present in this activity, especially since it is one of the sources of income for family agriculture. It has been the subject of academic interests and concerns, but not enough to contain the environmental impacts caused by the mismanagement of this economic activity [12].

In this way, despite having local economic relevance, livestock and coffee plantations, when managed incorrectly, cause problematic environmental impacts. The environmental impacts of these activities are, for example, the process of degradation of the physical, chemical and biological properties of the soil and the compromise of the local ecosystem [6]. Specifically, the problems caused by the use of agrochemicals and the action of tractors in the soil, causing compaction and greater soil turnover [2].

Regarding soil management in livestock, the problems caused may arise mainly from incorrect methods of plowing in areas of rugged relief, which, over time and through the action of erosive processes (intense precipitation and winds, for example), degrade the soil and may favor the emergence of gullies. Another consequence of improper handling of coffee and cattle breeding is the silting of water bodies, a phenomenon seen in Ribeirão São João and some of its tributaries. These activities are the ones that consume and waste water resources, as well as producing effects on the quality and quantity of water [22].

Therefore, given its high representation, the agriculture in the Ribeirão São João basin needs mitigation actions and mitigation of environmental impacts, linked to a correct territorial planning, in order to provide greater environmental, social and economic benefits.

Consolidated native vegetation was present in relatively low percentages compared to other river basins. The sub-basin of Ribeirão Estrela do Norte, also located in the state of Espírito Santo, for example, has 20% of native vegetation consolidated [5]. However, there was stability in the areas of native vegetation cover, while the vegetation in the initial stage of regeneration showed a small fall. In environmental terms, it means a positive factor, since it indicates that the anthropic action in this area was not drastic in the analyzed period, to the point of removing the native vegetation to give way to another type of soil occupation.

However, the low percentages of native plant cover consolidated and in the initial stage of regeneration indicate the need for mitigation actions and mitigation of the environmental impacts of economic activities, mainly agriculture and livestock, due to the consequences of the suppression of this plant. Some of them are, for example: loss of biodiversity, damage to the quality and quantity of surface water and soil exposure, which in turn leads to erosion and compaction [1]. Therefore, the low percentage of native vegetation is a worrying factor, although it has shown some stability during the period considered, indicating the need for actions that aim at the maintenance and even the expansion of native vegetation cover in this watershed.

Eucalyptus silviculture showed an increase of almost 1% in the analyzed period, indicating, therefore, a trend of growth of this crop in this river basin. Eucalyptus can cause beneficial environmental impacts such as, for example, soil recovery from degraded pasture. However, when handled incorrectly, it causes harmful consequences, such as damage to allelopathic effects and water resources [14].

The growth of eucalyptus forestry, which is linked to its improvement with technological research of genetic improvement and management, besides the use of wood in the production of cuttings and charcoal in small properties. However, planting must be done adequately, based on compliance with environmental preservation standards [24]. This growth is also seen in other river basins, such as the sub-basin of Ribeirão Estrela do Norte [5], thus highlighting the extraction of wood from eucalyptus as one of the economic activities that have been growing throughout the territory of the São João Ribeirão basin.

The macega presented percentages above 4% and succinct growth in the Ribeirão São João basin. However, these areas indicate a problem regarding the management and occupation of local lands, since they could be used with, for example, environmental recuperation or agroforestry systems. These systems present a higher level of sustainability, combating rural poverty, providing food security and conserving natural resources, contributing to a better quality of life in rural areas [15]. Therefore, they would bring greater use to the areas of macega and, moreover, would improve the local agricultural production to the detriment of the local monocultivos.

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The areas of exposed soil, although low coverage, had an increase in the analyzed period, which can be considered bad, because the soil is more vulnerable to erosive processes. These areas, in the sub-basin of Ribeirão São João, are arranged on unpaved roads and earthworks. In view of this situation, it is important to adopt measures such as the implementation of dry boxes to improve rainfall drainage and minimize soil erosion, good planning and maintenance of rural roads [5]. These measures are important for the improvement of the environmental quality of the sub-basin of Ribeirão São João, given the growth of this class.

Another class that is important to highlight is that of rocky outcrop, which presented percentages higher than 5%, which are significant values, justified by the local relief. However, the areas of mineral extraction do not predominate, indicating that the extraction of rocks is not a prominent activity in the region. The other classes had low representativeness, standing out only temporary and permanent crops, which, together, represented percentages lower than 2%. Fig. 2 and Fig. 3 show, respectively, the land use and occupation of the Ribeirão São João basin in the mapping of the years 2007-2008 and 2012-2015.

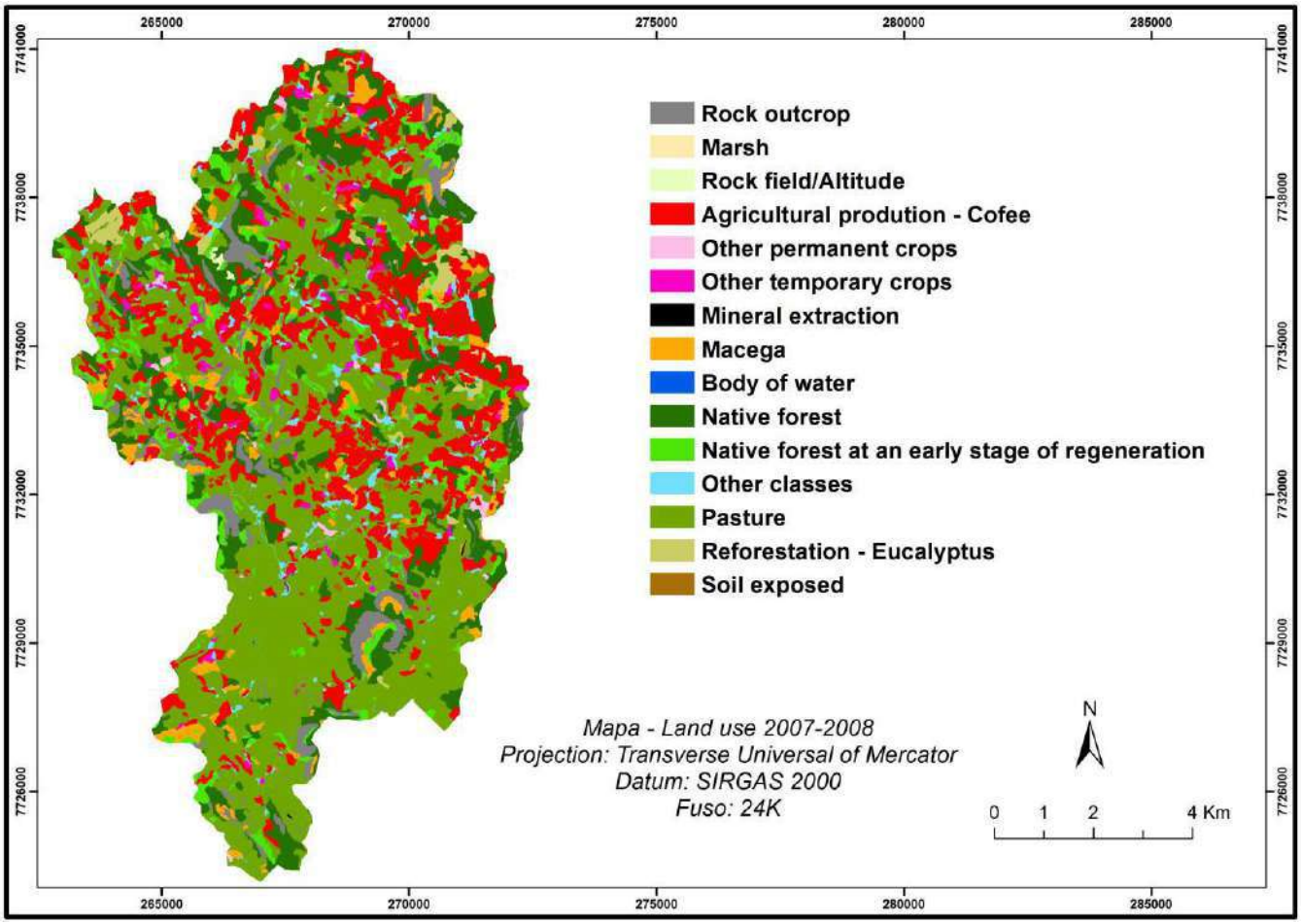

Fig. 2: Use of soil referring to the mapping of the years 2007-2008.

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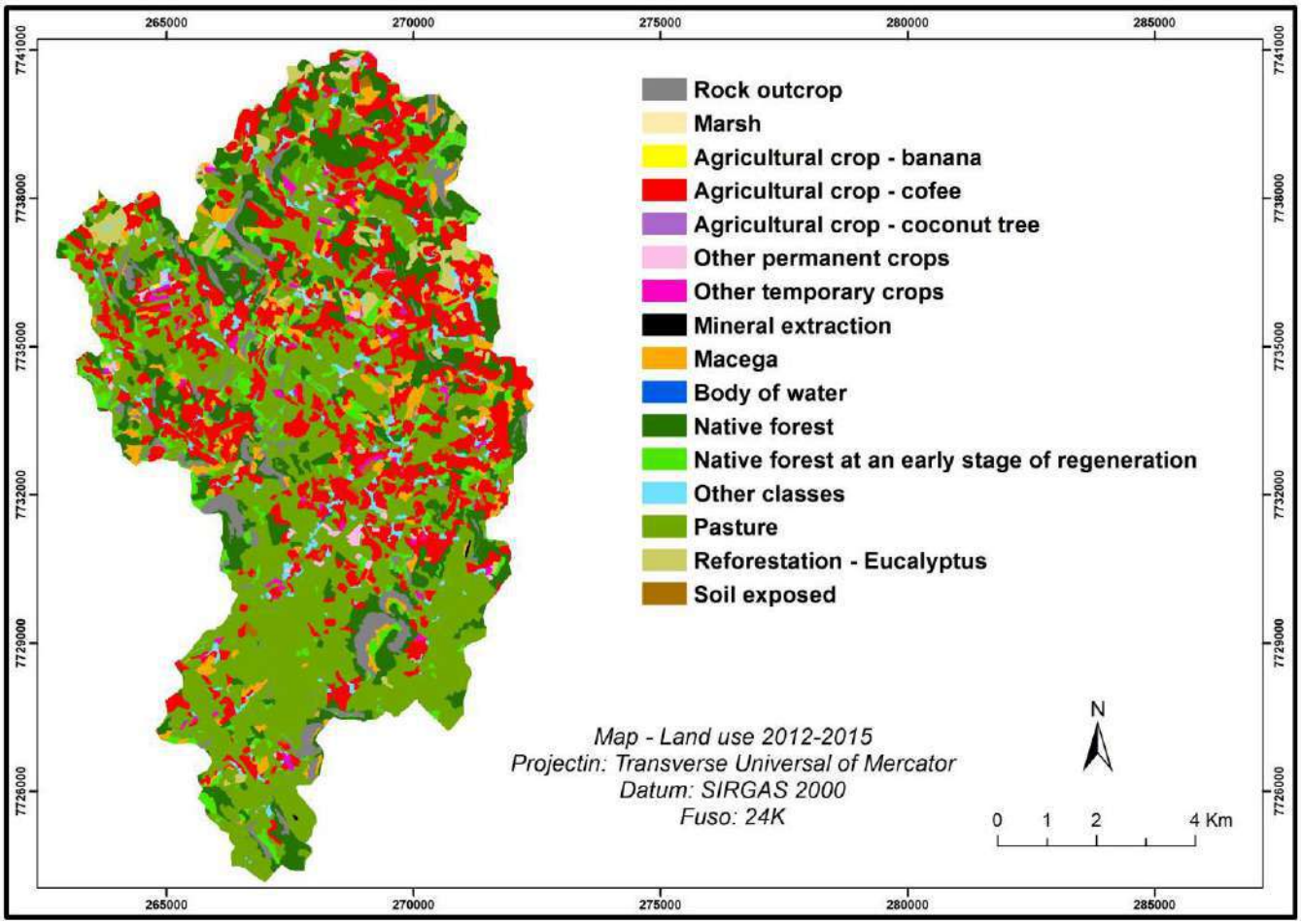

Fig. 3: Use of soil referring to the mapping of the years 2012-2015

In both maps, pasture was predominantly predominant in the southern portion of the watershed, while coffee cultivation was mostly disposed under small monocultures. However, several coffee growing areas were close to fragments of native forest, which in turn presented a fragmented pattern throughout the basin. Thus, one of the measures that could be considered would be the adaptation of agroforestry systems to these monocultures, as they would, for example, increase the circulation of fauna and flora in native forests, as well as improve the profitability of smallholders.

Another important factor is that several fragments of native forest were not linked to one another in a large part of the São João river basin. In view of this scenario, the implantation of ecological corridors linking these fragments is a relevant suggestion. These corridors represent one of the most promising strategies for effective regional planning for the conservation and preservation of flora and fauna. The Atlantic Forest, which is the predominant biome in the Ribeirão São João basin, for example, is one of the biologically richest and most threatened regions on the planet and urgently needs this type of planning [23].

The connection of forest fragments is of paramount importance due to the consequences of forest fragmentation, such as the extinction of species. Many of them require more forest area to survive. Most of the time, these remnants are surrounded by human activities [18], such as eucalyptus silviculture and agriculture, which are predominant economic activities in the area.

Some areas of macega were arranged close to the forest fragments, evidencing, therefore, needs of better management of the use of the local lands. In these areas, restoration or environmental restoration would be relevant because, in addition to increasing the vegetation cover of the soil, it would provide greater area for the circulation of the fauna and would improve the gene flow of the flora, besides softening the edge effect.

This effect is the set of modifications in the physical, chemical and biological parameters detected in the contact area of the plant fragment with the surrounding matrix [7], a phenomenon that can be emphasized for the

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Ribeirão São João basin and, while at the same time worrying about environmental issues.

IV. CONCLUSION

In general, the river basin of Ribeirão São João suffered a degradation process, due to the high representativeness of agriculture (pasture and coffee cultivation, mainly) and the low percentage of native vegetation cover, while eucalyptus silviculture presented a high evolution. The fragmented pattern of native vegetation is a concern, especially in ecological terms. Therefore, the adoption of measures aimed at mitigating the environmental impacts mentioned in the course of the work is of great necessity, providing better environmental quality and greater sustainability in this river basin. In this way, it is expected that this work can subsidize improvements and the accomplishment of future studies in the considered area.

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Environmental Education at Public High School of Itacoatiara City - AM

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Abstract— *The idea of sustainability in the Brazilian Agenda 21 requires governments and institutions to be attentive to good planning and formation of alliances in the performance of actions, should seek a better quality of life for the population. Thus, the objective was to understand the importance of the teaching practice focused on Environmental Education, in an interdisciplinary and contextualized way, in public high schools in the municipality of Itacoatiara - AM. This is a bibliographical and descriptive documentary research. Data were collected in the secretariats of three state public schools, a group of 35 senior students were asked to formulate and discuss issues involving topics of different subjects. It was found that only 5% of the students showed the interest aroused by teachers and local society for subjects such as Agenda 21 and related. However, 80% of them have been very interested in developing current issues such as those mentioned in Agenda 21. The rest seem to have no safe direction on the news they want to seize. There was also an opening of the high school students of the municipality to access issues pertinent to Agenda 21.*
Keywords*— *Environment; Agenda 21; Public education; Sustainability.

I. INTRODUCTION

Agenda 21 is a document that involves participation in which society, governments, economic and social sectors seek to diagnose problems, understand the conflicts involved and agree on ways to solve them, in order to build what has been called and progressive sustainability (Agenda 21/2018).

This assertion is supported by Sontag, Silva and Hofer (2016), who defend the idea of sustainability, set forth in Agenda 21, Brazilian, which permeates all dimensions of human life, such as economic, social, scientific, political and cultural, linking government, the productive sector and society, especially sectors of education. There is an indication that Brazil has not yet been fully successful in applying the theme. Making this type of research of paramount importance as a training component for professionals in the field (Veiga, 2010).

The objective of this study is to understand the importance of teaching practice focused on Environmental Education in an interdisciplinary way in public high schools in Itacoatiara City - AM, as well as its practical applicability in students' lives.

Historically, in Brazil, the incorporation of environmental issues in education occurred late. Only in 1999 was the law on the National Policy of Environmental Education promulgated. Law No. 9,795, which establishes the obligation to teach environmental education in basic, intermediate and higher education. The following year, the first undergraduate course in Environmental Management in Brazil emerged, and many top courses were quickly developed for environmental, ecological and sustainable issues (Demajorovic and Silva, 2012).

It is known that high school is the preparatory phase for undergraduate courses, emphasizing that environmental awareness and behavior are factors that transcend the contents seen in the classroom.

Therefore, there is a need to investigate the level of environmental awareness and behavior among students and teachers, as well as the possible influence of these aspects in the choice of a profession. According to Veiga (2010) there is an indication that Brazil has not yet been fully successful in applying the theme. Making this research of paramount importance for professional terms of excellence and carried out with their professions. Probably, this problem is more evident in public schools, although only those of high school of a single

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municipality of the interior of the state of Amazonas are considered.

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II. METHODOLOGY

It is a bibliographical and descriptive documentary research, with quantitative and qualitative approach. The scope of the study is the Brazilian scientific production on Environmental Education in the country. As regards the technical procedure, it was described as a documentary, to which Raupp and Beuren say: "[...] it is based on materials that have not yet received an analytical treatment or can be re-elaborated according to the research objectives [...] ", organizing information that is dispersed and giving it new importance as a source of consultation (Beuren 2012, p.89).

The acquisition of data on the implementation of the Agenda 21 school took place in three state public schools, in Itacoatiara City - AM; collected from records and minutes where the pact of caring for the school and community environment through the pedagogy of projects was signed with schools and State Secretariat of Education of Amazonas.

Information about the perception of students and teachers about the theoretical and practical application of Agenda 21 and the importance of topics related to Environmental Education in high school were organized.

It was then requested that a group of 35 students from the third year of high school who formulated questions involving the topics that would be the most relevant to them at this level of schooling; with the purpose of verifying the perception of the students regarding the application of Agenda 21 in school.

Pedagogues of the three schools surveyed contributed to answering five questions previously formulated. In addition, the SEDUC teacher pioneered the implementation of Agenda 21 in Itacoatiara City - AM cooperated with some pertinent information on the theoretical and practical applicability of Agenda 21 in state public schools of the municipality.

Finally, the data were analyzed and described in the table format. In addition, a discussion was sought next to the pertinent literature, using the method of comparisons and discussions.

III. RESULTS AND DISCUSSION

It was verified that it is mandatory to include Agenda 21 and relevant subjects in the subject's syllabus, at least 20% of the workload, as foreseen in LDB 9394/96 (BRAZIL, 2005). In the interpretation of Dias (2004) the proposal of the National Curricular Parameters (NCP) in high school is that environmental education should be one of the cross-cutting themes, emphasizing social, economic, political and ecological aspects. Emphasizing that among the advantages of this approach is the possibility of achieving a more inclusive vision and improving the understanding of social and environmental issues.

However, the results show that teachers and students are oblivious to these norms and ideas, worked only in the geography syllabus today. It was observed that in these schools there is a project called Agenda 21, which usually composes the Interdisciplinary and Literary Fair, which takes place in the second semester of each year, except for one of the investigated Institutions that, in a discrete way, is developing a project with the Environmental Education theme since the beginning of the school year.

These results corroborate those of SILVA (2013) who concluded that the environmental perception of teachers and students is fragmented in reference to the concepts of Environmental Education and Environment, that is, they do not contemplate the local socio-cultural aspects nor do they contribute to an improvement in the quality of life. He also emphasizes that environmental perception is essential to understanding the community's interrelationships with its environment and serves as a tool for planning environmental issues of local society.

It was also found that only 5% of the students demonstrated their interest in teachers and society for issues within Agenda 21 and others. However, 80% of them were very interested in developing these themes in the form of projects and, or in disciplines of biological and exact sciences. The remaining 15% do not seem to have a safe direction of what they want to learn again in high school.

For Veiga (2010) the inclusion of themes on Environmental Education, considering Agenda 21, the

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regular disciplines and projects have a closer relationship with the disciplines of Ecology and Economics and related.

We emphasize that the preliminary results indicate an openness to the introduction of these subjects, since the disciplines of Biology and Chemistry, related to Ecology and those of Mathematics and History, to Economics, are among the preferred ones.

Therefore, it was noticed in this research that there is still an awakening of those who govern education in our country on the practical issues of environmental education as inclusion in the subjects' menus and not only on sporadic projects or specific contents that will prepare this age group of external evaluations. Thus, currently the National Curricular National Base (BNCC), undergoes a reformulation, in which it has as a proposal to include in other disciplines the environmental issues in one of its axes, Nature Sciences and Their specific technologies: In contemporary societies, many are the examples of the presence of Science and Technology, and their influence on the way we live, think and act: from transportation to home appliances; from cellular telephony to the internet; from optical sensors to medical equipment; from biotechnology to environmental conservation programs; from submicroscopic to cosmological models; from the movement of stars and galaxies to the properties and transformations of materials. In addition, global and local issues with which Science and Technology are involved - such as deforestation, climate change, nuclear energy and the use of transgenic crops in agriculture - have already incorporated the concerns of many Brazilians. In this context, science and technology tend to be seen not only as problem-solving tools, both individuals and society, but also as an opening to new worldviews. (BNCC, 2018).

It is understood that with these changes, there will be a new high school with curricula where environmental issues will be part of daily activities of the school so that everyone has a better world with more quality of life.

IV. CONCLUSION

It was detected the need to understand the importance of teaching practice focused on Environmental Education in an interdisciplinary way. It was also verified that there is an openness of the high school students in the municipality to access, in a creative way, subjects pertinent to Agenda 21; which makes possible and plausible the practical applicability of issues related to Environmental Education at this level of schooling, even within the state.

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Environmental Education: Environmental Responsibility and Positive Evolutionary Parametrization

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Abstract *— In the last years the divulgation of the theme environmental preservation, care with the environment and responsibility are increasingly in evidence. To support the research in evidence was used the methodological procedure permeated by conducts of bibliographical research. So to understand this duality, environmental issue and responsibility with the environment, is to penetrate divisive strands of paradigms and concepts that are very strong and difficult to cohabit in fullness and that can walk together, since on the one hand, leadership is occupied by the economic system environmental protection issue. This time we have the capitalist economic system that was planned to acquire raw material to explore the nature, to manufacture and to profit and that sustains the artificial standard of the current modern life and on the other hand the nature that has its finite resources with its own cycle and species which do not reproduce with the same speed and proportion as their opponent aims, so it is exhausted, extinguished and subjected to major changes. The first quoted is a human creation to keep itself through the lucrative business that gained its stability in the Industrial Revolution and which currently strengthens and gains more importance without glimpsing competitors. The second has as its main object nature and its normal course of natural transformation, however, it is under the human domain that through its conduct in the exploratory economic model does not care about the consequences that its actions have been causing, since it acts with disregard, explores to supply the infamous ambition of immediate financial power, which in turn is unconcerned with the resources that end up culminating in an outcome not encouraging for the future of life on the planet. Drawing on the history of human habitation on the planet, one can deduce that the most intelligent being of all living species was able to bring extermination and destruction very quickly. The human species is endowed with better conditions than other living beings. By understanding these possibilities, it has used its abilities, it has mastered great inventions, perfected them for generations, and in the present situation it was able to create mechanisms, sophisticated technologies that nowadays have also become meters sufficient to account for the advances and the great losses of its history. These instruments were capable of evaluating their current economic management model and its destructive exploratory way of the environment. Faced with such a result and its lack of responsibility, various sectors with countries, scientists, groups of environmentalists, citizens, have collected data through deep studies and scientific to demonstrate what the human being is doing to his planet and if it continues thus, what it intends to leave to future generations. The analysis relies on scientific statistics to say that the current profitable paradigm implanted in the world with its exploratory project has simply over-extracted, contaminated resources and brought to the heights of extinction various species and natural resources. As a way to counteract these attitudes and mitigate such destruction, it is necessary to use the parameterization, which is a standardized evolutionary species of studies, possible, applicable and necessary factors of a one-dimensional evolutionary uniformity that can be applied in the educational field and gradually advancing to achieve effective goals each time for the protection of nature and the defense of the future of life on the planet.*

Keywords *— **Environmental education; Responsibility; Educational parameterization.***

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I. INTRODUCTION

The objective of this work is to analyze how organized environmental education and evolutionary applied in school and human responsibility would be essential in the project of preservation of the planet, for this to occur it is necessary to use a grid of parameters parameterized evolutionary each period with goals achieved accompanied by positive analyzes or deductions or self-criticisms to be able to have gains and advances propositive benefits of nature since the history of human existence and its action of degradation of the environment are real, leave no doubt, are patent and can bring a reading of what nature has undergone and what may occur in the future if this is not avoided.

It is known that the natural march inherent to the planet includes changes and changes in its cycle as shown by some traces left by nature itself and verified by human technology or the advanced studies of the modern modern sciences of the field. Many species have mutated and evolved and others have been decimated in a slow, natural process. On the other hand, there are other changes that have occurred due to human artificial interference through their actions in the environment due to their trajectory on the planet. It can be said that this action imposed by the most intelligent inhabitant of the earth, has caused great changes in the air, in the earth, in the water and in its natural cycle.

II. THE SENSE OF EVOLUTIONARY PARAMETRISATION IN THE ENVIRONMENTAL ISSUE

The environmental issue has attracted a great deal of attention and has become more pronounced in recent decades, especially in educational environments, especially in academic education among higher education students associating nature with ecological processes (Santos et al., 2009).

Analyzing history, one can see that the desire to unveil nature is very old and over the years, this relationship between man and nature has become so close that it enabled him to understand and dominate it. Researching some literature on the subject reveals the various ways in which nature is defined. For the Greeks, for example, there was already a great deal of concern in understanding the physis (Gonçalves 2006), so conceptualized by the pre-Socratics, and that Aristotle later defined it as something that merely happens if it makes present, whose beings are placed as that which involves and is close at hand (Foltz et al., 2005). The unveiling of reality was part of that era in order to be able to grasp and understand it by reason.

Already in the Middle Ages the definitions were changed to a theological conception defining nature as a divine work and man being the most perfect creature of creation with powers to dominate it. This definition was reinterpreted at the time of the modern sciences, which demonstrated its disagreement with the theological definition, affirming that nature has its own composition in physical causes (Braga and Reis 2004).

This new mechanistic interpretive posture of the time contributed to move the belonging of the human being to the nature, that of possession of this happened to treat it as something outside its reality, including considering it inferior to its superiority and showing with clear evidence its condition denatured; this new concept served as support and support for a paradigm shift that brought sensible consequences to the way of interpreting reality, which now as a higher being could condition nature as being a mechanical only gear and that could be dominated by it, taking into account his new way of understanding considered superior, rational, denatured and alienated from belonging to this environment, so that he can use it, subjugate it, free to seek support in the use of his own creations and technologies.

In this direction we have the theory of Nicolaus Copernicus who rejected the position of the earth as the center of the universe giving instead the heliocentric theory, according to Porto and Porto (2008). Another essential support was the Renaissance movement that provided a view of deacralized reality with purely physical causes (Braga and Reis 2004). This mechanistic perspective of nature allowed Descartes to base his theory by indicating that nature is the object of human reason and therefore inferior and can be dominated and interpreted in a way disconnected from it, is a reality that holds the human position as denatured.

To complete its position of being superior, the capitalist system was created and structured in the Industrial Revolution, mainly with the invention and with the technique that produced to produce in large scale supported by the modern domain of the sciences. It was possible to perceive that the new interpretive paradigm created by the human being as well as its imposition to transform the environment from its exclusive point of view was settled, facts that opportunized to extend the human idea to the practice with its inventions. This new behavior has led to an increase in large-scale production over the years. This has led to significant changes in the natural environment, such as the desire of modern science (Capra, 1986).

It is worth remembering that this paradigm, this new interpretative model of reality, is only a one-way analysis

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conditioned by the dictates of a system known as capitalist, since there are so many other human forms of reading reality that are unrelated and that carry different analyzes.

However, throughout human history there has never been an economic structure so well elaborated and diffused for a long time and that it extended its dominion in almost all the places of the planet. The analysis in this direction brings with it the certainty that there is much scope still to be unveiled by this economic system which has an enormous potential for innovation and apparently infinity in its domain.

The theory and practice recognized the human being as the top of all living beings, the main thinking and domineering being; with the power to exchange information and create new technologies, has given them the seal of being able to innovate and further their achievements.

Because of this, it created its denaturalized and "independent" condition, since it is the most intelligent being on earth, and has as great differentiator the ability to know, dominate, design and freedom of choice, understanding its environment as a project of its domain.

With this also enabled technological mechanisms that are able to safely form analyzes and this enabled reflections on this behavior that in a rapid survey allows to have data of its conduct and trajectory that in general lines deduces as positive and negative balances, but when compared to which faced other living beings, it has received the label of being more destructive of the environment among the others.

With the introduction of its technology in the natural world has had to pollute the environment and in the current scenario indicates that nature has been despised, exploited and decimated by its capitalist economic project.

As a result of this greedy project facts and evidence have been listed by current scientific studies and show the marked pollution of air, water, land and their chemical interference in modified and industrialized foods bringing about a difficult regeneration of nature.

It must be taken into account that this economic hegemony controlled, directed, reduced science and technology simply to this system, with this there was clear control of the role of science in a single direction, mutilating the knowledge and the amplitude of the research for providing understanding exclusive to this economic objective, leaving aside what could be included as social values, respect for life and little harm to nature.

When the social values are evidenced, we have to present the knowledge of several sectors that are indigenous sources of knowledge of many cultures in different places of the planet that could bring to the intellectual field several different dimensions of what cultural and economic hegemony did with knowledge and research, but by doing so imposed a controlling reductionist view exercised by the current system, since it turned money into arbiter of everything, including the fruit of the ardent and loving work of someone in a mere commodity or when a certain foreign culture to bring a solution, the result of its particular knowledge achieved by its other scientific development, will find the doors closed on account of a patent or a rule or law that protects certain controlling and financial group enabled to repress the open exchange between scientists determining to close their communication and their knowledge.

This reductionist science could also be able to be violent against the knowledge due to its exclusivity and pretension, in addition it was able to destroy the integrity of the nature weakening its natural capacity of regeneration introducing artificially chemical products and oblivious to its own regenerative matter , because its intention is to demean the nature and to transform it to supply immediate needs without caring for its consequences.

Possessing this information about the controlled knowledge, pollution and destruction that has been occurring in the environment due to the hegemonic ambition of capitalism is that initial reactions have been present in the past and more pronounced in the present to save the planet and the species, besides the more information, disclosures and attitudes of concern for the preservation of nature are being made available in the digital media that defend this cause.

In the same conduct are the manifestations of studies and various sectors of awareness that little by little has denounced the little dissemination of the knowledge of the patrimony of all and the reduction of scientific knowledge manipulated exclusively to the economic factor. Because of this, human vision and technique have been subjected only to financial gain, all of which are indifferent to environmental preservation because they treat nature with contempt and pollution.

On the other hand, the forms of awareness to preserve nature will have to use the same methodologies and techniques that were used by this power. Here it is necessary to observe, it is not enough goodwill and disclosure against all that has made this accused systematic, but to use the evolutionary logic that gave so much power and structure to the financial system in focus.

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Then the process of opening and exchanging knowledge aimed at this new order of value and environmental consideration can be initiated by the basis of the formation of the people that is easily deduced to be the school and it is in this formative field, object of discussion of the present theme, that is it is necessary to reinforce the education of the environmental conscience, since it is not enough to only show or mark dates in defense of the environment, but to adopt an evolutionary programming of subjects and actions subject to critical analysis open to innovation to progress in a standardized way, can be classified by parameterization applied in a school system that can have a sequence and improve its evolution in each series or at each stage.

This would also imply supporting periodic revaluations by reviewing what has already been achieved and of what can be improved by using new techniques unrelated to the exclusive and reductionist view of the current economic scientific stance. The evolutionary parameterization would be a kind of uniformization of techniques that achieve goals at each stage achieved and implanted to future learners proactive environmental social agents.

The capitalist industrial system has made great advances with its inventions of its techniques and in using the same instruments one has the ability to measure and know the damages and pollution to the natural environment, but in order to reach this conclusion it is necessary to research, to deepen the cognitive knowledge , to clarify and propose solutions with little environmental impact to the current technological world, opening doors to the dialogue between the reductionist science of economics and the other techniques with less destructive potential.

The current media also made it possible to disseminate information on the subject, especially with regard to concern for nature, and this has captured many supporters and followers of the idea, so much so that a destructive event of nature can be released in a few seconds favoring many views and its power of manifestation repudiating this fact.

However, school education and environmental perception should be elected and given special attention, since teacher and student education could have a much more recognized scope in the aspect of conscious protection training and organized behaviors based on in-depth studies with their safe data that knowledge can favor and be used in this sense of environmental preservation.

For this, the implementation of a modular architecture with the application of evolutionary parameterization in the school grid and the preparation of the teacher's perception in the first place that is the educator and then have its extension and inclusion of the student that will be prepared to each module that will leave more enabled to compare his reality with those that are being brought to his percept, which will consciously understand, aided by the connected imagination, the various internal images of himself, of evolutionary educational instruction and of reality to transform them into propositional knowledge.

The adult life of an apprentice can be the fruit of many choices presented in his basic education. Hence the great importance of electing environmental education within the aspect of preservation as one of the directives of the educational reality of their preferences and these choices actualize an aspect of their formative being in favor of conscious knowledge and certainly before the social gear will have a choice based on training base with less destructive power.

Training is an aspect of constant modulation, so living is to make choices and these choices having as bias the capacity to transform, but without destroying always becomes a value , since the environmental training was able to raise value of preservation with consciousness.

The anticipation of values for environmental preservation becomes an elective value with conscience and free will for those who will work with education and the next social agents and members of the tree of human knowledge.

Thus, faced with a culture accustomed to a denaturalized vision that imposes its knowledge and techniques first with fully profitable economic support, understanding that nature is only its source of supply of raw material and nothing more, it is possible with the same inventions to measure how much this has brought contempt, pollution and extermination to various species. It is time to say that human knowledge is not only a master's slave, but is at the service of all and for the good of all inclusive open to exchanges of experiences with other indigenous knowledge in the scientific world and in the name of knowledge patrimony of all thereby opening the fraternity distinct from the hegemony of financial empires. The training centers, which are the school environments, including higher education, have already demonstrated by their stories that they are the educational and training sites par excellence, indisputably seeders of formative culture for future generations, so they are also able to a theme so relevant to the maintenance of life on the planet, concern for nature, the environment, preservation, conservation and foster great research on the subject. The key to the opening of this secret will always be the sequenced education with the characteristics of an

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evolutionary parameterization that evaluates and proposes changes and visions of a profitable science and technique that does not come to envisage a collapse of life on the planet. For this to happen, it is necessary to recognize that the school is an integrated training environment with society and a partner in the formation of social agents concerned with environmental preservation. Finally, environmental education is generating a preventive awareness that gives people a contact with their outer world and the environment. But this concern has to be constant so that the human being can strengthen his conscience, his values, abilities, indispensable attitudes to judge and understand the environmental problems around him.

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Maternal-fetal Protection in Automobile Accidents and Reliability in the use of Existing Safety Belts

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Abstract*— *This study aimed to understand the mechanisms of lesions that occur in pregnant women involved in automobile accidents, their outcomes, and to evaluate the effectiveness and reliability in the use of existing seatbelts. A systematic review was conducted based on PubMed, Scielo, and Lilacs. Describers: Pregnancy, traffic accidents, pregnancy complications, seatbelts, protective devices. Criteria of inclusion: Articles published in the period from 2006 to 2017, in the English, Portuguese, or Spanish languages. Eight studies were selected that comprised the sample in this research. The findings indicate that the main mechanisms of lesions that occur in pregnancy due to an automobile accident are related to direct trauma on the abdomen, given that at the moment of an accident the objects located within the vehicle continue moving forward, causing the pregnant woman to project the torso forward, strongly compromising the uterus, even with the use of the sub-abdominal seatbelt; despite this, the majority of the authors relate that the non-use of the seatbelts could lead to even graver traumatisms, including adverse fetal consequences.

***Keywords*— Seat belt; Pregnancy; Auto Accident.**

I. INTRODUCTION

In the last decades, there has been a great change in the incidence of causes of maternal death. At the beginning of the century, the main causes were obstetric ones, determined by the lack of prenatal care and inadequate delivery assistance. Currently, with the improvement of medical services, hospitalization of births and decrease of parity, maternal mortality was significantly reduced. The same was not observed in relation to the fetal mortality rate, since non-obstetric pregnancies became more important (Corsi et al., 1998).

Pregnant women were rarely victims of trauma, but today it has become an increasingly common problem that has been increasing morbidity and mortality statistics, especially in large urban centers, and the most common are auto accidents and firearms. These types of accidents leading to maternal and perinatal deaths could be avoided, as they depend on the primary prevention attitudes of the people, the vehicle manufacturers, and secondarily on a better training of the health team that deals with emergencies and pregnant women victims of trauma (COSTA, RAMOS and SERRANO, 2005).

Automobile injuries may entail serious consequences (Weiss and Strotmeyer, 2002), such as premature labor or even fetal loss (El-Kady et al., 2004; Pearlman et al., 1990). Gestational age may be an important factor that affects the risk of fetal loss, since in the first two months of pregnancy there is a higher risk of fetal loss in the case of an automobile accident (El-Kady et al., 2004).

Many injuries and deaths resulting from auto accidents can be prevented with the proper use of safety equipment, in which the safety belt occupies a prominent place, since the correct use of such a device reduces both the mortality and the severity of the resulting injuries of traffic accidents (Adura et al, 2003).

Despite the great importance of the use of safety belts, some pregnant women do not use them either because of lack of habit or because they feel that they can be detrimental to the pregnancy or even the discomfort that they cause to them and this decision can entail risks and irreparable damages to the mother-fetus binomial (Adura et al, 2004).

The traumatized pregnant woman is a singular patient, because two people are victimized simultaneously. In

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addition, the physiological adaptations of the maternal organism during pregnancy alter the normal pattern of response to the different variables involved in the trauma. These alterations of the organic structure and function may influence the evaluation of the pregnant woman traumatized by the alteration of the signs and symptoms of the lesions, alter the approach and response to volume resuscitation, as well as the result of the diagnostic tests. Gestation may also affect the pattern and severity of the lesions (Pereira junior et all, 1999)

However, no accessory seems to have specific function for the protection of the abdominal area of a pregnant woman. An experimental series of vehicle collisions evaluated the effect of force transmitted to the uterus and concluded that the three-point seat belt provides superior protection for the mother and fetus when compared to the subabdominal. Following the abrupt deceleration, the trunk projected forward strongly compresses the uterus (550 mmHg increase) and the three-point belt can eliminate this pressure increase in the gravid uterus by the action of the diagonal strap that will prevent the body's the pelvis In experimental studies, the diagonal strap increased fetal survival from 50% to 92% (ADURA et al, 2003).

II. METHODOLOGY

A systematic review was performed on PubMed, Scielo and Lilacs databases. Descriptors: pregnancy, accidents traffic, pregnancy complications, seat belts, protective devices. Inclusion criteria: articles published in the period 2006 to 2017, languages English, Portuguese or Spanish.

III. RESULTS

We selected 08 papers that composed the sample of this research. The results indicate that the main mechanisms of injuries that occur in pregnancy in the event of an automobile accident are related to the direct trauma on the abdomen, since at the moment of an accident the objects housed inside the vehicle continue moving forward, leading to pregnant woman to project the trunk onwards by severely compressing the uterus, even with the use of sub abdominal belts, despite this, most authors report that non-use of these could lead to more severe trauma including adverse fetal consequences. They also report that the lack of prenatal orientation for the importance of wearing a seat belt is a factor that often contributes to discouraging the pregnant woman from not having as a habit to wear them. As a result, most authors point out that the main ones are: placental abruption, uterine rupture, severe bleeding, prematurity and fetal and maternal death. Regarding the effectiveness of seat belts, the authors generally state that the three-point seat belt would provide greater efficacy for the pregnant occupant by reducing the risks compared to the belts currently used.

IV. CONCLUSION

Based on this systematic review we observed the need to propose the creation of a model to be developed that has the function of providing the correct positioning of the vehicular safety belt in pregnant women, including an accessory for storage of memory device, pen drive type, which will provide access in emergency / emergency situations to the medical history of the pregnant woman.

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