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*Editor in Chief*

Dr. Swapnesh Taterh

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# FOREWORD

I am pleased to put into the hands of readers Volume-6; Issue-4: 2019 (Apr, 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: May, 2019

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52	<a href="#"><u><i>Preferences and Perceptions of School Children in Relation to New Styles and Colors of Dental Attire</i></u></a> Rise Consolação Iuata Costa Rank, Joana Estela Rezende Vilela, Lorena Pereira Vieira, Morgana Aguiar Gomes, Wataro Nelson Ogawa  DOI: <a href="https://doi.org/10.22161/ijaers.6.4.52"><u>10.22161/ijaers.6.4.52</u></a>	Page No: 442-448

# Influence of the Chemical Properties of Wood on the Odor Produced by the Kraft Pulping Process

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**Abstract**—Chemical reactions occur between inorganic compounds and wood chips during the cooking step of the Kraft process. White liquor, which in this process is composed of sodium hydroxide (NaOH) and sodium sulfide (Na<sub>2</sub>S), is mixed with wood chips in the digester in order to dissolve the lignin and produce wood pulp. However, other compounds are formed during the course of the chemical reactions. These compounds are volatile and malodorous due to the combination of the sulfur in white liquor and the carbon chains in lignin. This combination creates total reduced sulfur (TRS) compounds, which are malodorous gases responsible for the distinctive odor of the Kraft pulping process. This paper discusses the chemical composition of the wood species that contribute to these gas emissions. Gases are also released in other stages of the process, e.g., from the woodchips stored in the woodyard for factories that use only long pine fiber, from the digester, pulp washing filters, and from white, black and green liquor storage tanks. One way to reduce TRS emissions is through continuous attention to and correction of the pH levels of liquors containing sulfide ions.

**Keywords**— Kraft, Lignin, Mercaptans, Methoxy, Sulfur.

## I. INTRODUCTION

This paper describes a literary review aimed at gaining a better understanding about the influence of the chemical components of wood, especially lignin, on the Kraft pulping process, and particularly on the odor produced by pulp and paper mills and clearly noticeable in their proximities.

Wood is composed of several chemical components such as cellulose, extractives, inorganic compounds and lignin, which is distributed unevenly according to the anatomical structure of the tree. The word lignin comes from the Latin term *lignum*, which means wood. Lignin is directly responsible for odor pollution due to methoxy, a functional group originating from the formation of thiols. Lignin is responsible for the high methoxy content in wood, corresponding to about 16% in softwoods and 22% in hardwoods (FAVARO, 2015).

The main environmental problem caused by pulp mills is odor, and a characteristic of the Kraft process are pollutant emissions that include both malodorous gases and particulate matter. The main contributors to the typical odors produced by pulp mills are total reduced sulfur (TRS) gases, which consist of hydrogen sulfide (H<sub>2</sub>S), methyl sulfide mercaptan (CH<sub>3</sub>SH), dimethyl sulfide mercaptan (CH<sub>3</sub>)<sub>2</sub>S and dimethyl disulfide mercaptan (CH<sub>3</sub>)<sub>2</sub>S<sub>2</sub>, as well as sulfur oxide (SO<sub>x</sub>) and nitrogen oxide (NO<sub>x</sub>). Particulates consist mostly of sulfate, sodium carbonate and calcium (JERONIMO, 2000).

Some components are formed through reactions with lignin, such as the mercaptans methyl sulfide and dimethyl sulfide. The latter is produced through the oxidation of lignin-derived mercaptan groups, and the main emission sources of these gases are digesters, blow tanks and evaporators (RECH, 2007; CORREIA, 2008).

## II. KRAFT PULPING PROCESS

The Kraft pulping process started in 1870 and 1871, when two U.S. patents were granted to A. Eaton for the delignification of wood with a mixture of sodium hydroxide and sodium sulfide (KLEPPE, 1970; CORREIA, 2008). However, the first industrial application of the Kraft process was only possible thanks to an important discovery by Carl F. Dahl in 1879, who discovered that the chemical waste resulting from the recovery of the chemical cooking in the soda pulping process could be offset by adding sodium sulfate to the boiler. The sulfate was then reduced to sulfite during the soda reduction phase of the recovery system. The sulfite was then recovered from the alkaline pulping liquor (KLEPPE, 1970; KLOCK et al., 2013).

The process involves the high-temperature high-pressure chemical digestion of wood chips in white liquor, which is an aqueous solution of sodium sulfide and sodium hydroxide. The solution chemically dissolves the lignin, which holds the cellulose fibers together (JUNIOR et al., 2008; KLOCK et al., 2013). According to Kleppe (1970), the main reasons for the success of the Kraft process are as follows:

- An efficient and economical chemical recovery process for pulping materials;
- All commercial timber species can be used in this process;
- The discovery of chlorine dioxide as a pulp bleaching agent, its efficient use in the Kraft pulping process, and inexpensive pulping methods;
- Kraft pulping produces high strength cardboard paper whose properties are superior to those manufactured by other processes.

A negative aspect of the Kraft process is the characteristic odor it produces, caused by the emission of reduced sulfur compounds generated by the delignification of wood in general (RECH, 2007; MARTINS, 2011). The most common of these compounds are hydrogen sulfide, methyl sulfide mercaptan and dimethyl sulfide mercaptan. Methyl sulfide and dimethyl sulfide mercaptan are formed in reactions with lignin. Dimethyl sulfide mercaptan gas is formed via the oxidation of lignin-derived mercaptan groups. These compounds are emitted from several points in a pulp mill, but the main sources of these gases are digesters and blow tanks, as well as direct contact evaporators (RECH, 2007; CORREIA, 2008).

## 2.1 Chemical Composition of Wood

According to Cardoso (2009), wood has a complex chemical structure. Its vegetable tissues are composed of several chemical constituents distributed unevenly throughout the anatomical structure, varying within the same species and even within the fibrous wall. The chemical constituents of wood consist of mineral matter, secondary constituents, cellulose, hemicellulose and lignin. Table 1 describes the composition of these materials according to species.

Table 1: Biomass composition

Biomass	Cellulose	Hemicellulose	Lignin	Extractives
Softwoods	45±2%	30±5%	20±4%	5±3%
Hardwoods	42±2%	27±2%	28±3%	3±2%
Grasses	37±2%	29±2%	19±2%	15±2%

## 2.2 Lignin: A Component of Wood

Lignin is one of the main constituents of wood, corresponding to an average of 15 to 35% of plant tissue. Its structure varies according to the nature of the wood group (Angiosperms or Gymnosperms), the plant's age (early or late wood), and the tree's growth conditions (normal wood or reaction wood) (CARDOSO, 2009).

Lignin strengthens the cell walls and helps transport water, and together with extractives, prevents degradation by protecting the tree against pathogens, insects and herbivores (HATFIELD & VERMERRIS, 2001; BRUYAN, 2009; FINGER 2015).

Lignin is a homogeneous, branched, amorphous and polyphenolic material that derives from the enzyme-mediated dehydrogenative polymerization of three phenylpropanoid monomers: p-coumaryl alcohol, coniferyl alcohol and sinapyl alcohol. These alcohols, also known as monolignols, have differences in the substituent groups of the aromatic ring and are the precursors of the units known as p-hydroxyphenyl (H), guaiacyl (G) and syringyl (S), respectively (LIN, 1992; SALIBA, 2001; BOERJAN et al., 2003).

According to Lin (1992) and Saliba (2001), the chemical structures of the precursors of lignin units behave as illustrated in Fig. 1.

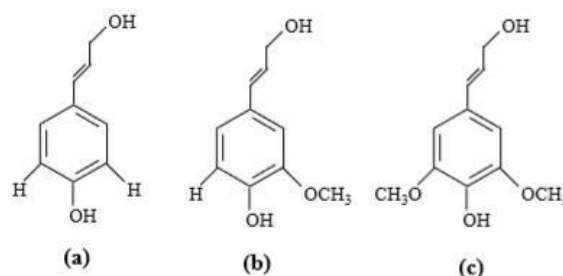


Fig. 1: chemical structure of the precursors of lignin units: (a) p-coumaryl alcohol, (b) coniferyl alcohol (c) sinapyl alcohol.

The dehydrogenative polymerization of monolignols causes them to bind to one another through C-C and R-O-R' bonds, forming a heterogeneous structure, as depicted in Figure 2 (PEREZ et al., 2002).

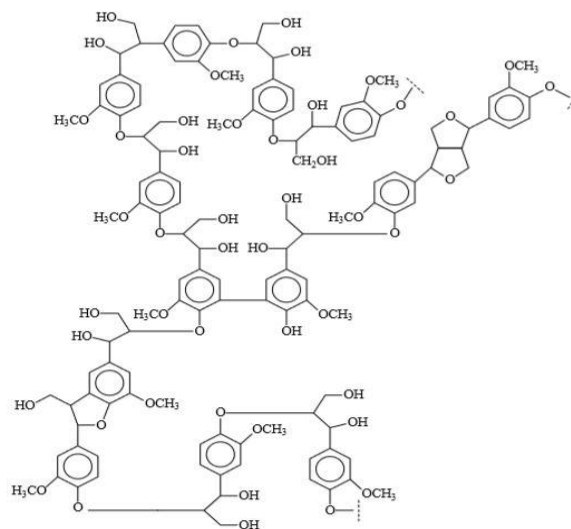


Fig. 2: part of a chemical structure of lignin.

The bonds between phenylpropane units and functional groups give lignin a unique and complex structure. The lignin macromolecule also contains a variety of functional groups that affect its reactivity (FAVARO, 2015).

The main functional groups of lignins are (ARGYROPOULOS et al., 2002; FROASS et al., 1996; KUKKOLA et al., 2004; SENAI, 2013; FAVARO, 2015):

- Methoxy groups (-O-CH<sub>3</sub>): the most characteristic functional group of lignin (92 to 96 units per 100 phenylpropane units [PPU]). Although hemicelluloses contain some methoxy groups, their content in wood comes almost entirely from lignin, corresponding to about 16% in softwoods and 22% in hardwoods. Hemicelluloses are responsible for the characteristic odor of Kraft pulping, originating from the formation of mercaptans.

- Hydroxyl groups (-OH): these groups may be phenolic or aliphatic. Only a small portion of them is free, since most of them bind to neighboring phenylpropane units.
- Free phenolic hydroxyl groups, corresponding to 15 to 30/100 PPU.
- Carbonyl (-C=O) and carboxyl (-COOH) groups, corresponding to 10 to 15/ 100 PPU.
- Ether groups (R-O-R'): may be aromatic or aliphatic.
- Double bonds (-C=C-).
- Ester groups (R-COO-R').

The main groups are illustrated in Fig. 3, which shows the lignin structure proposed by Casey in 1980.

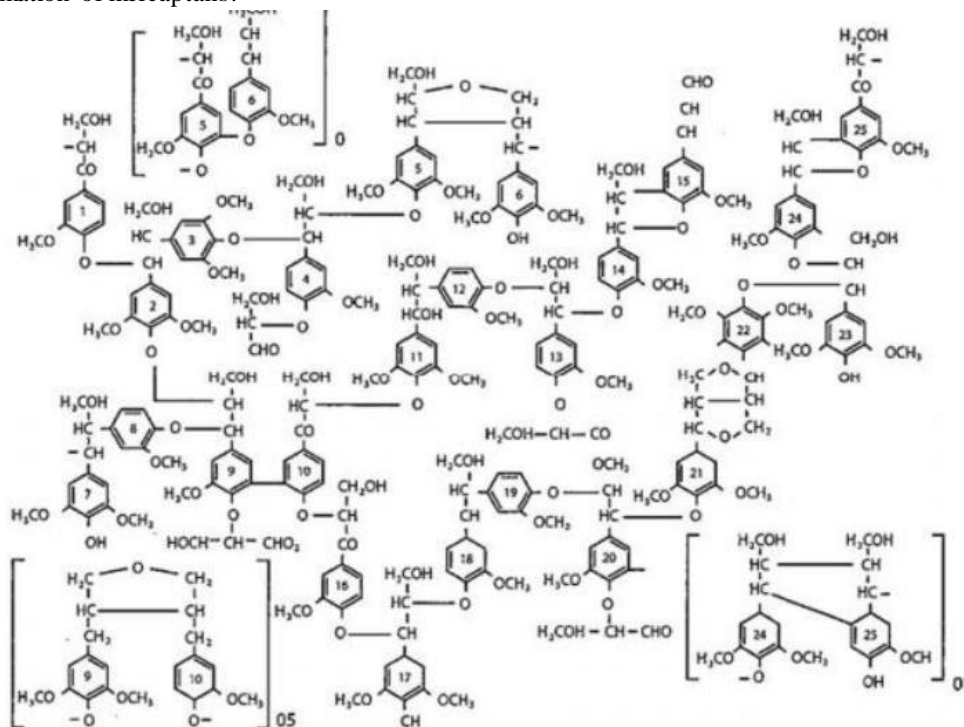


Fig 3: proposed structure of lignin.

### 2.3 Methoxy Groups

Lignin-rich woods and xylans tend to contain larger numbers of methoxy groups. Methoxys are present in greater number in hardwoods. They appear in the monomeric groups guaiacyl and syringyl, mostly in glucuronic acid, which is the xylan of hardwoods, and in hexuronic acids formed in Kraft digestion. Methoxys are precursors of the formation of mercaptan because they react with sulfur to form the methyl sulfide mercaptan compound (FOELKEL, 2013).

Lignins are formed from the three basic precursors mentioned earlier herein. The p-coumaryl compound does not contain methoxy, while coniferyl and synapyl

have 1 and 2 groups per mole, respectively. The methoxy group is considered a functional group characteristic of lignins and their derivatives, and it is extremely important to determine its content for the analysis of the macromolecule (MORAIS et al., 1992). Figure 4 illustrates the chemical structure of sinapyl alcohol (LIN, 1992; SALIBA, 2001).

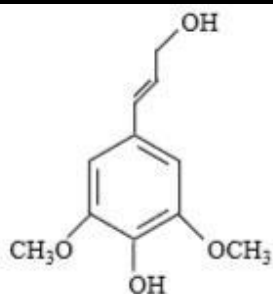


Fig. 4: chemical structure of sinapyl alcohol.

## 2.4 Formation of Mercaptans

According to Foelkel (2013), methyl sulfide mercaptan is formed through reactions between the methoxy groups from hardwood lignin and xylans. The reaction between these methoxys and the hydrosulfide ion ( $\text{HS}^-$ ) occurs when the ion begins to form as the pH level of the liquor decreases through the consumption of caustic soda by wood. Methyl sulfide mercaptan is the first mercaptan to be formed, when the pH level is still high. By becoming available in this environment, it can be converted into dimethyl sulfide mercaptan as the pH decreases and the number of hydrosulfide ions increases. Reactions between hydrosulfide ions and methyl sulfide mercaptan lead to the formation of dimethyl sulfide mercaptan, after which dimethyl disulfide mercaptan is formed through further reactions with the hydrosulfide.

According to Silva et al. (2001), due to their pronounced nucleophilicity, hydrosulfide ions divide the methoxy groups of lignin to form methyl sulfide mercaptan. This mercaptan is formed during Kraft cooking and is dissolved in black liquor in low concentrations. It is a weak acid that dissolves in aqueous media. It is also extremely fetid, even at low concentrations (RECH, 2007). Due to its highly unpleasant odor, which most humans can detect even at low concentrations (odor detectable starting at 0.0016 ppm), methanethiol is used to add odor to several hazardous odorless gases (MITCHELL, 2002). The main components of the Kraft odor are four gases: hydrosulfuric gas, methyl sulfide mercaptan, dimethyl sulfide mercaptan and dimethyl disulfide mercaptan. These are compounds of low molecular weight and low solubility in hot water, which spread easily through the atmosphere. These compounds are all measured together, but they can also be measured individually to determine their individual concentrations, and they form the set of reduced sulfur compounds (FOELKEL, 2013).

According to the Agency for Toxic Substances and Disease Registry (ATSDR, 1992) and Mitchell (2002), inhaling methyl sulfide mercaptan can lead to neurological disorders and death. However, the ATSDR provides no information about limits of concentration and

their consequences to health. Figure 5 illustrates the behavior of the molecule, according to Sixta et al. (2006).

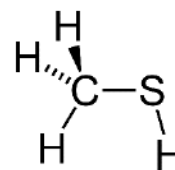


Fig. 5: methyl sulfide mercaptan molecule.

## 2.5 Pollutant Emissions

The sulfur compounds responsible for the odor characteristic of the Kraft process are formed in the reaction between hydrosulfide ions and the methoxy groups of lignin. Due to their strongly nucleophilic nature, hydrosulfide ions divide the methoxy groups to form methyl sulfide mercaptan and the corresponding catechol structure (Figure 4). Methanethiolate ions may separate the methoxy group to form dimethyl sulfide mercaptan or they may become oxidized, forming dimethyl disulfide mercaptan. The weakest nucleophiles are hydroxyl ions, whose reaction with the methoxy groups is negligible (GIERER, 1985; DA SILVA, 2001). Fig. 6 demonstrates, according to Gierer (1985), how divisions occur in a process also known as cleavage.

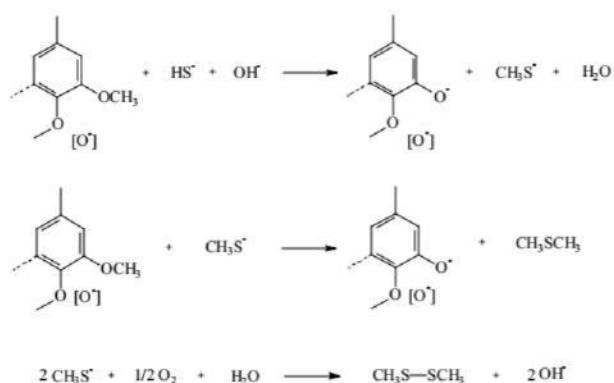


Fig. 6: division of methoxy groups of lignin, hydrosulfide ions and methanethiolate.

## 2.6 Ways to Prevent or Reduce the Production of Odor

The odor produced by Kraft pulp and paper mills is strongly influenced by two factors. Firstly, odors are not emitted from a single source but are generated at various locations in the manufacturing plant, and a change in the process may reduce the emissions from some of these sources but may also directly impact others. Secondly, the limits established for the odor emanating from hydrogen sulfide and methyl sulfide mercaptan are in the order of parts per billion (ppb), making it difficult to keep the ambient air concentrations consistently below these values in the proximities of these mills (RECH, 2007).

Foelkel (2013) states that, at low concentrations, the odor is not harmful to people's health, but it can become a source of discomfort or an offensive stench to those who live in the surroundings of pulp and paper mills. One way to reduce the generation of these gases is to use anthraquinone under optimized conditions of delignification. The use of anthraquinone increases the yield of pulp and improves its quality, in addition to reducing the emission of TRS (CARASCHI et al., 2005). TRS emissions can also be reduced through continuous attention to and correction of the pH levels of liquors containing sulfide ions. The pH level can be adjusted inside the digester, in the evaporation and at the entrance of the digester in the recovery boiler (FOELKEL, 2013).

### 2.7 Use of Anthraquinone in the Kraft Process

Anthraquinones are a class of compounds applied in the production of typical products via different manufacturing processes. These compounds are widely used in the industry, even in the field of cosmetics. Toxic contaminants may be present in some anthraquinone manufacturing processes, which may thus limit their approval by inspection agencies. Therefore, not anthraquinone, but the presence of contaminants is banned (FOELKEL, 2013).

According to Gomide and Oliveira (1979), Kraft pulping processes that use anthraquinone give rise to wood polysaccharide oxidation reactions and hydrolysis of the lignin ether bonds. This leads to oxidation of the reducing group of carbohydrates, stabilizing them against terminal depolymerization reactions, which in turn increases the yield because this stabilization protects the carbohydrates against degradation and solubilization reactions.

The research findings of Jerônimo et al. (2000) indicated that the use of anthraquinone improved delignification, thereby reducing sulfidity. According to their findings, soda-anthraquinone delignification yields slightly lower results, but offers a promising potential for manufacturing plants that generate odors which pose a serious problem. Silva et al. (2002) used anthraquinone in the eucalyptus kraft pulping process, and evaluated the impact caused by its use based on their results. According to these authors, the use of anthraquinone decreased the formation of TRS, reducing the formation of methyl sulfide mercaptan by up to 63%, and also retaining a larger content of xylans.

Starting at the beginning of this century, the most modern plants have been operating with much more high-tech digesters, as well as odor-free recovery boilers. As a result, the effects of anthraquinone have not been as significant as in plants that use older technology digesters operating above their design capacities and producing pronounced odors (which is no longer the case in state-of-

the-art digesters and recovery boilers). This new situation has led several older mills to still use anthraquinone as a pulping aid (with or without other reagents) (FOELKEL, 2013).

### III. CONCLUSION

As can be seen, the chemical components of wood are directly linked to the unpleasant odors generated in the Kraft process. These odors are produced by lignin, which not only interferes in the quality of the final product but also impacts the quality of the air around pulp mills, allied to the sulfur that is inserted into the process through sodium sulfide. This study emphasizes the importance of understanding the reactions that involve lignin constituents, such as the cleavage process of methoxy groups that leads to the formation of methyl sulfide mercaptan, one of the malodorous components of TRS. The offensive smell produced by the process is a particularity of each plant, as pointed out in this paper. The chemical components may vary in quantity from one tree to another, just as factories may operate with equipment using technologies that are more advanced than others, which in this case helps to minimize the odor, and also the daily operating conditions in general. Although several studies have focused on reducing the emission of these TRS gases using anthraquinone (AQ), and despite the claim by some authors that AQ is not a product harmful to human health, it is impossible to conclude that the product of the reaction between AQ and lignin is innocuous. Given the fact that the lignin structure is extremely complex and still largely unknown, several studies in this field are still being conducted.

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# The Perception of Leaderships On Governance In The Extractive Reserves Of The State Of Rondônia

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**Abstract**—Governance relies on a set of principles, rules and procedures that stakeholders (the ones interested in the results and performance of the organization) establish to optimize the management of organizations. It was developed a research of applied nature and quantitative approach, where bibliographical procedures and surveys were used to reach the descriptive goals. The proposal was developed, in the first stage, by constructing a theoretical framework on governance based on literature and based on institutional documents and regulations. It has been found that Disclosure is an obligation to inform or give transparency of the product of strategies, policies and processes, Accountability is essential in mandatory reports and also as an instrument of transparency of acts spontaneously, and Compliance, that states that managers must ensure for the sustainability of organizations, through the goal of sustainability. The research findings reflect a disturbing reality regarding the involvement of managers in regard of the importance of the information to extractivists, as well as the qualitative nature of the information provided by the institutions. In the observation, the highlighted concept was accountability.

**Keywords-** Extractive Reserves. Governance. Leadership.

## I. INTRODUCTION

The study of Governance has been developed as time passes and the need to seek evolution in the styles of government and administration within the state and federal spheres grows. In the Extractive Reserves of the State of Rondônia it would not be different, there is a great concern with the management, with the frequency of the accountability processes of the participants of the

reserves, with the demands by the communities and organizations on the effectiveness and quality of the practices and with the compliance with the laws, norms, and ethics of those who practice it.

Based on Machado (2012), governance is related to the ability and capacity of the government to develop efficiently and responsibly the management of resources and public policies; to make the government more open, accountable, transparent and democratic; as well as to promote mechanisms that allow the participation of society in the planning, decision and control of the actions that allow the reaching of the common good.

The achievement of effective governance in public entities is linked to fundamental steps such as: leadership, integrity and commitment, that is, personal qualities of everyone in the organization. The other three elements can be responsibility, integration and transparency, which characterize products of the strategies, systems, policies and processes established in the organization, according to Barret (2003).

Public sector governance addresses corporate governance principles, addressing disclosure, accountability, compliance, and fairness (SLOMSKI, 2011, p.132): Disclosure - Obligation to inform or provide transparency of the product of strategies, policies and processes. Fairness - Equity in government policies and actions, with the aim of achieving social welfare. Accountability - Essential in mandatory reports and also as an instrument of transparency of acts. Compliance - Managers must ensure the sustainability of organizations, through the vision of sustainability.

This study was motivated by the following question: what is the perception of the leaders of the

Extractive Reserves in the state of Rondônia on three principles of governance (disclosure, accountability and compliance) in the economic, organizational / cultural, social / cultural, ecological and environmental perspectives?

## II. THEORETICAL FRAMEWORK

In order to develop the research, a theoretical study was carried out on the concepts of: governance, extractive reserves in the State of Rondônia, the Governance processes within the extractive reserves and, finally, the study of endogenous development.

### 2.1 Governance

Governance is comprehended as a process whereby the Public Power, the private sector and the civil society search for sustainable alternatives for the implementation of Public Policies. Governance presupposes democracy, it is not an isolated action of civil society seeking greater spaces of participation and influence. On the contrary, this concept includes "the joint action of the state and society in the search for solutions and results for common problems" (VIEIRA, 2011, 22), but it is undeniable that the emergence of non-state actors is central to develop the idea and practice of governance.

Based on the Brazilian Corporate Governance Institute (2008), the relationship between ownership and management takes place through the board of directors, independent auditors and the fiscal council, which are fundamental instruments for the act of control. Good corporate governance ensures to the partners and members involved in the interests of the organization: equity, transparency, responsibility for the results (accountability) and obedience to the laws of the country (compliance).

In this subject, Andrade and Rossetti (2011) describe three principles of governance, which are:

**Accountability**: which is accountability in a responsible manner, based on best practices of social control, with responsibility to assume the consequences of their acts and of all the acts.

**Compliance**: which is compliance with the regulatory norms of the bylaws, internal regulations or legal institutions. It is the need for division of efforts between managers in the process of leading and directing the management and effective performance of the organization.

**Disclosure**: which is the transparency of the information that impacts the projects (RESEX) and which involves results, opportunities and risks. To act in a transparent way with the goal of to establishing a sensation of trust between internal and external publics.

The study of governance is quite vast and requires a great number of observations, however in order to have a theoretical basis and to carry out the application of the study, the concepts of governance applied to Extractive Reserves were discussed.

### 2.2 Extractive reserves in the state of Rondônia

Extractive Reserves were conceptualized in 1985, at the First National Meeting of Rubber Tappers, which sought a method of providing greater security to rubber tappers in the practice of their activities, which were threatened by the expansion of large pastures, deforestation and land speculation happening at the time. Being very similar to the Indian Reserves and also lands of the Federal Government, this nomenclature was defined so that the beneficiaries the members of the communities that already there could be better assured (MEMORIAL CHICO MENDES, 2017).

Based in the information given by the Grupo de Trabalho Amazônico (2008) in the state of Rondônia, there are twenty five extractive reserves, with a total of 1,705,257 hectares, which represents 7.15% (seven comma fifteen per cent) of State's surface. In the municipality of Machadinho do Oeste, there are several extractive reserves, with an area of approximately 161,210.90ha: Roxinho, Mogno, Angelim, Ipê, Castanheira, Freijó, Massaranduba, Maracatiara, Seringueira, Garrote, Piquiá, Itaúba, Jatobá, Sucupira, Aquariquara and Rio Preto Jacundá.

The Rio Cautário reserve is located in the municipalities of Costa Marques and Guajará-Mirim, with 146,400ha. The Pedras Negras reserve is located in the municipalities of São Francisco do Guaporé and Alta Floresta do Oeste, with an extension of about 124,408ha; the Curralinho reserve is located at Costa Marques with 1,757.65ha; the Rio Pacás Novos reserve located in Guajará-Mirim has 342,903,5029ha; and the Rio Jaci-Paraná reserve located in Porto Velho, Nova Mamoré and Buritis has 191,324.3118ha.

Besides of State's reservations, it is also located at the state of Rondônia four federal extractive reserves: the Rio Ouro Preto, Lago do Cuniã, the Barreiro das Antas and the Rio Cautário (GTA, 2008).

Although there are several extractive reserves at the state, there are still places like Rio Candeias, that have not been able to formalize the reserve, despite the interest of the local residents.

### 2.3 Governance in Extractive Reserves

Governance in Extractive Reserves refers to an idea of a territory that has managed to mobilize all the actors involved in the pursuit of sustainable development,

carrying out activities such as collective multi-sectoral actions, so that common rules can be designed to facilitate cooperation. This requires local regulations of local politicians' competence and responsibility. This idea of governance, therefore, imposes itself and refers to a more general problem that highlights the conditions capable of producing effective local action by limiting risks and perverting effects, anticipating unforeseen conflicts and facilitating engagement of local actors. These ideas make more and more sense as there are numerous interactions between public authorities, civil society and all technical actors and experts in conducting local affairs (DURAN, THOENIG, 1996).

Analyzing this reality in the Extractive Reserves shows that these governance actions are concretized through the realization of work that constitutes an opportunity for exchanges within the Deliberative Council and the engagement of its members. There may be three types of representatives individuals in this regard: politicians, civil society representatives and technicians and experts. These debates, then, are marked by the ambientization of local situations and by the change of the mode of production of public action (TEISSERENC, 2010).

Together with politicians lies the diversity and heterogeneity that are filled by the presence of representatives of local power and representatives of the Union within each extractive reserve; technicians are the representatives who have competence and degree of legitimacy to invest in the territory of the Reserve when they are needed; as for the representatives of the social movement, experience shows that one of the effects of the debates is to show the differences of points of view and interests according to the different sub-categories of actors represented.

For governance practices to be effective within extractive reserves, it is necessary for these three individuals to think in a similar way and to have common goals. The relationship between politicians and members of social movements is the main challenge, as politicians must take into account the use of land and the sustainable management of the natural resources of the territory and the benefit of the social movement, since local communities find it very difficult to recognize their right to the land and the management of their resources, as well as the recognition of their identity, which is the foundation of their citizenship.

With regard to the existing relationship between politicians and technicians and experts, is the search for the experiment of new tools and instruments, which are the diagnoses and plans of management elaborated through participatory processes with the intuition of local

actions that are capable of meeting the demands of sustainable development.

Regarding the representatives of the social movement and the technicians and experts, the great question is the support that the technicians and experts could provide to the movement, especially with regard to the defense of their new rights, with the valorization of their competencies and of their qualifications. This challenge calls into question the ability of technicians and experts to recognize the "social" competencies of the actors of the social movement and their willingness to contribute to the appreciation of the local knowledge and practices of these same actors (TEISSERENC, 2010).

The relationships that should exist in partnerships, as described above, end up being influenced negatively and do not happen. So to possibilitate the practice of governance in the extractive reserves, it was necessary to carry out a tripartite interactive work that demands capacities of the three categories of actors - politicians, experts and civil society - to cooperate, as described.

What defines territorial governance It is not only the existence of a Deliberative Council, but rather a set of new practices to which the functioning of the Council and its integration into the local institutional system will possibilitate. Governance is not the result of the works of a new institution that replace those that existed previously to contribute to the management of the territory. It is presented in the form of a set of practices among several actors concerned with promoting a collective capacity of government to face the fragmentation of the local system (Le Gals, 1995), renouncing connections that might exist between governors and governed, that were founded on practices to take advantage, to a new type of relationship that permanently combines issues of inclusion and exclusion. Nevers (1997) states that these practices, which are based on cooperation of work and coordination between local actors, may contribute not only to the renewal of local modes of production but as well as to the recognition and legitimation of the group of actors involved.

Another type of governance that is very relevant within Extractive Reserves is forest governance, which is considered appropriate by FAO (2011) if it is characterized by stakeholder participation, transparency in the decision-making process, accountability of social actors and respect for legislation and predictability of decision-making. In addition, there are aspects such as efficient and effective management of natural, human, financial resources and equitable allocation of resources and benefits that are essential to the success of governance practices.

In this same line of reasoning, FAO (2011) developed a framework motivated by the understanding that governance is the context and product of the interaction of a number of social actors and stakeholders with widely accepted interests in forest governance, since forest management is essential to combat climate change and the context provides alternatives for sustainable forest management to be properly implemented and managed.

#### 2.4 Development in the General Context and Leadership

The term "development", for a long time, was intrinsically linked to the idea of economic growth. Singer (1977) presents the current of scholars who defend or acknowledge the difference between growth and economic development. Growth, therefore, is seen as a process of quantitative expansion, more commonly observed in the relatively stable systems of industrialized countries, while development is a process of qualitative transformations of the economic systems of the underdeveloped countries. In this perspective, development would be the process of moving from one system to another, understanding the historical reality of the world economy. Another contribution to the analysis of economic development is attributed to Shumpeter (1988). This author comprehends the phenomenon of development in the contemporary phase through past development, understanding that the historical factor is a tool for understanding economic development, but, explains it without using the historical factors in a complete way.

Sachs (2000) suggests that the term development is isolated from its potential adjectives, since it has been "sliced" according to the discourses and interests of various currents of thought. In order to satisfy all the stakeholders, the term would always come accompanied by a set of qualities, such as "social-political-human-economic-cultural...". All together to clarify that the term "development" is multidimensional.

Sachs (2004) argues that, first of all, it is necessary to think globally and act locally, that is, to visualize problems of a global nature and to assess the impacts on local processes.

Silva (2005) conceptualizes sustainable development as a process of transformation that occurs harmoniously in the spatial, social, environmental, cultural and economic dimensions from the individual to the global. The society, for the author, is a complex adaptive system where economic and spatial transformations occur, and thus it is not possible to analyze the development process partially. He affirms that the changes are irreversible and continuous, extending the

responsibility of the society towards the present and future generations.

Endogenous development originated in the mid-1970s, when proposals for bottom-up development strongly emerged. From this point of view, a current of study was developed based on the collaboration of new approaches to the problem of unbalanced and unguided growth.

In 1990, the big question that permeated the endogenous development model was concentrated in trying to understand why the level of growth varied across regions and nations, even when provided with the same conditions in the pursuit of productive factors such as financial capital, hand labor or technology. The solution would be to try to find, among these factors, those determined within the region, it was then that endogenous regional development was defined as an internal process of continuous expansion of the capacity of aggregation of value on the production, as well as of the absorptive capacity of the region, whose unfolding is the retention of the economic surplus generated in the local economy and / or the attraction of surpluses from other regions. This process results in the expansion of employment, output, and local or regional income in a defined regional development model (AMARAL FILHO, 1996).

There are two dimensions of endogenous development: economic, in which the local business community uses its capacity to organize, as efficiently as possible, the productive factors of the region; and social-cultural, where values and local institutions serve as a basis for the development of the region (Vázquez Barquero, 1988).

The idea of endogenous development is based on the execution of policies to strengthen and qualify internal structures, always seeking the consolidation of an originally local development, creating social and economic conditions for the generation of new productive activities, within the perspective of an open economy (Amaral Filho, 1996).

The concept of leadership is another one that needs to be addressed so that the positioning of the extractive reserves leaders can be understood. Thus, strategic leadership can be defined as the ability to influence people in their decision making, voluntarily and routinely, being able to maintain financial stability and to increase the organization' long-term viability (Rowe, 2002). Another type of leadership that stands out is managerial leadership, that occurs when leaders adopt impersonal and passive attitudes toward goals that arise from need and are based on the origin of organizations

and are closely linked to the history and culture of the organization (Zaleznik, 1977).

Visionary leadership is directly linked to the authority that the leader has to influence the thinking and people's attitudes, ie the power to delegate at various dimensions, being more proactive, shaping ideas rather than opposing them, exerting influence in a way that determines the direction the organization should take. Visionary leaders work to improve choices and new approaches to old problems (Rowe, 2002).

These concepts are necessary for the comprehension of how development occurs in Extractive Reserves.

### III. METHODOLOGY

This research was based on the study of the management of Extractive Reserves, taking into consideration the reflection on the quality of community participation through the use of governance indicators and of the search for understanding of relationships built between communities of extractive reserves and the other governmental and non- governmental institutions. It was characterized as a quantitative research because it was developed within the natural environment of the researched ones, with interpretation of the observed phenomena and attribution of meanings through a numerical scale (GIL, 2008).

Regarding the procedures, this research was characterized as a case study, due to the collection and analysis of information regarding the extractive reserves. Regarding the aim, it is a descriptive research, since records and describes the facts what were observed without interfering on them. It is a study of applied nature, for producing data, generating a product and result.

The readings on governance in extractive reserves of the State of Rondônia were based on observational perspective with the goal of improving the local players in the aspects of: frequency of accountability (managers and controllers) to the other participants of the reserves on the results of the accorded goals (support and scope); frequency of collection and demand by communities and organizations on the effectiveness and quality of practices; and frequency of collection and demand by communities and organizations on compliance with laws, standards and ethics of practitioners.

Initially, documentary analysis of official sources were held. Then, testimony from community leaders, managers, technicians and researchers directly involved in the implementation and management of extractive reserves of the State of Rondônia were collected.

### IV. ANALYSIS AND DISCUSSION OF RESULTS

The reading about governance in the extractive reserves of the State of Rondônia was reflected from an observational perspective, favoring the possibility of improving the local performance from the following aspects: frequency of accountability (managers and controllers) to the other participants in the reserves, on the results of the committed goals (support and scope); frequency of collection and demand by communities and organizations on the effectiveness and quality of practices; and frequency of collection and demand by communities and organizations on compliance with laws, standards and ethics of practitioners.

The occurrence on practices on the probability scale was described as high (9 and 10 points), moderate high (7 and 8), moderate (5 and 6), moderate low (3 and 4) and low (0-2). Evidences from the official documents and testimonies of community leaders, managers, technicians and researchers directly involved in the execution and management of extractive reserves in the State of Rondônia were used as a basis. The analysis does not exhaust the discussion; on the contrary, it raises it, emphasizing, simply, the need for more in-depth studies.

Chart 1 – Perception of Leaderships

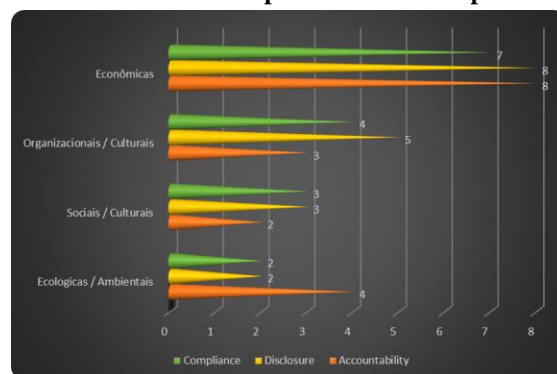


Fig. 1: Perception of Leaderships

According to chart 1, on economic perception, disclosure and accountability are highlighted, in view of the organization in the associations and cooperatives, bringing positive results to the extractivists and their representatives (presidents of the cooperatives), showing transparency in the process of the sale of the extraction. With this, compliance stands out in regard of fulfilling the established standards. In the organizational / cultural perception, the disclosure stands out by the normatization of the extractive reserves documents, then the compliance. It was noticed that the extractivists have notion of the documents that govern the extractive reserve, however, there is no clarity that is a concession of use.

On the Social / cultural perception, compliance and disclosure are highlighted. The extractivists are aware of the rights to the education and health service, as well as cultural activities, but in the matter of transparency in the accountability of actions, it is clear the lack of support. Finally, in ecological and environmental perceptions, the extractivists suffer from the invasions of the loggers, Indians and Bolivians, who, in a way, bring damage to the environment, as well as the lack of structure (toilets, garbage collection) that strongly influences the result.

The extractive reserve communities created grassroots associations and brought together families around common interests and, despite the difficulties, achieved relative success in the process of changing the situation of inequality and social exclusion. The research showed that in the extractive reserves of the State of Rondônia there is dissatisfaction among community dwellers regarding the accountability of the results of ecological / environmental and social / cultural goals traced and moderate satisfaction with organizational / cultural goals.

## V. CONCLUSION

With the accomplishment of the research, it is observed the capacity of the population of extractive reserves to gain relevance due the interest on being perceived and valued by the external and internal agents. If, on the one hand, they receive support from public and private entities, on the other hand, it should be emphasized that the endogenous development of communities correlates with their power to decide what they want. Such change can only take place in two ways: local action and institutional action that contribute favorably to effective democratic participation in decision-making spaces.

It is noticed that the governance in the extractive reserve is compromised due to the alteration of documents (natural limit), the farmers disregarding the demarcation and the very existence of the extractive reserve. The Zoning and Management Plan is elaborated and financed by private companies and the lack of compliance with environmental licensing contributes to this fragility.

This study was able to conduct a survey of how those involved in the Extractive Reserves development process are feeling and how management is working, thus leaving as a suggestion for future research the realization of a strategic plan aimed at changing these scenarios and that can be implemented to meet the needs of rubber tappers.

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# Workplace Safety Culture Model [WSCM]: Presentation and Validation

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**Abstract**— *The literature on Workplace Safety Culture (WSC) has evolved in the conceptual dimension in a movement away from technical aspects toward more human aspects, but remains incipient regarding the creation of measurement instruments and quantitative evaluation with a totality of technological, organisational and human factors. To fill this gap, this article presents and validates the Workplace Safety Culture Model (WSCM) applied in a survey, with a total of 1196 operational employees of six factories, from metallurgical sector. To validate the WSCM, the statistical procedure Exploratory Factor Analysis (EFA) was used to reduce the set of variables to a lower number of factors to characterize the attribute dimensions of the object in question. The results presents a reduced version of the proposed model, distributed in ten factors: Leadership, Commitment, Pressure at Work, Infrastructure, Learning, Efficiency, Management System, Feedback, Responsibility, and Communication. The results of the EFA produced a factor structure with relatively higher loads on the appropriate factors. The WSCM offers us a robust tool to analyze an organization's WSC maturity. For the methodological improvement of the model, we suggest future research with diverse cultural contexts.*

**Keywords**— *Organizational Culture, Safety Culture, Workplace Safety Culture.*

## I. INTRODUCTION

The concept of Safety Culture (SC) has been studied in the last 25 years by many researchers from different academic fields. In these studies, we identified two distinct perspectives: the engineering approach, which focuses mainly on the formal aspects that influence business security (procedures, managerial systems, controls and policies), and a psychological approach, which focuses on the perceptions, feelings and attitudes of employees (Antonsen, 2009).

These two SC approaches are reflected in studies on Workplace Safety (WS), in which we identified parallel managerial practices that hinder the integration of Risk Management and Behavioral Sciences (Douglas

& Wildavsky, 1983; Maguire & Hardy, 2013; Hardy & Maguire, 2016).

In this sense, in the last two decades, some researchers have found that WS problems are often not only associated with technical issues (Sneed & Henroid, 2007; Taylor, 2011). Past studies have indicated that when there is a shortcoming of understanding the value of safety and its priority within the workplace, then unsafe behavior that leads to 80-90% of accidents will likely be the result. Then, organizations are now focusing on the relevant human factors which contribute to workplace safety (Clarke, 2013; Jiang & Probst, 2016; Mullen *et al.*, 2017). Studies have demonstrated that even employees with technical knowledge of WS sometimes show behaviors that are inconsistent with the safety standards required by companies (Henroid & Sneed, 2004; Sneed & Henroid, 2007).

Based on these conclusions, some researchers have examined more closely the importance of the concepts of organizational culture and the role of intangible variables for the management of safe human behavior (Lee *et al.*, 2012).

Nevertheless, if on the one hand the literature on the theme has evolved in the conceptual dimension, it remains incipient regarding the creation of quantitative instruments for measuring and evaluating WSC that reinforce the importance to address the concept 'safety culture', with a comprehensive approach, where technological, organizational and human aspects are included. (Van Nunen *et al.*, 2018; Seo *et al.*, 2004; Seo, 2005; Reiman & Rollenhagen, 2014). To bridge this gap, this article proposes a quantitative model to measure Workplace Safety Culture (WSC), the Workplace Safety Culture Model (WSCM). The aim is to validate the instrument in order to evaluate the contribution of each construct (dimensions, indicators and variables) to explain the proposed model, applying it to the metallurgical sector.

The article is divided into six parts in addition to this introduction. In the following section, the theoretical framework is presented, relating Organizational Culture (OC) with Safety Culture (SC), Workplace Safety (WS)

and Workplace Safety Culture (WSC). In the third part, the methodology of the work is presented, describing the WSCM, its validation and application. In the fourth part, the results of the empirical research are presented and analyzed. In the fifth section, the limitations of the WSCM are discussed. In the last section, the final considerations regarding the benefits of applying the WSCM to companies are given, along with suggestions for future research in the field.

## II. THEORETICAL FRAMEWORK

### Organizational Culture (OC)

In the history of the concept of organizational culture (OC), three distinct periods can be identified (Barbosa, 2010). In the sixties, the concept of OC was correlated with the movement of organizational development and the humanistic conception of organizational values. At the time, OC was perceived as an instrument for improving companies, but there was little interest in treating it as a competitive advantage. In the eighties, studies of Japanese companies showed the relevance of OC in the economic and business environment. In those days, epistemological discussions took place on the nature of OC, in a pragmatic and substantive dimension, in an attempt to transform the concept of OC into a variable of managerial strategy and competitiveness. Yet, new models of organizational theory and strategy design emerged (Bourantas *et al.*, 1990). Researchers began to investigate values, creeds, rituals, customs and other variables that appeared to influence organizational performance. In the mid-nineties, OC came to be understood and studied as an intangible asset of firms and was associated with the role of leadership (Schein, 1992:13). A definition to provide an understanding of OC and the role of the leader may be described as: "*A pattern of shared basic assumptions that was learned by a group as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems*".

Three fundamental levels can be distinguished at which OC is manifested (Schein, 1992): visible artifacts, espoused beliefs and values and basic underlying assumptions. When a new employee begins working at a company, the first thing he observes is the artifacts: layout, architecture, the way people dress and how they greet and relate to each other. At the second level of OC, we have the values that govern attitudes and behaviors and help us to understand why members of an organization act the way they do. Finally, at the third level, unconscious and invisible, taken-for-granted assumptions determine how the members act, feel, think and perceive the company. These are unconscious beliefs

that are considered natural, premises that govern the actions, behavior and reasons for the acts of the members of the company.

### Safety Culture (SC): concepts

The term Safety Culture (SC) emerged in the wake of the Chernobyl disaster in 1986, and has been used ever since by numerous industries to describe the 'security status' of a company (Flin, 2007). It is characterized by complexity, challenging content-wise, and has become one of the most popular safety concepts (Van Nunen *et al.*, 2017; Fleming *et al.*, 2018).

Most definitions of SC mention the way people think or behave in relation to shared values, attitudes, perceptions and beliefs with regard to safety and reflect a view whereby safety culture is something that characterizes a company, rather than something that it possesses (Cox & Cox, 1991; Hale, 2000; Fang *et al.*, 2006).

Several researchers (Hofstede, 1991; Johnson & Scholes, 1999; Cooper, 2000; Guldenmund, 2010; Nielsen, 2014) have used the three-level model (Schein, 1992) to understand SC and explain the factors that influence it (Sorensen, 2002). Others have sought to clarify the relationship between SC and safety climate (Glendon & Stanton, 2000). They address how basic assumptions are manifested in beliefs and artifacts and observed behaviors and represent what is internalized by members of a company (Johnson & Scholes, 1999). They argue that basic assumptions are reflected in the policies, structures, monitoring systems and organizational management. They use the concepts of Social Cognitive Theory to explain SC (Cooper, 2000), creating equivalence for the three-level model (Schein, 1992).

Finally, two authors from this decade made great contributions towards aligning the three-level OC model (Schein, 1992) and SC: Guldenmund (2010) and Nielsen (2014). The artifact level is related to safety communiques, slogans and messages, documents, audit and accident reports, work procedures and dress codes with regard to safety equipment (Guldenmund, 2010). Visible artifacts are manifested in behavioral indicators, structural conditions and results of safety climate research, represented by the expectations and actions of supervisors (Nielsen, 2014).

Shared values can be identified in implicit messages from the leadership prioritizing safety over productivity and in the attitudes of employees regarding safe practices, shared responsibilities concerning risk prevention and safety communications (Guldenmund, 2010; Nielsen, 2014). Finally, basic assumptions are manifested in the shared beliefs of the members of the company concerning what is and what is not safe and acceptable risk behavior.

Based on the models of Guldenmund (2010) and Nielsen (2014)



Fig.1: OC model of Schein (1992) applied to SC

Source: The authors

**Safety Culture (SC): measurement tools and maturity**

According to Fleming *et al.*, (2018:3) “Safety culture is a prevalent construct in industrial safety management and arguably one of the most important developments in industrial safety in recent history.”

Safety Culture (SC) studies have been conducted in different fields of knowledge, including organizational psychology (Wallace & Chen, 2006; Christian *et al.*, 2009), risk management (Smith *et al.*, 2006), people management (Wiegmann *et al.*, 2004) and engineering (Varonen & Mattila, 2000). Furthermore, they have been conducted in different industrial sectors, such as manufacturing (Cooper & Finley, 2013; Zohar & Luria, 2003), construction (Biggs *et al.*, 2010), health (Gaba *et al.*, 2003), oil and gas (Mearns *et al.*, 1998) and aviation (McDonald *et al.*, 2000; Gibbons *et al.*, 2006).

In those studies, we observed that the terms safety culture or climate are used at random. Some authors believe that

there is no difference between the constructs (Guldenmund, 2000; Lee & Harrison, 2000), while others view safety climate as a sub-concept of safety culture (Zohar, 2000; Cooper, 2000; Glendon & Stanton, 2000; Neal *et al.*, 2000).

Despite these conceptual differences, which will not be examined in-depth in this article, most authors use survey style techniques to identify and assess employees’ perceptions regarding organizational issues, changing only the indicators, factors and variables that are evaluated considering that the core of the safety culture construct is about proactively managing safety (Cooper, 2016; Fleming *et al.*, 2018).

In this sense, in Table 1 we list important tools for measuring SC that have been developed since the eighties.

Table.1: SC Measurement Tools

Authors	SC Measurement Tools
Zohar (1980)	Multilevel Safety Climate Scale
Cox & Cox (1991)	Cox & Cox Questionnaire
Glendon <i>et al.</i> (1994)	Safety Climate Questionnaire
DuPont Sustainable Solutions (1995)	DuPont Safety Perception Survey-DuPont Bradley Curve
Diaz & Cabrera (1997)	Safety Climate Questionnaire
Reason (1997)	Safety Culture Model
Cooper (2000)	Reciprocal Safety Culture Model
Mearns <i>et al.</i> (2001)	Offshore Safety Questionnaire
Singer <i>et al.</i> (2003)	Stanford Tool

Carder & Ragan (2003)	Minnesota Safety Perception Survey
Silva et. al.(2004)	Organizational and Safety Climate Inventory
Health and Safety Executive HSE (2005)	Safety Culture Model
Fang et. al. (2006)	Safety Climate Questionnaire
Parker et.al.(2006)	Development Levels for Safety Culture Maturity
(TC)/Railway Association of Canada (RAC) (2007)	Safety Culture Model
Clark (2010)	Clarke's Model of Safety Culture
Chen & Li (2010)	Hospital Survey on Patient Safety Culture
Fleming &Scott (2013)	Safety Culture Model
Morrow et.al. (2014)	Safety Culture Model
El-nagaret al. (2015)	Safety Performance Index

Source: The authors

The theoretical framework shows that Workplace Safety Culture (WSC) seeks to adapt the concepts of OC and SC to WSC practices (Lee *et al.*, 2012). Most of the tools in Table 1 served as a basis for constructing instruments applied to WSC.

In the academic literature, several authors have sought to conduct studies of WSC measuring: (i) safety policies, strategies, and procedures designed to control the risks that may affect employees safety (Carder & Ragan, 2003), (ii) the existence of a written declaration reflecting the organization's commitment to safety (Mearns *et al.*, 2003); (iii) the extent to which the firm encourages its workers to participate in activities relating to their safety (Vredenburg, 2002); (iv) the existence of training plans to develop employee competences and skills in safety (Grote & Künzler, 2000); (v) the transfer of information to employees about the possible risks in the workplace and the correct way to combat them (Cox & Cheyne, 2000); (vi) the existence of procedures to evaluate the risks and establish the necessary safety measures for avoiding accidents and the existence of an organized plan in case of emergency (Wu *et al.*, 2008); (vii) the extent to which the firm's managers are committed to their workers' safety (Rundmo & Hale, 2003); (viii) the degree of workers' compliance with the safety procedures and the extent to which they participate in improving working conditions (Cox & Cox, 1991); (ix) safety performance in terms of: number of personal injuries; material damage; employees' motivation; and absenteeism or lost time (DeJoy *et al.*, 2004).

The lack of consensus in the definition of SC and the different priorities imposed by the organizations explain the difficulties of developing a unified model of

measurement. (Fleming *et al.*, 2018) Many safety theories and models coexist today, with different dimensions and factors of SC and WSC measuring.

Through a comprehensive literature review we identified several important safety performance indicators.

Most SC models have common factors and dimensions, but it is not possible to state that there is a correct model. It is imperative to select the model that best fits the sector or organization. There is a consensus that WS models must be multidimensional, but it is not specified exactly what dimensions these models should comprise. (Fleming & Wentzell, 2008).

In health care industries for example, Colla *et al.*, (2005) identified in Patient SC (PSC) models five common dimensions: leadership, policies and procedures, staffing, communication, and reporting. Some PSC models include different dimensions such as learning, blame orientation (Cooper, 2000; Hofmann & Mark, 2006) and job satisfaction (Sexton *et al.*, 2006).

Reviews by Flinet *et al.* (2000) and Guldenmund (2000) covered in attitude questionnaires, identified that the number of dimensions varied from two to 19 range, focusing on five common dimensions: management, safety systems, risk, work pressure, and competence.

The human side of safety and the importance of human factors in accident causation is seen as a key factor to improve safety performance (Hale, 2000). Therefore, behavioral dimensions as leadership, commitment, teamwork, feedback, work pressure, learning, responsibility and communication were included in the majority of the WSC models.

Table 2 shows some recent SC models and their respective dimensions and factors:

Table.2: SC Dimensions and factors

Authors	SC models: dimensions and factors
Aksom & Hadikusumo (2008)	(a) worker involvement, (b) safety prevention and control system, (c) safety arrangement, and (d) management commitment.
Anderson (2009)	(a) managers' prioritization of safety, (b) safety communication, (c) individual risk

	assessment,(d) supportive environment and (e) safety rules and procedures.
Chen & Li. (2010)	(a) Supervisor/manager expectations and actions promoting safety, (b) Organizational learning-continuous improvement, (c) Teamwork within units, (d) Communication openness,(e) Feedback and communication about error ,(f) Non punitive response to error ,(g) Staffing,(h) Hospital management support for patient safety,(i) Teamwork across hospital units ,(j) Hospital handoffs and transitions (k) Overall perceptions of safety (l) Frequency of event reporting.
Halligan & Zecevic (2011)	(a) leadership and commitment to safety, (b) open communication founded on trust, (c) organizational learning, (d) a non-punitive approach to adverse event reporting and analysis, (e) teamwork, and (f) shared belief in the importance of safety.
Ismail & Ismail (2012)	(a) leadership,(b)organizational commitment,(c) management commitment, (d)safety training and (e)resource allocation.
Fleming & Scott (2013)	(a) leadership, (b) safety integration, (c) accountability, (d) resiliency, and (e) learning and Safety values.
Cooper & Finley (2013)	(a)management/supervision, (b)safety systems, (c)risk, (d)work pressure, (e) competence, and (f) procedures/rules.
El-nagaret <i>al.</i> (2015)	(a) worker factors (employee risk-taking behavior and compliance to safety rules and procedures: beliefs, attitudes and perceptions of responsibility and control); workers' relationship with or the behavior toward fellow crew members, the supervisor, and the employing firm; (b) environmental factors (physical space, the working procedure, tools and methods used and resources available); (c) organizational factors (application of safety rules, safety education/training, commitment, the perception of formal and informal organizational policies, practices, and procedures , combination of reward and punishment; communication and feedback, employee's involvement and employee empowerment).

Source: The authors

By embracing a behavior-based system, DuPont (DuPont, 2019) initiated a survey to determine why one plant site performs better than other. With the support of safety consulting professions DuPont develop the Safety Perception Survey (Stewart,1999) to evaluate employees' perceptions of their safety program. The survey consists of 24 multiple-choice questions that measure and organization's SC across three dimensions: leadership, structure, and processes and actions. The results from the survey are plotted on the DuPont Bradley Curve, a model with four maturity stages (reactive, dependent, independent and interdependent) to track the evolution of their SC (DuPont, 2019).

Fleming (2001) considered that the maturity model concept was appropriate to safety culture management within the offshore oil and gas industry and develop the Safety Culture Maturity Model (SCMM) to assist organizations in establishing their current level of safety culture maturity and identifying the actions required to improve their culture. According to the author: "*Cultural or behavioral approaches to safety improvement are at their most effective when the technical and systems aspects of safety are performing adequately and the majority of accidents appear to be due to behavioral or cultural factors*" (Fleming, 2001:4).

Cooper (2016) revised his famous Reciprocal Safety Culture Model (Cooper,2000) and claimed that safety culture assessments would be much better served by combining the results of situational safety management system audits, behavioral sampling efforts and the results of safety climate surveys to produce an overall average score for a facility/organization. According to Cooper (2016): "*Safety Culture Maturity models could be used as a de facto measure of the safety culture product as they primarily focus on what organizations do*" (Cooper,2016:25).

### III. METHODOLOGY

In this third part, the methodology of the work, the **Workplace Safety Culture Model (WSCM)** is described and validated (face validity, semantic and Exploratory Factor Analysis). Its application at six companies in the metallurgical sector is also described.

#### **Workplace Safety Culture Model (WSCM)**

The proposed Workplace Safety Culture Model (WSCM) is founded on recent studies of SC and WSC. Its theoretical premises are that: (i) WSC affects safety behavior; (ii) employee commitment and support from the leadership regarding safety issues affect safety outcomes; (iii) individual attitudes to safety influence safety

behavior; (iv) perceptions of safety management systems influence safety behaviors; (v) the climate at work defines the directives for individual behavior; (vi) improvements in behavior and workplace safety are ambitious goals and mere training is probably not sufficient to induce significant effects; (vii) the organizational communication style and its frequency are important factors in the cognitive perception of employees; (viii) the introduction of improvements to internal safety indicators of companies changes their accident rates, improving performance in terms of safety; and (ix) the safety climate affects safety performance, with the knowledge and motivation of employees as mediators in this process.

The proposed WSCM has eleven dimensions (Learning, Feedback, Leadership, Management System, Communication, Commitment, Pressure at work, Responsibility, Infrastructure, Efficiency and Teamwork), as described in Table 3. They encompass the main aspects of WSC. The dimensions, indicators and variables used to compose the WSCM can be identified in the SC and WSC models in the organizational literature and are summarized in Table 3. Even so, the construct of the WSCM is completely original and guarantees the distinctiveness of the tool.

Table.3: Concept of the WSCM Dimensions

Dimension	Concept
Learning	The ability of an organization to learn from its mistakes. Investigations of WS incidents and incidents should prioritize learning and process improvement, and avoid focusing on finding guilty.
Feedback	The results of the evaluations of the suggestions are communicated formally. A formal acknowledgment is made to the author of the suggestions chosen for implementation. The feedback should be of daily use.
Efficiency	Indicators, goals and results should be known to all. Managers continuously guide behavioral changes that impair WS.
Pressure at Work	Excessive demands for results that negatively affect WS practices. Limited time to comply with standard procedures. Lack of leadership support and hostile work environment.
Infrastructure	Assesses the availability of resources such as accessible and adequate installations, equipment, supplies and high quality training in workplace safety.
Management System	Aims to provide systems for the management of activities, policies and procedures to identify critical control points for the execution of WS practices, with regular and thorough inspections to gauge employees' compliance in their activities. Evaluates the level of standardization to avoid system. The balance between individual risk-aware and rule-compliant, to meet the need for concurrent standardization and flexibility required in organization.
Responsibility	Evaluates the role of the owner in care over WS. Emphasizes the importance of WS, taking disciplinary measures to maintain procedures. Promoting a vision of responsibility for each person in choosing safer practices.
Leadership	WS seen as a non-negotiable value. Leadership clearly defines organizational expectations. Their behaviors in WS actions are exemplary. It inspires confidence and is considered a model.
Teamwork	Assesses the degree of collaboration and mutual respect among employees to ensure WS. Initiatives and decisions that encourage cooperation between organizational areas for safer performance in practice.
Communication	Assesses the existence of a communication plan that aids the quality of the transfer of information and knowledge of WS between managers and employees. How, when and what to communicate regarding safety issues to employees. Employees are encouraged to speak freely about any subject that might affect WS.
Commitment	Assesses the use of positive (recognition) and negative (punishment) reinforcement tools for employees engaged in, and committed to, WS behaviors and improving WS outcomes. Pride in working safely.

Source: The authors

To facilitate their operationalization, these dimensions were subdivided into indicators, with their respective

variables, constituting a construct, bearing in mind that a construct is a tool that helps to measure a concept or a

variable that cannot be measured directly (Fuchs, 2009).  
In turn, the indicators represent the indices that promote

the understanding of the level of internalization of the  
value of WS in a company.

Table.4: Dimensions, Indicators and Variables of the WSCMI

Dimension	Indicators	Variables	Authors
Learning	Learning	Accident investigations are used to identify flaws in WS systems, rather than guilty.	Jahn, (2016)Reason, (1998), Anderson (2005),Grote &Künzler (2000)
	Learning	The causes of accident occurrences are used to learn and improve WS systems.	(2000)
	Information	Employees receive information on the causes of accidents at work.	Cooper (2016), Chen & Li. (2010)
Feedback	Feedback	Managers give feedback to those involved when work-related accidents occur.	Cox & Jones, (2006), Burke&Signal (2010), El-nagaret al. (2015)
	Dialogue	Managers accept suggestions from employees to improve WS.	
	Enhancement	Good suggestions for improving WS are implemented.	
	Investigations	After the occurrence of accidents appropriate recommendations are implemented.	
Efficiency	Suggestions	Managers encourage employees to give suggestions to improve WS practices.	
	Metrics	Indicators are adequate to identify and measure WS nonconformities.	Carder & Ragan (2003), Vredenburgh (2002), Cooper & Finley (2013)
	Metrics	The indicators are known to employees.	
	KPIs Goals	The employees know the goals and the monthly results of the WS indicators.	
Work Pressure	Orientation	Managers guide when they observe behaviors harming WS.	
	Volume of activities	The charge for productivity does not interfere with WS rules and procedures.	Noroozi (2013) Singer et al. (2003); Mearns et al. (2001); Clarke (2010); Chen & Li (2010); Diaz & Cabrera (1997);Cooper & Finley (2013), Cooper (2016)
	Pressure at work	If there is pressure for results, this does not affect the employees' WS practices.	
	Pressure over deadlines	The time required to perform activities with WS is sufficient.	
Infrastructure	Dimensioning professionals	The number of employees is adequate to carry out activities with WS.	
	Orientation	Collaborators know the purpose of Personal Protective Equipment (PPE) before they start their work.	Grote &Künzler (2000), Singer et al.(2003); Fang et al. (2006); Clarke (2010); Silva et al.(2004); Chen & Li (2010)
	Processes	There is strict control over the use of PPE.	
	Training	Employees receive WS training at least every two years.	
Management System	Equipment	Personal Protective Equipment (PPE) is always available to support the work.	
	Management systems	Managers apply disciplinary measures when employees do not follow WS rules.	Glendon&Stanton (2000),Guo& Yiu (2015), Anderson (2005), Tzannatos&Kokotos (2009), Cooper & Finley (2013), Cooper (2016).
	Autonomy	Employees may refuse to continue work if they believe this may affect WS.	
	Reports	Employees consider it important to report a security error of a colleague.	
Responsibility	Reports	The reported accidents are analyzed by the company.	
	Refuse	Collaborators have the autonomy to interrupt a work.	
	Recognition	Managers recognize when they observe work according to WS standards.	Anderson,(2005),Griffin & Neal (2000),Huang et al.(2006),Vredenburgh(20
lity	Errors	Managers treat WS errors reported as a learning	

		opportunity.	02),DeJoyet <i>et al.</i> , (2004).
Leadership	Model	Leaders are considered role models.	Burke & Signal (2010),Wu
	Trust	Leaders reinforce that WS is a non-negotiable value.	<i>et al.</i> (2008), El-nagaret <i>al.</i>
	Orientation	Leaders implement corrective actions immediately after learning that some unsecured practice has been performed.	(2015),Cheyneet <i>al.</i> ,
	Walk the talk		(2002),Clarke
	Recognition	Leaders are often seen in the operational areas.	(2013);O'Connor&Carlson
	Priority	Leaders recognize and celebrate the achievements in WS. Leaders consider WS a priority.	, (2016).
Teamwork	Collaboration	Employees assist colleagues in avoiding work-related accidents.	Grote & Künzler (2000),
	Help	Managers encourage employees to help colleagues to avoid work-related accidents.	Guo & Yiu (2015),
	Proactivity	The managers act to solve problems that could harm WS. Employees are alert to the safety of colleagues and interfere whenever necessary.	DeJoyet <i>et al.</i> (2004), Chen
	Trust		& Li (2010).
Communi- cation	Quality	Managers keep employees up-to-date on WS rules, procedures and practices.	Glendonet <i>al.</i> , (1994);
	Content	Employees can talk freely with managers about issues that are affecting WS practices.	Cox &Cheyne (2000);
	Rules	Information on WS rules and procedures is available.	Glendon& Stanton (2000);
	Information	Employees receive information on the causes of occupational accidents.	Neal <i>et al.</i> (2000);
	Communi- cation	Internal communication (posters, banners, internet etc.) about WS is present in all areas.	Anderson (2009);Fleming
	DDS	Communication over WS is performed in the Daily Safety Dialogues (DDS).	(2001); Mearns
	Goals	The managers inform the collaborators the goals and indicators of WS.	<i>etal.</i> (2003); Rudmo&
Commitment	Recognition	Managers recognize when they observe work according to WS standards.	Hale(2003); Dejoyet
	Learning	Managers treat WS errors reported as a learning opportunity.	<i>al.</i> (2004); Eket <i>al.</i> (2007);
	Security error	Employees consider it important to report a security error of a colleague.	Cooper (2016).
	Report	The reported accidents are analysed by the company.	Cox & Cheyne (2000);
	Autonomy	Collaborators have the autonomy to interrupt a work.	Rundmo& Hale (2003);

Source: Prepared by the authors

### Semantic Validation of the WSCM

To validate the content of the dimensions, 265 employees participate of 26 workshops, and 36 interviews were conducted with participants from different hierarchical levels of six organizations in metallurgical sector. The workshops and individual interviews were intended to obtain real-life stories on WS that illustrated day-to-day work. After a brief reflection on the meaning of each of the eleven dimensions, during the workshops, each group, with ten participants, had 20 minutes to tell a story of something that strengthened the WS practices and behaviors at their company. In the case of the interviews, the script with the dimensions was presented

a week beforehand for the interviewees to reflect on a real story that illustrated a WS practice or behavior related to each dimension.

Given the difficulties involved in aligning theory and practice for the two groups (individual interviews and workshop groups), we reformulated some variables that composed these dimensions so that the research instrument would portray everyday situations involving WS at the organizations, thus facilitating the participants' responses.

During the workshops, we also conducted a semantic assessment (pre-test) of the WSC, i.e., to ensure that the



affirmatives proposed in the WSC were easy to understand and unambiguous.

Thus, we validated the level of objectivity of the tool and estimated the time required for its completion in conditions identical to those of the study. The analysis showed that the general evaluation of the dimensions of the WSC was reliable. However, it was necessary to calibrate some affirmatives to reduce the tendency towards automated responses.

### Face Validity of the WSC

The purpose of Face Validity is to gauge the adequacy of the variables and the dimensions (constructs). To this end, the constructed variables were evaluated by specialists on the themes of the constructs to validate whether the variables had a correlation with the proposed dimensions (constructs) (Bagozziet al., 1998).

For the acceptance of the Face Validity, an agreement of at least 80% between each specialist and the correlations serves as the decision criterion for the acceptance of the variables that theoretically refer to the presented dimensions (constructs). The number of specialists determined by some authors in the studies they conducted is at least six subjects (Bagozziet al., 1998).

The specialists were invited to participate through the forwarding of a questionnaire containing the orientations necessary to correlate the variables and the constructs. The seven specialists are professors, consultants and researchers at a large university in Rio de Janeiro [Brazil], with a doctoral degree in the field of Organizations, Organizational Behavior and Human Resources, the focus of the themes in the constructs.

The results of the correlations varied between 82% and 89%, with a consensus in most of the constructs. The specialists also suggested adjustments to the texts of some variables. Following an evaluation by the authors, the suggested adjustments to the content were incorporated into the research instrument.

### Statistical Validation of the WSC: Exploratory Factor Analysis

To validate the WSCM, the statistical procedure Exploratory Factor Analysis (EFA) was used to reduce the set of variables to a lower number of factors to characterize the attribute dimensions of the object in question (Hair Jr. et al., 1998).

EFA is based on the significance of the variability of data in order to identify common factors within a set of observable variables. When summarizing data, EFA captures the latent dimensions that represent the set of data in a lower number of concepts than the original individual variables (Hair Jr. et al., 1998). This statistical technique is considered adequate for interpreting

perception in survey style research and for evaluating the validity of a construct or research tool (Williams et al., 2010).

To apply EFA, we followed the protocol established by Williams et al. (2010), as follows:

(i) Sample size: Hair Jr. et al. (1998) state that EFA should not be used in a sample with fewer than 100 units.

(ii) Ratio (N: p ratio): Hair Jr. et al. (1998) and Tinslay and Tinslay (1987) claim that in EFA at least five times the number of variables that will be analyzed should be used.

(iii) Factorability of the Correlation Matrix: To interpret the results of the Factor Analysis, the significance of the factor loadings is defined, with loadings between 0.30 and 0.40 with low practical significance. Higher than 0.40, they have some significance. Loadings higher than 0.50 are considered to have practical significance (Hair Jr. et al., 1998).

(iv) KMO: The Kaiser-Meyer-Olkin Sample Adequacy Measure (KMO) is a statistical test that compares the magnitudes of the correlation coefficients observed with the magnitudes of the coefficients of partial correlation, suggesting the proportion of variance of the items that may be explained by a latent variable (Lorenzo-Seva, Timmerman & Kiers, 2011). For the interpretation of the KMO index, values smaller than 0.5 are considered unacceptable. values between 0.5 and 0.7 are considered mediocre; values between 0.7 and 0.8 are considered good; values greater than 0.8 are considered optimal (Hutcheson & Sofroniou, 1999).

(v) Bartlett's Test: Bartlett's Test of Sphericity tests whether the correlation matrix is an identity matrix (each variable is perfectly correlated with itself ( $r=1$ ), but does not show a correlation with the other variables ( $r=0$ ). The test also evaluates the overall significance of all correlations in a data matrix (Hair Jr. et al., 1998).

Bartlett's Test Values with  $p < 0.05$  indicate that the matrix is factorable (Tabachnick & Fidell, 2007), rejecting the null hypothesis that the data matrix is similar to a matrix-identity.

(vi) Factor Extraction: The aim of the rotation is to simplify the factor structure of a group of items, i.e., high loads of items in a factor and lower loads of items in the solutions of the remaining factors.

(vii) For this study, Principal Component Analysis was applied, because they provide the best results when the samples present non-normal distribution (Costello & Osborne, 2005; Fabrigaret al., 1999).

(viii) Accumulated Percentage of Variance: According to Hair Jr. et al. (1998), variance explained is commonly as low as 50-60%.

(ix) Eigenvalue: Represents total variance explained for each factor. Studies recommend an eigenvalue higher than one (Williams *et al.*, 2010).

(x) Rotation Test: Rotation maximizes the high loads of items and minimizes low loads of items, thus producing a more interpretable and simplified solution. Considering the possible existence of correlation between the variables of the model, the oblique rotation was used, since it does not delimit the interaction between the factors. If the factors are not correlated, the results obtained by oblique rotation will be similar to those obtained by orthogonal rotations (Fabrigar *et al.*, 1999; Sass & Schmitt, 2010). The promax method was used to present results in line with the proposed model.

Finally, to measure the reliability of the proposed measurement, Cronbach's Alpha Coefficient is recommended as a consistent indicator to analyze the reliability of a scale (Hair Jr. *et al.*, 1998; Sijtsma, 2009). Although there is no absolute value, Cronbach's Alpha values equal to or higher than 0.70 reflect an acceptable level of reliability (Hair Jr. *et al.*, 1998).

To analyze the collected data and apply the aforementioned statistical techniques, the SPSS 20.0 statistical package was used.

### Survey, Sample and Data Collection

For the survey, the entire workforce of the six factories was invited to participate. A total of 1196 (57% response rate) completed questionnaires were collected at the six factories (Table 5). These responses came from all the areas of the companies. The sub-sectors of the factories are: metallurgy, machinery and equipment, electronics and naval.

The sample is predominantly made up of professionals who have been with the company for up to ten years (75%), are between 26 and 45 years old (72%), are male (84%), have an education level up to Middle School (82%). This profile portrays Metallurgical companies (Dieese, 2011) and enables WSC to be researched as perceived by employees.

The questionnaire was applied to the WSC sample in person. The sample was chosen at random and composed of employees from different levels of the operational area of six factories in the metallurgical sector, located in Brazil. The sample selection followed the study of Fey & Denison (2003), as it demonstrated that respondents from different areas and levels of the organization tend to evaluate the organizational structure in a way similar to the leadership.

To collect the data at the companies, a survey of perceptions was conducted with the aid of a predominantly structured questionnaire based on the constructs and indicators of the WSC. The data were

collected from groups of up to 50 people per hour, who were invited to the auditorium of each factory by the researchers. Participants were invited by the Human Resources areas of each company to go to the factory auditoriums, where they were instructed to complete the questionnaire which, after being completed, was placed without identification in a closed urn to guarantee total confidentiality. The questionnaire was made up of 37 questions to be answered using a seven-point Likert scale (1 = I totally disagree to 7 = I totally agree), prepared based on the eleven dimensions and their respective indicators, as shown in Table 5.

Table.5: Sample Profile

Class	N	n	%
<b>Company</b>			
• 1	835	209	25%
• 2	975	273	28%
• 3	365	175	48%
• 4	468	183	39%
• 5	758	164	22%
• 6	670	192	29%
<b>Time with the Company</b>			
• Less than 1 year		296	25%
• 1-5 years		365	30%
• 6-10 years		240	20%
• 11-15 years		105	9%
• 16-20 years		121	10%
• Over 20 years		69	6%
<b>Employee Age</b>			
• 20-25 years		169	14%
• 26-35 years		506	42%
• 36-45 years		356	30%
• 46-55 years		140	12%
• Over 55 years		25	2%
<b>Gender</b>			
• Female		194	16%
• Male		1002	84%
<b>Schooling</b>			
• Elementary School		300	25%
• Middle School		681	57%
• High school		165	14%
• University		47	4%
• Postgraduate		3	0%

Source: Prepared by the authors

## IV. RESULTS AND DISCUSSION

The Exploratory Factor Analysis began by verifying the adequacy of the sample for the technique. The result of

the Anti-Image Correlation Matrix showed that 95% of the correlation of coefficients had an MSA higher than 0.500, indicating that the inter-correlations of the 37 variables were strong, based on the Measure of Sampling Adequacy. The most conclusive tests, KMO (0.910) and Bartlett's Test of Sphericity ( $\chi^2 = 15539.24$ , sig. < 0.000), confirmed the satisfactory use of the technique in accordance with Hair Jr. *et al.* (1998). These results made it possible to proceed with the data treatment and the use of EFA to summarize the variables and identify the latent dimensions.

The results of the EFA produced a factor structure with relatively higher loads on the appropriate factors. The variables loaded strongly on one factor, demonstrating that there is no overlap between the factors and that all the factors were structured independently. The highest loadings signaled the correlations of the variables with the factors in which they were loaded.

The criterion for the extraction of factors was Eigenvalue > 1, extracted using the Principal Component Analysis technique and oblique rotation using the Promax method.

In the initial theoretical and empirical model, it was assumed that the WSC was explained with eleven

dimensions (communication, commitment, infrastructure, pressure at work, feedback, learning, management system, leadership, efficiency, teamwork and responsibility).

The EFA reduced the 53 variables to 37 variables, distributed in 10 factors named: "Leadership" (Factor 1); "Feedback" (Factor 2); "Infrastructure" (Factor 3); "Efficiency" (Factor 4); "Communication" (Factor 5); "Pressure at work" (Factor 6); "Learning" (Factor 7); Teamwork (Factor 8); "Management System" (Factor 9); e "Commitment" (Factor 10).

All the variables presented communalities between 0.447 and 0.791, showing that at least 61.084% of the variables were explained by the factors.

The internal consistency of the factors was evaluated by Cronbach's alpha. Measuring the internal consistency is a necessary stage for evaluating both the factors and the questionnaire and knowing whether they are reliable and have the capacity to measure what is proposed. Hair Jr. *et al.* (1998) highlighted that an alpha higher than 0.600 on a scale of 0.000 to 1.000 is considered satisfactory for exploratory studies. In this study, the Cronbach's alpha values varied between 0.700 and 0.844 (Table 6). These results have satisfactory internal consistency.

Table.6: Denomination of the factors, eigenvalues, variance explained and Cronbach's Alpha

Denomination of the factor	Number variables	eigenvalues	Variance Explained	Cronbach's Alpha
Factor 1 Leadership	5	3.355	9.067	0.801
Factor 2 Feedback	4	2.664	7.201	0.760
Factor 3 Infrastructure	4	2.574	6.958	0.776
Factor 4 Efficiency	4	2.449	6.620	0.761
Factor 5 Communication	5	2.309	6.240	0.804
Factor 6 Pressure at Work	4	2.139	5.782	0.700
Factor 7 Learning	3	2.017	5.452	0.825
Factor 8 Teamwork	4	1.961	5.301	0.713
Factor 9 Management System	2	1.664	4.497	0.701
Factor 10 Commitment	2	1.468	3.968	0.702
Total	37	22.601	61.084	0.903

Source: Prepared by the authors

The first factor, "Leadership" explained 9.067% of the variance (Table 6) and showed the importance of the role of the leadership in strengthening WSC and applying practices focused on WS (Table 7). El-nagaret *al.* (2015) point to the fundamental importance of safety leadership in every day operations, ensuring safety before profit and developing safety competencies. Effective safety leadership at all levels of the organization should be manifest in managerial behaviors and actions (Cheyneet *al.*, 2002).

According to WS research (Burke & Signal, 2010; Wu *et al.*, 2008), when the leadership is not considered a model in the practice of safety, or it is not open to hearing and

accepting suggestions from employees to ensure WS, behaviors are not internalized. The employees perform these tasks most of the time because they must, not because it is what they want. Leadership plays a fundamental role in developing an honest and trusting WS vision, taking a proactive approach to safety with clear goals and shared purposes, and explaining the "whys" of desired behaviors (O'Connor & Carlson, 2016).

The second factor, "Feedback" explained 9.067% of the variance (Table 6) and showed the way the organization deals with the information, how the organization analyses the accidents and near misses at the workplace, as well as if the organization keeps the employees informed about

these events (Table 7). Provide a proper feedback, encourage employees to make suggestions to improve WS and act on deviations reported is very important to internalize WSC (Cox & Jones, 2006).

The third factor, "Infrastructure" explained 6.95% of the variance (Table 6) and assesses the availability of resources such as accessible and adequate installations, equipment, supplies and high quality training in workplace safety (Table 7). The infrastructure dimension was identified by a number of authors (Grote & Künzler, 2000; Singer *et al.*, 2003; Fang *et al.*, 2006; Clarke, 2010; Chen & Li, 2010) as relevant and, therefore, it was included in the WSCMI model.

The fourth factor, "Efficiency" explained 6.62% of the variance (Table 6) and describes the indicators the organization has in order to improve the performance of safety at the workplace and the guidance to employees, when their behavior is harming or can jeopardize WS (Table 7). As we can confirm in literature review, the WS indicators are important elements to reinforce desired behavior (Carder & Ragan, 2003; Vredenburg, 2002; Cooper & Finley, 2013).

The fifth factor, "Communication" explained 6.24% of the variance (Table 6) and assesses the existence of a communication plan that aids the quality of the transfer of information and knowledge of WS between managers and employees (Table 7). Leadership and managers should provide adequate information about the causes of accidents, incidents and deviations occurred. Only with a transparent communication and an open dialogue it would be possible to reinforce shared values and practices. (Rudmo & Hale, 2003; Dejoyet *et al.*, 2004; Eket *et al.*, 2007; Cooper, 2016).

The sixth factor, "Pressure at work" explained 5.78% of the variance (Table 6) and represents excessive demands for results that negatively affect WS practices (Table 7). In immature WSC, there are many activities and considerable pressure for results, no concern over what happens and demands for productivity are given priority (Noroozi, 2013; Cooper & Finley, 2013).

The seventh factor, "Learning" explained 5.45% of the variance (Table 6) and captured if the indicators and investigations of WS accidents and incidents are used primarily for and improving processes (Table 7). Accident

investigations should be used to identify flaws in WS systems, and learning from the causes of accident occurrences will prevent incidents. (Anderson 2005).

The eighth factor, "Teamwork" explained 5.30% of the variance (Table 6) and assesses the degree of collaboration and mutual respect among employees to ensure WS (Table 7). Collaboration, cooperative behavior, trust and mutual respect between employees are fundamental for guaranteeing WS. Managers should encourage employees to help colleagues and employees should assist colleagues to avoid work-related accidents. (Grote & Künzler, 2000; Guo & Yiu, 2015).

The ninth factor, "Management System" explained 4.50% of the variance (Table 6) and evaluates the management of activities, policies and procedures to identify critical control points for the execution of WS practices (Table 7). When a formal safety management system is installed, safety performance tends to improve. (Tzannatos & Kokotos, 2009; Cooper & Finley, 2013; Cooper, 2016).

The tenth factor, "Commitment" explained 7.60% of the variance (Table 6) and describes the support given by the organization as far as Safety is concerned (Table 7). Aksorn & Hadikusumo (2008) evaluated the effectiveness of SC programs in the Thai construction sector and revealed that management commitment and safety management system practices were very important in reducing the number of unsafe conditions. Employees need to be actively and voluntarily engaged in SC process to ensure all unsafe behaviors were reported (Ismail *et al.*, 2012). The literature review highlighted that the commitment is reflected in many ways on "good safety culture" (Ismail *et al.*, 2012; Ostrom, 1993; Carder & Ragan, 2003).

Finally, one dimension did not have any variables with sufficient factor loading: "Responsibility". As the content of the variable of these dimension is not present in the other variables, its non-loading represents a reduction in the original model. Some authors included the responsibility dimension in the risk perception dimension (O'Connor & Carlson, 2016) and others may not have identified variables related to responsibility and for this reason did not include these indicators in their studies.

Table.7: Loadings and Communalities

	Factor 1 Leadership	Factor Load	h2
V1	Leaders are often seen in the operational areas.	0.760	0.699
V2	Leaders are considered role models.	0.720	0.616
V3	Leaders implement corrective actions immediately after learning that some unsecured practice has been performed.	0.701	0.560
V4	Leaders recognize and celebrate the achievements in WS.	0.686	0.637
V5	Leaders consider WS a priority.	0.658	0.607

NL	Leaders reinforce that WS is a non-negotiable value	Not load	
<b>Factor 2 Feedback</b>		<b>Factor Load</b>	<b>h2</b>
V6	Managers accept suggestions from employees to improve WS.	0.692	0.609
V7	Managers give feedback to those involved when work-related accidents occur.	0.682	0.608
V8	Good suggestions for improvement WS are implemented.	0.668	0.560
V9	Managers encourage employees to make suggestions to improve WS practices.	0.580	0.571
NL	After the occurrence of accidents appropriate recommendations implemented.	Not load	
<b>Factor 3 Infrastructure</b>		<b>Factor Load</b>	<b>h2</b>
V10	Personal Protective Equipment (PPE) is always available to support the work.	0.733	0.582
V11	Collaborators know the purpose of Personal Protective Equipment (PPE) before they start their work.	0.728	0.584
V12	There is strict control over the use of PPE.	0.633	0.639
V13	Employees receive WS training at least every two years.	0.562	0.587
<b>Factor 4 Efficiency</b>		<b>Factor Load</b>	<b>h2</b>
V14	Employees know the indicators.	0.705	0.645
V15	Indicators are adequate to identify and measure WS nonconformities	0.703	0.663
V16	The employees know the goals and the monthly results of the WS indicators.	0.661	0.636
V17	Managers guide when they observe behaviors harming WS	0.368	0.580
<b>Factor 5 Communication</b>		<b>Factor Load</b>	<b>h2</b>
V18	Information on WS rules and procedures is available.	0.656	0.639
V19	Managers keep employees up-to-date on WS rules, procedures and practices.	0.635	0.643
V20	The managers inform the collaborators the goals and indicators of WS.	0.626	0.679
V21	Internal communication (posters, banners, internet etc.) about WS is present in all areas.	0.560	0.495
V22	Communication over WS is performed in the Daily Safety Dialogues (DDS).	0.537	0.529
NL	Employees can talk freely with managers about issues that are affecting WS practices.	Not load	
NL	Employees receive information on the causes of occupational accidents.	Not load	
<b>Factor 6 Work Pressure</b>		<b>Factor Load</b>	<b>h2</b>
V23	The time required to perform activities with WS is sufficient.	0.722	0.582
V24	The number of employees is adequate to carry out activities with WS.	0.701	0.584
V25	The charge for productivity does not interfere with WS rules and procedures.	0.684	0.639
V26	If there is pressure for results, this does not affect the employees' WS practices.	0.500	0.587
<b>Factor 7 Learning</b>		<b>Factor Load</b>	<b>h2</b>
V27	Accident investigations are used to identify flaws in WS systems, rather than guilty.	0.723	0.665
V28	The causes of accident occurrences are used to learn and improve WS systems.	0.719	0.647
V29	Employees receive information on the causes of accidents at work.	0.498	0.537
<b>Factor 8 Teamwork</b>		<b>Factor Load</b>	<b>h2</b>
V30	Managers encourage employees to help colleagues to avoid work-related accidents.	0.754	0.670
V31	The managers act to solve problems that could harm WS.	0.703	0.684
V32	Employees assist colleagues in avoiding work-related accidents.	0.605	0.657
V33	Employees are alert to the safety of colleagues and interfere whenever necessary.	0.383	0.508
<b>Factor 9 Management System</b>		<b>Factor Load</b>	<b>h2</b>
V34	Employees may refuse to continue work if they believe this may affect WS.	0.882	0.791
V35	Managers apply disciplinary measures when employees do not follow WS	0.863	0.769
NL	rules.	Not load	
NL	Collaborators have the autonomy to interrupt a work.	Not load	
NL	Employees consider it important to report a security error of a colleague.	Not load	

The company analyzes the reported accidents.

	Factor 10 Commitment	Factor Load	h2
V36	Managers recognize when they observe work according to WS standards.	0.713	0.579
V37	Managers treat WS errors reported as a learning opportunity.	0.665	0.592
NL	Employees consider it important to report a security error of a colleague.	Not load	
NL	The reported accidents are analysed by the company.	Not load	
NL	Collaborators have the autonomy to interrupt a work.	Not load	

Source: Prepared by the authors

As one of the main goals of this study was to test the WSCM to evaluate WSC, the results showed that there is a divergence between the proposed model and the model resulting from the EFA. However, the variables that loaded in the factors indicate that there was total convergence with the face validity and the WSCM. This shows that the original WSCM was developed with stable and valid measures of WSC.

## V. LIMITATIONS OF THE STUDY

There is a clear need for reliability in the sample used, despite the results of the Bartlett and KMO tests. One limitation of the study may be related to the influence of the differences in organizational culture of the companies in question (as they are located in regional contexts with different traits of the national culture) on the results (Hofstede, 1991). Only further studies can determine the conclusive stability of the WSCM, bearing in mind the academic support of diverse authors regarding the importance of certain dimensions, such as Leadership and Commitment. For future studies and research, it is important to consider samples diversified by region in multicultural countries with large geographic dimensions.

## VI. CONCLUSION

The WSCM model meets the basic requisites of a valid measurement of WSC. It has been shown to have good reliability and convergent validity in that it correlates with tools intended to measure indicators and variables that concentrate on similar subjects, all related to WSC.

This study shows that the WSCM is an important instrument in advancing the measurement of WSC in companies in the metallurgical sector. The theoretical premises of its dimensions, indicators and variables that influence WSC provide robust support for the identification of the WSCM.

The results point to ten factors that explain 63.884% of the data variance: Leadership, Commitment, Pressure at Work, Infrastructure, Learning, Efficiency, Management System, Feedback, Responsibility, Communication. On the other hand, the statistical analyses did not support the variance of one factor identified in the literature: Responsibility. The fact that the loadings occurred with ten of the eleven selected dimensions indicates that the

WSCM is very robust. However, it requires further testing for its generalization, with a larger and more diverse samples to minimize possible bias resulting from different organizational cultures and subcultures.

Thus, the proposed WSCM needs to be applied to a larger and more diverse sample of companies in different sectors, with the introduction of elements of segmentation, such as number of employees, gross revenues and geographic locations to increase the legitimacy of the tool.

Finally, the result of the application of the WSCM aids the development of intervention projects intended to align a company's WSC with the behavior expected from employees. The application of the WSCM leads to benefits for companies that have become aware of the importance of WSC, as it enables them to identify the degree of internalization of their WS practices, which effectively sustain a company's WSC.

The future research with a larger sample of companies, will pave the way for the WSCM to be valid and reliable in establishing with precision the level of WSC maturity in each organization.

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# Optimization of metakaolin-based Geopolymer Composite using Sisal Fibers, response Surface Methodology, and Canonical Analysis

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**Abstract**—In the present context, geopolymer appears as an ecologically viable alternative compared to Portland cement, due to lower CO<sub>2</sub> emissions rate. The objective of this work is to study reinforced geopolymer pastes with elongated sisal fibers by means of parameters such as flexural strength. For this, metakaolin was used as an aluminosilicate source material in addition to a combination of sodium silicate and sodium hydroxide as the activator solution. The influence of the independent variables sisal fiber percentage, molar ratio between activator and metakaolin, and the curing time was evaluated through an experimental design. The statistical model of central composite planning was used to optimize the results obtained. The best value for the modulus of rupture was of approximately 9.3 MPa, obtained with 2 days curing, with the activator/metakaolin ratio of 0.59 and percentage of sisal fiber of 4.34.

**Keywords**—Mechanical properties, Modulus rupture, Natural fibers, Sisal fibers.

## I. INTRODUCTION

Among the challenges of the construction materials industry is the creation of new technologies that include reducing the emission of carbon dioxide (CO<sub>2</sub>) and other pollutants, recycling of industrial waste and by-products, improving the performance of materials, in order to meet more ambitious design demands and higher durability requirements [1,2].

Alkaline activation of the geopolymer has been emphasized due to the potential of reduction of carbon dioxide emissions compared to materials based on Portland cement [1], being possible a reduction of up to 64% in greenhouse gas emissions [3]. The term geopolymer is used to describe alkali-activated low calcium aluminosilicate binders. This definition covers the use of pozzolans and blast furnace slag as precursor materials, but Portland cement may still be added in minor amounts [4]. In addition, properties such as excellent mechanical strength, durability for acid attack

and high fire resistance [7,8], make this material economically suitable for use in infrastructure employments. It should be noted, however, that the manufacturing process of this material usually requires high cure temperature and pH, which may compromise its field use, being important the development of a system with ambient temperature cure [9].

The process of hardening of the geopolymer occurs through the activation of a solid in an alkaline system [10], being frequently used as alkaline liquid combinations of sodium hydroxide (NaOH) or potassium hydroxide (KOH) with sodium or potassium silicate. According to [11], the solutions of activation of sodium silicate and sodium hydroxide increase the polymerization process of the ionic species present in the system. However, it is essential that this combination between the two activators is balanced to maintain the high pH of the system and a high content of soluble silicon ions (Si<sup>4+</sup>).

[5,12] affirm that there is potential for the application of geopolymer concretes in the prefabricated industry due to the greater control of handling and curing of the materials in these places, besides the capacity of use of the geopolymer in reinforced composites with fibers, prefabricated slabs for paving, bricks and prefabricated pipes. According to [13], in 2007 the Australian company Zeobond commercially launched, on a pilot scale, a geopolymeric concrete, called E-Crete<sup>TM</sup>, whose base material is a mixture of fly ash and blast furnace slag. Their applications range from infrastructure works to licensed repairs.

There are still challenges that geopolymers have to be adopted in the construction industry. According to [5,14] among them: different nomenclatures used in the literature to define geopolymeric material, high cost and risk management of the alkaline solution, misconceptions about geopolymeric properties, mainly from the cement industry, which affirms that alkali is detrimental to all systems. In addition, the adoption of composition-based construction standards, where a maximum amount of

additional cementitious material is allowed. It is also observed the difficulty in practicing steam cures or high temperatures required for certain geopolymers, with a conservative stance of the construction industry in which it refers to new products.

Moreover, the geopolymer, as well as Portland cement-based materials, have fragile type rupture mode [15]. An alternative to improve the mechanical properties is the incorporation of fibers in the matrix, which promote an increase of the toughness and improvement of the resistance to the flexion through the control of propagation of the fissures [16]. In this context, the use of natural fibers as reinforcement material is notable, since, compared to synthetic fibers, they have low preparation energy, what can justify the lowest cost [17]. Several natural fibers have already been used in geopolymers to improve mechanical performance, such as cotton [18], flax [19], Luffacylindrical [20] and bamboo fibers [21].

Regarding the shape and distribution of the fibers, two types of fiber reinforcement commonly used are mentioned, the continuous one, characterized by long fibers and incorporation through blankets or layers, and the short and discrete fibers, whose length is less than 50 mm and are introduced into the matrix by means of mixing or spraying techniques. In the configuration of continuous fibers, they can be aligned in a preferential direction, unlike the conformation assumed by the short and discrete ones, in which the fibers assume random orientation [22].

The effect of each parameter as well as of their interactions on modulus of rupture was studied using a central composite design (CCD) coupled with response surface method (RSM) and optimized by canonical analysis technique. The CCD consists in a first order factorial design ( $2^k$ ) with additional points (center points and axial points). The central composite design (CCD) together with the response surface methodology (RSM) permit to find the optimum operating conditions with a reduced number of experiments [23] by estimating the main effects of each variable linear, quadratic and the interaction between the variables [24,25]. RSM enables to identify new operating conditions that produce desired improvements. According to [26], optimal operating conditions can be obtained by combining the adjusted response surface methodology with canonical analysis that is the reduction of the response surface that allows determining the nature of the stationary point and the response system.

Considering the heterogeneity of methodologies and results presented in the literature, the objective of this

work was to analyze the influence of the variables sisal fiber percentage, the mass ratio between activator and metakaolin mass and curing time in the production and characterization of geopolymer composites.

## II. MATERIALS AND METHODS

### 2.1 Characteristics of materials

#### 2.1.1 Sisal fibers, metakaolin, sodium hydroxide and sodium silicate

The sisal fiber was acquired by SisalIndústria e ComércioLtda located in the city of São Paulo – Brazil. The metakaolin used in this investigation was donated by Metacaulim do BrasilIndústria e ComércioLtda, located in the city of Jundiaí, state of São Paulo - Brazil. A combination of sodium hydroxide (NaOH) and sodium silicate ( $\text{Na}_2\text{SiO}_3$ ) was used as alkaline solution for the dissolution of aluminosilicate phases. Sodium hydroxide was present in micro pearl form and was acquire by Dinâmica Química Contemporânea Ltda. The sodium silicate, purchased by Una-Prosil, have oxides ratio equals 2.0 ( $\text{SiO}_2/\text{Na}_2\text{O}$ ). The fibers were submitted to tensile test at speed application equals to 0.4 mm/min until material rupture in an INSTRON model 5982 with 5 kN load cell.

### 2.2 Materials characterization

#### 2.2.1 X-ray diffraction analysis (XRD) of the metakaolin and geopolymer

The RIGAKU, Miniflex model, with  $\text{CuK}\alpha$  radiation (1.540 Å) was used to identify the characteristics peaks presented in  $2\theta$  angle between  $5^\circ$  and  $90^\circ$  at a  $0.02^\circ$  step. The crystallographic datasets of the crystallographic database ICSD (Inorganic Crystal Structure Database) were used to analyse the obtained diffractograms. This study was carried out at the Multiuser Laboratory of the Institute of Chemistry of the Federal University of Uberlândia (IQ/UFU). The geopolymer were transformed into powder for characterization and later were sifted in a sieve with 75  $\mu\text{m}$  opening.

#### 2.3 Design of experiments (DOE)

The central composite design was chosen as the experimental design for the development of the analytical procedures, with the input variables  $x_1, x_2, \dots, x_n$  scaled to coded levels [27], which ranged from  $(-\alpha)$ , corresponding to the minimum level, and  $(+\alpha)$  equivalent to the maximum level, with an alpha of orthogonality ( $\alpha$ ) of 1.41421. Table 1 show the coded and decoded values of the variables, determined by equations 1, 2 and 3.

Table.1: Coded and uncoded levels of variables used for central composite design.

Parameters	Symbol		Codedlevels				
	Uncoded	Coded	-1.414	-1	0	1	1.414
Sisal fibers (wt%)	%sisal	$x_1$	0	0.85	3	5.15	6
Activator/metakaolinratio	NaSi/Met	$x_2$	0.352	0.41	0.55	0.69	0.748
Cure time (days)	C.T.	$x_3$	1	5	14.5	24	28

$$x_1 = \frac{(\% \text{sisal} - 3.0)}{2.15} \quad (1)$$

$$x_2 = \frac{(\text{NaSi} / \text{Met} - 0.55)}{0.14} \quad (2)$$

$$x_3 = \frac{(\text{C.T.} - 14.5)}{9.5} \quad (3)$$

Where %sisal, NaSi/Met and C.T. are the variables percentage of sisal in the geopolymer, sum of the masses of sodium (Na) and silicate (Si) by the mass of metakaolin, and cure time, respectively.

The overall analyses of the experimental data was performed using the software *Statistica12*, and the experimental data were submitted to a multiple regression with the purpose of measuring the effects of the studied variables for later adjustment of the model. The significance level of 10% was adopted for the analysis of the regression parameters [24].

### 2.3.1 Optimization

According to [26], optimal operating conditions can be obtained by combining the adjusted response surface methodology with canonical analysis. The optimization of the operating conditions for the modulus of rupture was performed using the canonical analysis technique. The response function can be expressed in terms of the parameters, according to Equation (4):

$$\hat{y} = b_0 + \underline{x}'\underline{b} + \underline{x}'\underline{B}\underline{x} \quad (4)$$

where,

$$\underline{x}' = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_k \end{bmatrix}; \underline{b} = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_k \end{bmatrix}; \underline{B} = \begin{bmatrix} b_{11} & \frac{b_{12}}{2} & \dots & \frac{b_{1k}}{2} \\ \frac{b_{21}}{2} & b_{22} & \dots & \frac{b_{2k}}{2} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{b_{k1}}{2} & \frac{b_{k2}}{2} & \dots & b_{kk} \end{bmatrix}$$

The optimal condition (global maximum point, global minimum or saddle point) is obtained through the derivative of the adjusted surface equation in relation to the vector of variables, this value corresponding to zero in the case of the stationary point, as presented in Equations 5 and 6.

$$\frac{\partial \hat{y}}{\partial \underline{x}} = \frac{\partial}{\partial \underline{x}} [\hat{y} = b_0 + \underline{x}'\underline{b} + \underline{x}'\underline{B}\underline{x}] = \underline{b} + \underline{B}\underline{x} = \underline{0} \quad (5)$$

$$x_0 = -1/2B^{-1}b \quad (6)$$

The nature of the stationary point is defined by the translation the adjusted surface from the origin ( $x_1, x_2, x_3, \dots, x_k$ ) = (0,0,0, ... 0) to the stationary point  $\underline{x}^0$ , ( $w_1, w_2, w_3, \dots, w_k$ ), whose axes correspond to the main ones of the contour system, represented by Equation 7:

$$\hat{y} = \hat{y}_0 + \lambda_1 w_1^2 + \lambda_2 w_2^2 + \dots + \lambda_k w_k^2 \quad (7)$$

Where  $\hat{y}$  is estimated response at stationary point and  $\lambda_i$  are the characteristics roots of the equation.

The determination of the nature of the stationary point  $\underline{x}_0$  is analyzed by the characteristic root signals, where  $\lambda_i < 0$ , is the maximum response point,  $\lambda_i > 0$ , minimum response point and  $\lambda_i$  for different signals, saddle point. The canonical analysis was implemented using the software *Maple17*.

### 2.4 Geopolymer preparation

The fibers were moistened and aligned on a sheet of filter paper. The fibers were weighed and cut into the size of the specimens (0.17 m length x 0.04 m wide), with more than one layer being added as necessary. The extremity was then secured with adhesive tape. The thickness of each specimen was 0.01 m. After making the fibers, the alkaline activators were then weighed and dissolved in distilled water, separately. The mass ratio of sodium silicate to sodium hydroxide was equal to 2.5 and the water-metakaolin ratio was 0.7. The molarity values of the sodium hydroxide and sodium silicate were 15 and 12 M, respectively, chosen according to reports in the literature. The NaOH solution was first mixed for 1 min with the Na<sub>2</sub>SiO<sub>3</sub> solution and the extra water (corresponding to the water mass according to the water-metakaolin ratio). The mixture was then added to the metakaolin and homogenized for 5 min. Subsequently, a layer of the material was placed in the silicone forms, for subsequent addition of the blankets. Finishing occurred with another layer of geopolymer, with sealing of samples with plastic film and curing at room temperature (25 ± 5

°C). For each CCD formulation, five specimens were molded.

## 2.5 Composites characterization

### 2.5.1 Flexural strength test

The rupture test was performed under laboratory ambient conditions ( $25 \pm 5$  °C) between 1 and 28 days of age, obtaining the values of modulus of rupture. The rupture test method used was the four-point flexural test recommended by [28], in which the load application is done in two points of the sample, generating a constant moment between the points of load, using a Universal Machine of Instron brand tests, model 5982, and load cell of 5 kN. The distance between the lower supports was 150 mm and the load application speed was 2 mm/min.

### 2.5.2 Scanning electron microscopy (SEM) of the geopolymer

The ruptured specimens were cut using a circular saw, and they were impregnated with an epoxy resin and posteriorly sanded. Subsequently, the test specimens metallization was performed with gold in the Multiuser Laboratory of the Institute of Chemistry of the Federal University of Uberlândia (IQ/UFU) and the Dispersive Energy Spectroscopy (EDS) coupled to the MEV (model Vega3 and Tescan brand), was used to verify the composition of the matrix.

## III. RESULTS AND DISCUSSION

### 3.1 Characteristics of materials

#### 3.1.1 Sisal fibers, metakaolin, sodium hydroxide and sodium silicate

The sisal fiber presented specific density of  $1511 \text{ kg/m}^3$ , with a diameter of  $230.14 \mu\text{m}$  ( $\pm 43.48$ ). Young's modulus, elongation and strength were  $11.47 \text{ GPa}$  ( $\pm 2.78$ ),  $0.59 \text{ mm}$  ( $\pm 0.09$ ), and  $371.61 \text{ MPa}$  ( $\pm 81.63$ ), respectively [29,30]. According to [17], the great variability of the results of tensile strength and modulus of elasticity can be explained by three factors: the parameters of the tests, the characteristics of the plants and the measurements of the sections fibers. The accuracy of the instrumentation, the length of the meter and the type of claw are some test conditions that may interfere in the final values of the mechanical properties of the fibers. Adding to this, as a characteristic of plants, one has the diversity of plant sources, ages, and types of processing and microstructure. Finally, the uncertainties in the measurement of the cross-sectional area of the fiber may lead to a discrepancy in the mechanical parameters. The metakaolin presented a particle diameter of 12 micrometer and a specific density of  $2650 \text{ kg/m}^3$ . According to with the chemical characterization, it presents expressive percentages of  $\text{SiO}_2$  (51.57%) and

$\text{Al}_2\text{O}_3$  (40.5%), making approximately 92% of these two compounds. It also has small amounts of  $\text{Fe}_2\text{O}_3$  (2.8%),  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$  ( $< 1\%$ ) [31]. Sodium hydroxide has 98% purity and was dissolved in water to obtain a 15-molar solution. The sodium silicate, with a specific density of  $570 \text{ kg/m}^3$ , contains 52.1% of  $\text{SiO}_2$  and 26.1% of  $\text{Na}_2\text{O}$ , with total solids equals 78.2%.

### 3.2 Materials characterization

#### 3.2.1 X-ray diffraction analysis (XRD) of metakaolin

Fig. 1 shows the composition of metakaolin through the XRD pattern.

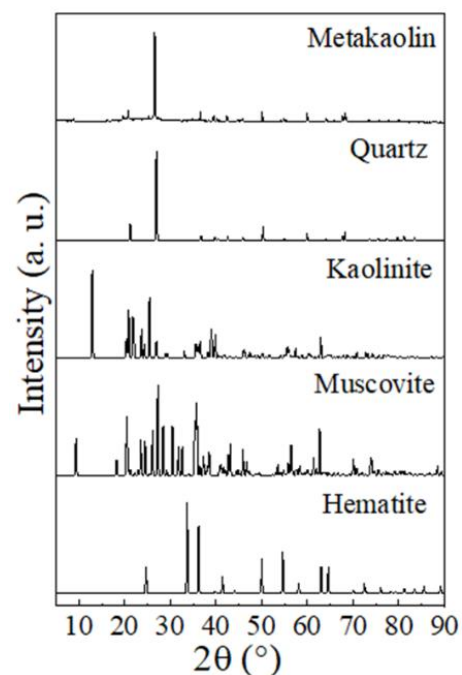


Fig. 1. XRD patterns of the metakaolin.

According to Fig. 1, observed a crystalline pattern, with no apparent halo, suggesting that amorphous phases are not present in large quantities. The main mineral phase was the quartz with  $2\theta$  diffraction peaks equal to  $21.2^\circ$ ,  $26.96^\circ$ ,  $36.70^\circ$ ,  $39.72^\circ$ ,  $42.54^\circ$ ,  $45.88^\circ$ ,  $50.24^\circ$  e  $54.90^\circ$ ,  $59.86^\circ$ ,  $64.04^\circ$ ,  $73.46^\circ$  (ICSD-89281). In addition, kaolinite peaks evidenced, possibly, that calcination of kaolinite was not complete ( $2\theta = 20.90^\circ$ ,  $36.54^\circ$ ,  $50.20^\circ$ ,  $75.60^\circ$  - ICSD - 68698). It was also observed the peak of impurities, such as muscovite ( $2\theta = 36.42^\circ$ ,  $45.90^\circ$ ,  $54.80^\circ$ ,  $60.04^\circ$  - ICSD-60569) and hematite ( $2\theta = 36.5^\circ$ ,  $50.00^\circ$  - ICSD - 15840) [32,33].

### 3.3 Design of experiments (DOE)

Table 2 shows the values of the response variable (modulus of rupture) for the 18 experiments of the experimental design obtained by the flexural tests.

Table 2. The experimental conditions studied in CCD matrix, with uncoded values of parameters.

E*	%sisal (%)	NaSi/Met	C.T. (days)**	M.R. (MPa)***
1	0.85	0.41	5	6.41
2	0.85	0.41	24	4.12
3	0.85	0.69	5	4.56
4	0.85	0.69	24	3.63
5	5.15	0.41	5	6.47
6	5.15	0.41	24	8.01
7	5.15	0.69	5	9.48
8	5.15	0.69	24	7.97
9	0.00	0.55	14.5	4.15
10	6.00	0.55	14.5	9.23
11	3.00	0.352	14.5	3.95
12	3.00	0.748	14.5	6.99
13	3.00	0.55	1.06	7.09
14	3.00	0.55	27.9	10.48
15	3.00	0.55	14.5	9.05
16	3.00	0.55	14.5	9.22
17	3.00	0.55	14.5	8.91
18	3.00	0.55	14.5	9.06

\*E: Experimental plane; \*\*Cure time; \*\*\*MR: Modulus of rupture

### 3.3.1 Modulus of rupture (M.R.)

A polynomial equation was developed that correlates the modulus of rupture (M.R.) in function of the independent variables, obtained by multiple regression, represented by equation 8.

$$M.R. = 8.97 + 1.7x_1 - 1.06x_1^2 + 0.41x_2 - 1.67x_2^2 + 0.13x_3 - 0.01x_3^2 + 0.66x_1x_2 + 0.41x_1x_3 - 0.21x_2x_3 \quad (8)$$

Where M.R. corresponding to Modulus of Rupture (MPa).

According to equation 8, the linear and quadratic variables of the percentage of sisal fiber ( $x_1$ ) and the quadratic variable mass ratio between activator and metakaolin ( $x_2$ ) were significant, representing the modulus of rupture at a 90% confidence level. Each parameter has a significance analysis according to the probability value ( $p$ -value). Significant variables had a  $p$ -value of less than 0.10 ( $p < 0.10$ ). The coefficient of determination  $R^2$ , which is defined as the fraction of the total variance of the dependent variable that is explained by the model equation [34] obtained was 0.86. [35] recommend an  $R^2$  value greater than 0.80 to obtain a good fit model. Since the presented variable has a higher than recommended value, it was possible to construct the response surfaces.

The percentage of sisal added in the matrix showed a positive effect (+1.70). However, when the addition of large amounts of sisal fibers occurs, the value of this parameter does not tend to increase the value of the response, which is probably due to the incorporation of residual air bubbles, from the process of filling the forms [18]. The same happened for the quadratic form of the variable that corresponds to the mass ratio between activator and metakaolin, in which larger quantities do not tend to increase the resistance value, possibly explained by the excess of unreacted material in the final compound, which, being leachate may interfere with the final resistance [36].

Fig. 2a shows the response surface for M.R. as function of the %sisal ( $x_1$ ) and the NaSi/Met ratio ( $x_2$ ), with C.T. at the central level ( $x_3 = 0$ ). Observed that the highest values of mechanical resistance were reached when the %sisal ( $x_1$ ) was at the upper limit of the studied range (+0.8) (corresponding to the decoded value of 4.72% of sisal fibers), and the NaSi/Met ( $x_2$ ) ratio near the center point that is, with a decoded value of 0.55, obtaining a result of approximately 10 MPa. The amount of soluble silicon ions in the final compound, although important for increasing the rate of polymerization and formation of a denser structure [11,37], in excess may not react for gel formation, being leached and interfering with the ultimate strength of the geopolymer [38].

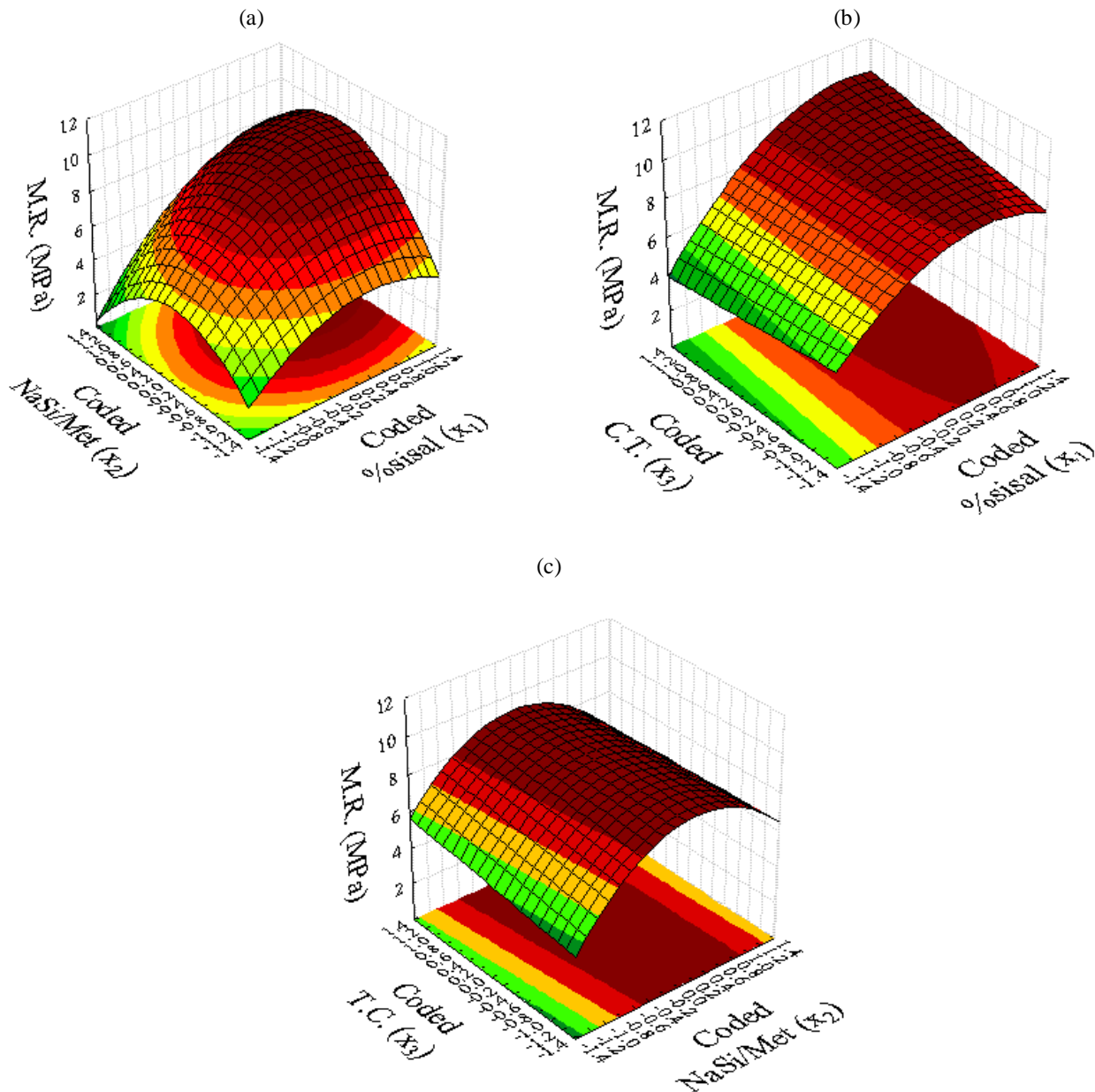


Fig. 2. Response surface of the modulus of rupture: (a) C.T. at the central level ( $x_3 = 0$ ); (b) NaSi/Met the central level ( $x_2 = 0$ ); (c) %sisal at the central level ( $x_1 = 0$ ).

Relative to the percentage of sisal in the final mixture, the amount of fibers has the tendency to increase the flexural strength controlling the propagation of cracks, which led the material to withstand a greater load [39].

Figure 2b shows the response surface for M.R. as function of %sisal ( $x_1$ ) and C.T. ( $x_3$ ), with NaSi/Met ratio at the central level ( $x_2 = 0$ ). Observed the M.R. values increase with the %sisal ( $x_1$ ) at a coded value of approximately +1.0 (5.15% sisal fibers as decoded value), with low C.T. ( $x_3$ ), resulting in the M.R. value of approximately 10 MPa. As explained previously, the fiber, when inserted in the geopolymer matrix, acts as a

stress transfer bridge through the cracks, generating a post-cracking load capacity. In addition, the geopolymerization process continues to occur for more advanced curing times and, as a result, the average strength increases [40].

Figure 2c shows the response surface for M.R. according to NaSi/Met ratio ( $x_2$ ) and C.T. ( $x_3$ ), with the %sisal at the central level ( $x_1 = 0$ ). Observed an increase in the mechanical strength value for a NaSi/Met ratio ( $x_2$ ) near the center point (decoded value of 0.55), with a low influence of C.T. ( $x_3$ ). Thus, a value of about 9MPa was obtained. Silica is important for the continuous process of



geopolymerization and consequent improvement of the mechanical parameters. However, if mixed in excess, it tends to form unreacted grains, which negatively interfere with the strength of the final geopolymer.

3.3.2 Canonical analysis

Obtained the Equation 9 by reducing the quadratic form to the canonical form. According to the stationary point, it was verified the existence of a saddle point, that is, the characteristic roots ( $\lambda_i$ ) have opposite signs and the stationary point is not characterized by a minimum or a maximum point (saddle point).

$$\hat{y} = +8.332 - 1.829w_1^2 - 0.931w_2^2 + 0.031w_3^2 \quad (9)$$

Table 3. Values of  $w_3$  according to the values decoded of  $x_1, x_2, x_3$ , and response prediction.

$w_3$	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5
%sisal	3.968	4.156	4.345	4.534	4.723	4.912	5.101	5.290	5.490
NaSi/Met	0.601	0.599	0.597	0.595	0.593	0.591	0.589	0.587	0.586
C.T.	-7.493	-2.819	1.855	6.530	11.204	15.878	20.553	25.227	29.901
M.R.	8.965	9.114	9.277	9.457	9.652	9.863	10.090	10.332	10.589

According to Table 3, observed that, for values of  $w_3 \leq 5.0$ , the value for curing time is physically impossible (-2.819). In addition, values of  $w_3 \geq 8.5$  were discarded as optimal points because presented a very small increase in resistance to curing times (C.T.) longer than 28 days. Thus, it was observed that the most

Observed that, to optimize the rupture modulus that is, increase the value of this parameter, the variables  $w_1$  and  $w_2$  must be zero, since the response decreases in the direction of these, therefore, finding several values for  $w_3$ . From the presented variables, the following restrictions were applied, according to the equations 1, 2 and 3:  $x_1 \geq -1.41421$ ,  $x_2 \geq -3.928$ , and  $x_3 \geq -1.5263$ , so that the values are physically possible.

Table 3 presents the decoded results, according to the recurrence equations, for the conditions in  $x_1, x_2$  and  $x_3$  and several values for  $w_3$ .

adequate conditions for the optimization of the rupture modulus consisted of  $w_3 = 5.5$ , and  $w_3 = 6.0$ , with all values of the independent variables belonging to the studied range (Fig. 3).

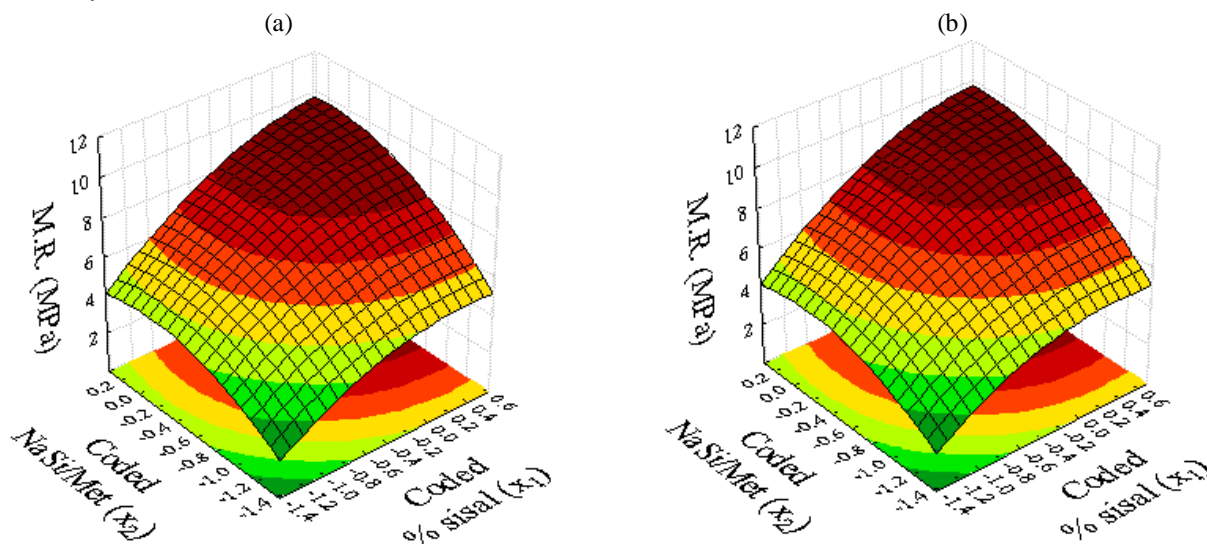


Fig. 3. Optimized response surface: a)  $w_3 = 5.5$ ; b)  $w_3 = 6.0$ .

In addition, the values of  $w_3 = 5.5$  and  $w_3 = 6.0$  were chosen, once the curing time was the parameter that presented greater diversification of values when analyzed the results of modulus of rupture. Comparing  $w_3 = 5.5$ ,

and  $w_3 = 8$ , corresponding to approximate cure times of 2 and 25 days, respectively, observed that there was a very small increase in the M.R. value of approximately 11%.

This result indicated that the production of the geopolymer is feasible for lower cure times.

For the optimized conditions,  $w_3 = 5.5$  and  $6.0$ , values for the modulus of rupture of  $9.27$  and  $9.45$  MPa, respectively, were obtained. According to results presented in Table 2, a modulus of rupture of  $9.22$  MPa was obtained with  $14.5$  days of cure. With the optimization process, it was possible to obtain close values, working with times cure lower (approximately  $2$  days), reducing the geopolymer aging process by about  $87\%$ .

### 3.4 Geopolymer characterization

#### 3.4.1 X-ray diffraction analysis (XRD)

Fig. 4 shows the diffractograms of the geopolymers. Among the mineral phases identified, observed the quartz predominance, with  $2\theta$  diffraction peaks equal to  $21.2^\circ$ ,  $26.96^\circ$ ,  $36.70^\circ$ ,  $39.72^\circ$ ,  $42.54^\circ$ ,  $45.88^\circ$ ,  $50.24^\circ$ ,  $54.90^\circ$  and  $59.86^\circ$  (ICSD-89281). Additionally, peaks present in the raw material remained in the geopolymer pattern, such as kaolinite ( $2\theta = 20.90^\circ$ ,  $36.54^\circ$ ,  $50.20^\circ$ ,  $75.60^\circ$  - ICSD - 68698), muscovite ( $2\theta = 36.42^\circ$ ,  $45.90^\circ$ ,  $54.80^\circ$ , and  $60.04^\circ$ ) and the hematite ( $2\theta = 36.5^\circ$  and  $50^\circ$  - ICSD - 15840)<sup>41,42</sup>. Observed that the crystallized structures present in the metakaolin diffractogram also appear in the final geopolymer compound, in smaller quantities, due to the possible hard dissolution, being these non-reactive crystals, which did not participate in the geopolymerization reactions, with a possible filling function [42,43,44]. [42] argued that secondary minerals such as quartz and muscovite play an important role in acidic resistance since the release of alkali cations in the solution is hampered, resulting in less degradation and loss of weight. In addition to the crystalline peaks of metakaolin, there was no new crystalline reaction product formed, as also observed by [45].

[46] explain that, for times shorter than  $240$  days, the binder does not have enough time to grow in a well-defined structure, thus presenting in amorphous and semi-crystalline phases. One of the possible explanations for the non-appearance of amorphous halos, characteristic of geopolymers would be the high quartz peak, which may make their presence less evident [44].

#### 3.4.2 Scanning electron microscopy (SEM)

According to SEM analyses, observed a good matrix-fiber interaction in the experimental planes (E) studied. Since there was no total rupture of the test specimen, a fact also observed by [15], the analyzed section is presented in the sanded form, and it is not possible to verify the mechanism of rupture of the sisal fiber. The presence of fiber detachment in the matrix possibly occurred due to the drying process of the samples in an oven for further

preparation for microscopic analysis. Analyses of the EDS on the fiber (represented by the rectangle) proved the presence of the matrix within the same (Fig. 5) where chemical elements belonging to the matrix (Si, Al, O, Na) and fiber (such as carbon, denoted by the letter C) were identified. Observed in the geopolymer of the experimental plane E2 (Fig. 6) that, despite the good matrix-fiber interaction, occurred of fiber agglomerations, which can result in poor interfacial adhesion and in the creation of pores in the matrix, contributing to the decrease of flexural strength of the composite [18].

The presence of pores and cracks of varying widths can be observed in practically all the samples. According to [47], the existence of pores in the matrix possibly was caused by the entrapment of bubbles resulting from the dissolution process and geopolymerization reaction.

Fig. 7 shows the EDS of the geopolymer of to the experimental plane 3. Analyses were performed on the darker color particles in the geopolymer and the result revealed that they are unreacted  $\text{SiO}_2$  particles (represented by the rectangle). Noted that there is a large presence of this material distributed in the matrix, which possibly influenced the results obtained for mechanical strength of the composite since the unreacted material tends to be less resistant than the geopolymer [36,38].

The same phenomenon was observed for the experimental planes 3, 4, 5, 7, 8, 11, 12 and 13, 15, 16, 17 and 18. The experimental planes E3, E4, E7 and E8 are those with activator/metakaolin ratio equal to  $0.69$ , and possibly the presence of unreacted material is due to the excess amount of silicon ions in the mixture, and even at  $24$  days of cure it is still possible to observe the existence of these materials. After  $24$  days of cure, it was still possible to observe the presence of these materials in the geopolymer. The same happened, probably, for the experimental plane 12, which presented an activator/metakaolin ratio of  $0.748$ . The geopolymer for experiment 11 (E11), with a cure time of  $14.5$  days, presented the lowest activator/metakaolin ratio (NaSi/Met), resulting in one of the less dense matrices between the experimental planes. According to [37], a smaller amount of silicate present in the activator solution tends to decrease the rate of geopolymerization, resulting in a less dense and compact matrix at shorter times cure.

Fig. 8 shows the surface of the geopolymer of experimental plane 9 (E9). This geopolymer presented a different configuration compared to the other samples since it was not reinforced with sisal fibers. Observed in this geopolymer that the rupture occurred in a fragile way, as was also observed by [15,43]. Probably because it was not subjected to the sanding process of the sample, the surface presented a rough surface, with homogeneous and

compact structures, with the presence of pores that, as previously stated, may have been incorporated in the binder dissolution process or of the geopolymerization reactions [47].

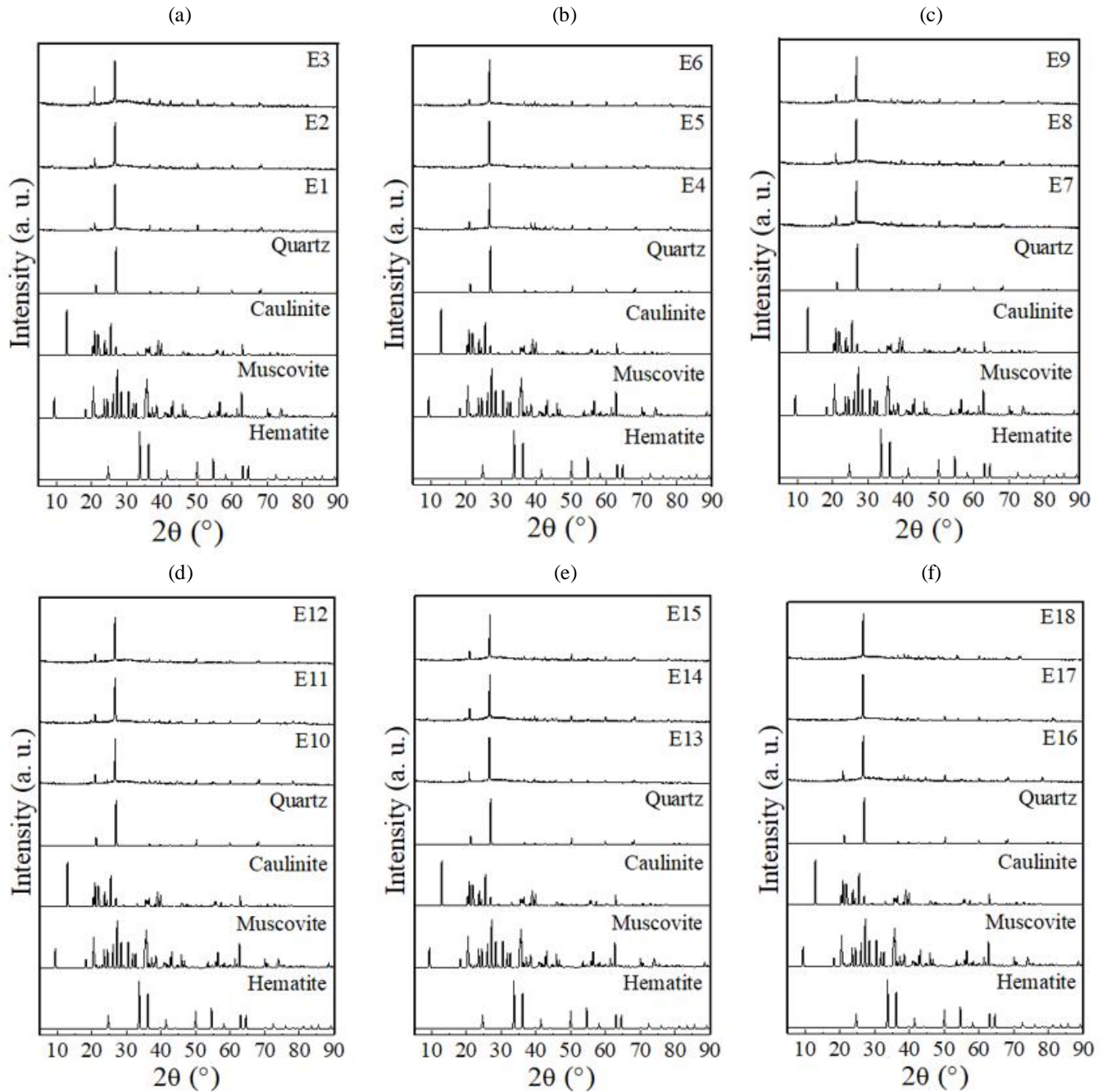


Fig. 4. XRD patterns of the geopolymers: a) E1, E2, E3; b) E4, E5, E6; c) E7, E8, E9; d) E10, E11, E12, e) E13, E14, E15; f) E16, E17, E18.

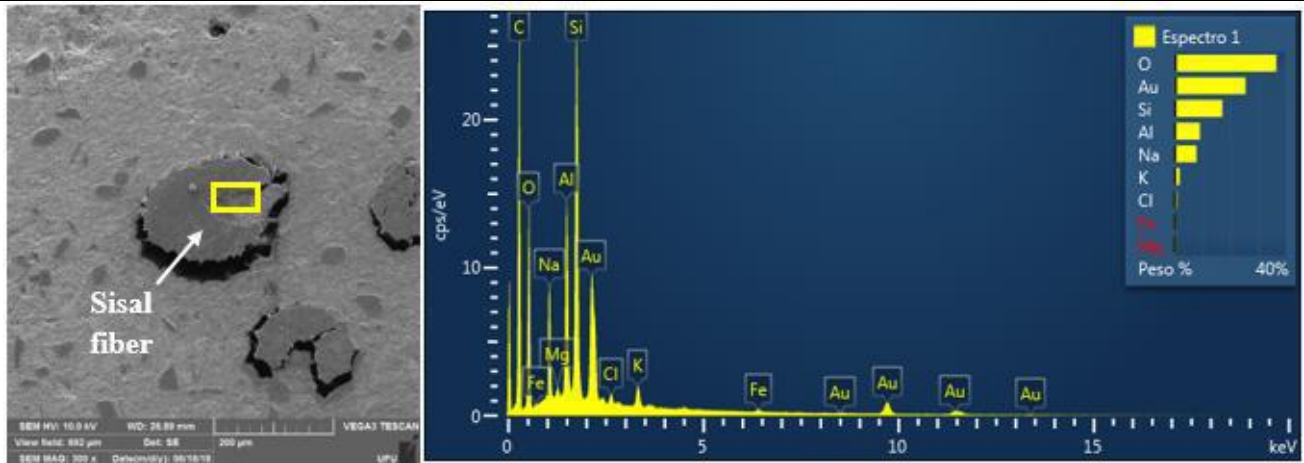


Fig. 5. EDS for matrix impregnated on sisal fiber.

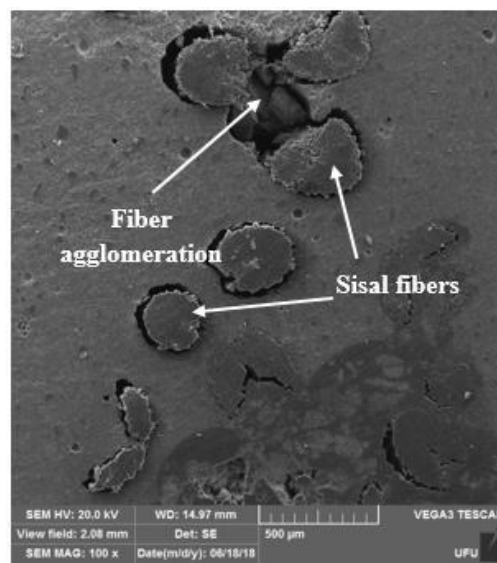


Fig. 6. Fiber agglomeration in the geopolymer of experimental plane 2 (E2).

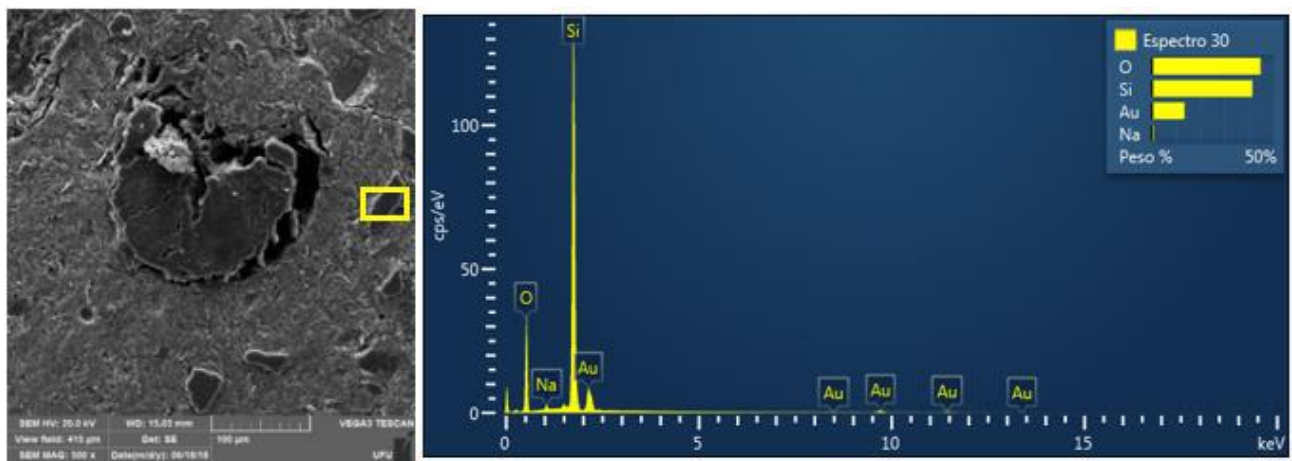


Fig. 7. EDS of the dark particles present in the geopolymer of experimental plane 3 (E3).

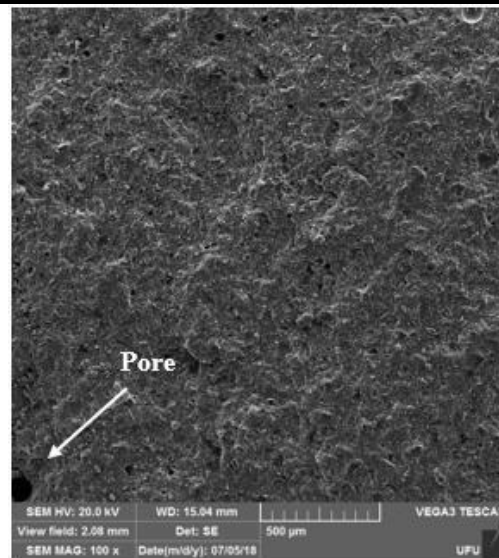


Fig.8: Surface of the geopolymer of experimental plane 9 (E9).

#### IV. CONCLUSION

The use of long sisal fibers improved the mechanical properties of the composites, increasing the modulus of rupture compared to the non-reinforced matrix. Unreacted products were found in the matrices with higher amount of activator and/or shorter curing times, demonstrating that may influence in the final mechanical strength value. The best value for the modulus of rupture was of approximately 9.3 MPa, obtained with 2 days curing, with the activator/metakaolin ratio of 0.59 and percentage of sisal fiber de 4.34, evidencing the potential of the geopolymer with the use of fibers and high initial strength.

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# Optimization of the Percentage of Cellulose, Latex and Metakaolin in the Production of Cementitious Composites

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**Abstract** – In this work the influence of the addition of the variables cellulose kraft pulps, natural rubber latex and metakaolin as reinforcements in cementitious composites was studied. The influence of the analyzed variables on the properties of the cementitious composites was evaluated through an experimental design (DOE) at 28 days age. The best modulus of rupture was the 12.29 MPa presented by the composite with 7.097% cellulose, 0.37% latex and 50.155% metakaolin. The composite with 5.928% cellulose, 1.85% latex, and 55.195% metakaolin had the best toughness of approximately 1.10 kJ/m<sup>2</sup>. According to the results obtained contact angle, it was possible to prove that the latex adhered to the pulp, hydrophobizing it. Therefore, it was concluded that it is possible to use the natural rubber latex in the cellulosic pulp and the metakaolin to protect the fiber in cementitious composites.  
**Keywords** – Cellulose kraft pulp, Design of experiments, Flexural strength, Natural rubber latex.

## I. INTRODUCTION

One of the main problems the civil construction is the generation of waste, the scarcity of natural resources, the energy consumption, the gases emission, that is, the impact caused to the environment. According to [1], the 20% of global CO<sub>2</sub> emissions related to industry, the cement industry accounts for approximately a quarter of total emissions. In this sense, research is being carried out with the objective of reducing environmental impact by use renewable materials. The natural fibers deserve special attention because they present interesting properties, such as good mechanical in fragile matrices, ductility, stiffness, low density, toughness, high availability, have a renewable source and low production cost [2,3,4,5].

Although the advantages presented, studies have shown limitations on the use of natural fibers as reinforcement in cementitious matrices. The alkalinity of the cement paste deteriorates the fiber by the lignin,

hemicelluloses and the amorphous part of cellulose degradation and solubilization, reducing mechanical performance of the fiber and, consequently, the durability of the composite. This occurs because the presence of hydroxyl groups in the celluloses structure, characterizing their polar and hydrophilic nature, increases the water absorption that facilitates alkaline attack and causes dimensional instability. In addition, the precipitation of cement hydration products, mainly calcium hydroxide (CH), in the lumen of the natural fibers resulting in their embrittlement by a process called mineralization [5,6,7].

The treatment of natural fibers are the focus of several researches, or even matrix, to enable their use. Among the treatments is the reduction of the alkalinity of matrix by replacing part of the cement with pozzolanic materials, the chemical treatment of the fibers and the physical treatments of the fiber (thermomechanical treatments and the physical modification of the fibers) [8,9,10,11,12].

The natural rubber latex (NRL) in a stable state with ammonia is a natural polymer often used in cement composites. [13] reported in their study that latex forms a film in the voids, pores and micro cracks of the composites that provides greater adhesion between the fiber and matrix, reducing its permeability. Thus, there is reduction of chemical attacks increasing the durability of composites. [14] observed a reduction in water absorption in cement composites with the addition of approximately 2.5% NRL.

Hemp fibers were studied with the application of a latex coating (NRL) to improve durability and mechanical properties of composites [15]. According to the authors, the latex coating improved the durability of hemp fiber in the pozzolanic mortar mix, with improved bonding between the fiber and the mixing. In this way, the mechanical properties were increased, providing a considerable durability to the composites.



The NRL is an alternative between the materials used in the modification of the composites, for being of a renewable source and has a hydrophobic character. The hydrophobicity of the latex possibly protects the fiber physically against the degradation caused by the alkaline water contained in the pores of the pulp. Moreover, the use of latex as a composite addition enables improvements in their properties, for example in porosity reduction and water absorption, as previously mentioned [13,17]. The aim of the present work was to study the influence of parameters like cellulose kraft pulps, natural rubber latex and metakaolin as reinforcements in cementitious composites.

## II. MATERIALS AND METHODS

### 2.1 Characteristics of materials

#### 2.1.1 Cellulose kraft pulp, cement, latex and metakaolin

The composites were molded using cellulose, with the specific mass of  $1.5 \text{ g/cm}^3$ , extracted from *Eucalyptus urograndis*, processed industrially by the Kraft method, and supplied by Suzano (Limeira/SP). The bleached kraft sheets were cut in smaller pieces and dispersed in water by mechanical shaking. They were filtered to remove excess water. The pulps were stored in plastic bags under refrigeration. The cement used was the Ultra Fast - CPV ARI, of the Holcim brand. The manufacturer supplied the properties of the cement. Farm Varginha, located in Araguari, provided Minas Gerais natural rubber latex, extracted from the rubber tree (*Hevea brasiliensis*). The latex was stabilized with an ammonium hydroxide solution ( $\text{NH}_3\text{OH}$ ) in the proportion of 50 mL of  $\text{NH}_3\text{OH}$  solution to 5 L of latex. Part of the cement used in the composites was replaced by Metacaulim HP ULTRA, provided by Metacaulim do Brasil Indústria e Comércio Ltda (Jundiaí-SP). This product consists of  $\text{SiO}_2$  and  $\text{Al}_2\text{O}_3$  in the amorphous phase [17].

### 2.2 Materials characterization

#### 2.2.1 Cellulose and composites characterization

##### 2.2.1.1 X-ray diffraction analysis (XRD)

The cellulose fibers were submitted to X-ray diffraction analysis to identify their characteristic peaks presented in  $2\theta$  between  $10^\circ$  and  $90^\circ$ . This study was carried out at the Multiuser Laboratory of the Institute of Chemistry of the Federal University of Uberlândia (IQ/UFU). A Shimadzu diffractometer, model XRD-6000, with  $\text{CuK}\alpha$  radiation ( $1.540 \text{ \AA}$ ), voltage of 40 kV and current of 30 mA was used. As for the composites of the experiments, they were transformed into powder and later they were sifted in a sieve with  $75 \mu\text{m}$  opening.

##### 2.2.1.2 Scanning electron microscopy (SEM)

The samples were cut in the dimensions of  $1 \text{ cm} \times 1 \text{ cm}$  and placed in an oven at  $50 \pm 1 \text{ }^\circ\text{C}$  for 24 hours. The

composites of the experiments were investigated with the objective of analysing their surface microstructure, the presence of pores, the fiber-matrix interface, and the distribution of cellulose and latex in the pulp ( $1 \text{ cm} \times 1 \text{ cm}$  in size). The analyses were carried out using the microscope model Vega3, brand TESCAN, located in the Laboratory of Multiusers of the Institute of Chemistry of UFU (IQ/UFU). Gold was used at a voltage of 5 kV to metallize the fibers.

#### 2.2.1.3 Contact angle analysis

Contact angle measurements were performed using a contact angle equipment of Theta Lite Optical Tensiometer, model TL100, with 60 frames per second CCD, located in Laboratory 06 of the Federal University of the Triângulo Mineiro (UFMT), Univerdecidade II campus, Uberaba/MG. A syringe type Hamilton, 100 microliters of capacity with a volume drop of 5 microliters. The contact angle was used to evaluate the surface energy of cellulose and of the cellulose with latex molded by the Hatschek method. The solvent used to measure the contact angles was deionized water.

#### 2.2.2 Cement, latex and metakaolin characterization

The cement, latex and metakaolin were analyzed by X-ray diffraction to determine its characteristic peaks. The analysis were performed in the same apparatus and for the same configurations used for cellulose. The SEM analyzes of latex were performed in the same apparatus and for the same configurations used for cellulose. For that, removed the moisture from the investigated samples, in an oven, at  $45 \pm 1 \text{ }^\circ\text{C}$  for 24 h [16]. For the sample whose cross section of the latex was evaluated, the integrity of the cross-sectional structure was insured by immersing the sample in liquid nitrogen and fracturing it using a tweezer. The mechanical properties of the latex were evaluated by direct tensile test, using the Instron brand machine, model 5982, with a 5 kN load cell was used. This test was performed according to the parameters used by [18] for determination of plastic tension. By this test, it was possible to determine the tensile strength, maximum deformation and Young's modulus characteristic of latex. The Instron brand test machine, model 5982, with a 5 kN load cell was used for the test. The chemical, physical and mechanical analysis of the cement was performed by the Lafarge Holcim manufacturer. The chemical composition, granulometric composition, physical properties and pozzolanic activity of metakaolin were obtained through the material data sheet provided by Metacaulim do Brasil [17] on its website. The Materials and Structures Laboratory of the Federal University of Paraná (UFPR) made the analysis of the chemical composition.

2.3 Design of experiments (DOE)

The experiments were molded into a fixed volume (160 cm<sup>3</sup>) and were carried out according to a central composite design (CCD). CCD with four center points and using alpha for orthogonality of 1.41421, resulting in 18 experiments. Table 1 shows the limits of the factors studied and the respective values coded and uncoded for a percentage of cellulose in the mixture (X<sub>1</sub>), latex (X<sub>2</sub>) and metakaolin (X<sub>3</sub>).

The effect of the independent variables on each response variable was studied using a CCD and the response surface method developed by the software *Statistica12*. The studied response variables were fitted in a quadratic model using linear regression analysis and *p-value* less than 0.10 (*p* < 0.10) were considered

statistically significant. The coded variables were determined by equations 1, 2 and 3:

$$X_1 = \frac{(Cel_{(\%) } - 5.0)}{3.5} \tag{1}$$

$$X_2 = \frac{(Lat_{(\%) } - 0.115)}{0.095} \tag{2}$$

$$X_3 = \frac{(Mk_{(\%) } - 19)}{15} \tag{3}$$

Where Cel, Lat e Mk are coded variables of percentage of cellulose, latex, and metakaolin, respectively.

Table.1: Coded and uncoded levels of variables used for central composite design.

Parameters	Symbol		Coded levels				
	Uncoded	Coded	-1.414	-1	0	+1	+1.414
Cellulose (%)	Cel	X <sub>Cel</sub> (X <sub>1</sub> )	0.05	1.5	5.0	8.5	9.95
Latex (NRL) (%)	Lat	X <sub>Lat</sub> (X <sub>2</sub> )	0	0.02	0.115	0.21	0.249
Metakaolin (%)	Mk	X <sub>Mk</sub> (X <sub>3</sub> )	0	4.0	19	34	40

2.3.1 Optimization

The nature of the stationary point was determined by canonical analysis. This technique consists of a translation of the origin of the response surface (*x1, x2, x3, ..., xk*) = (0,0,0, ..., 0) for the stationary point. Consequently, the canonical form of the adjusted surface is written as a function of new variables (*w1, w2, w3, ..., wk*), whose axes correspond to those of the main system contours. The optimal conditions of percentage of cellulose (%Cel), percentage of latex (%Lat) and percentage of metakaolin (%Mk) for the variables responses were determined by canonical analysis. Equation 4 represented the function in terms of these new variables [19].

$$\hat{y} = \hat{y}_0 + \lambda_1 w_1^2 + \lambda_2 w_2^2 + \dots + \lambda_k w_k^2 \tag{4}$$

After the translation of the response surface into the canonical form, the signal and magnitude of the stationary point of the characteristic roots  $\lambda_i$  can determinate the nature of the stationary point. Therefore, if  $\lambda_i < 0$ , a move in any direction from the stationary results in a decrease in  $\hat{y}$ , which means that the stationary point is a point of maximum. In contrast, if  $\lambda_i > 0$ , the stationary point is a point of minimum. If  $\lambda_i$  have a different signal, the stationary point represents a saddle point. In this work, the canonical analysis was implemented using the software *Maple 17*.

2.4 Composites preparation

The mixing and preparation of the composites were carried out using the principle of the Hatschek process

[20]. Initially, the cellulose was incorporated into the water, followed by latex, cement and metakaolin. To each material added to the mixer, the mixture was stirred for 5 min until its complete homogenization. The mass solids concentration, for each composite, was 40%. The specimens had dimensions of 20 cm x 20 cm the side and 4 mm in thickness.

2.5 Composites characterization

2.5.1 Flexural strength test

Flexural tests was performed at 28 days of age. The rupture test method used was the four-point flexural test recommended by [21], in which the load application is done in two points of the sample, generating a constant moment between the points of load, using a Universal Machine of Instron brand tests, model 5982, and load cell of 5 kN. The distance between the lower supports was 150 mm and the load application speed was 2 mm/min.

III. RESULTS AND DISCUSSION

3.1 Characteristics of materials

3.1.1 Cellulose kraft pulp, cement, latex and metakaolin  
The composites were molded using cellulose, with the specific mass of 1.5 g/cm<sup>3</sup>, extracted from *Eucalyptus urograndis*. In the process of obtaining the cellulose pulp, a solids content of 13.33% [22] was obtained after the filtration step. The mechanical and chemical properties of Portland cement CPV ARI presented values according to the requirements of ABNT NBR 16697:2018. Natural

rubber latex with a solids content of 43.33% by weight was obtained after drying the emulsion according to [16]. According to with the chemical characterization of metakaolin, it presents expressive percentages of  $\text{SiO}_2$  (51.57%) and  $\text{Al}_2\text{O}_3$  (40.5%), making approximately 92% of these two compounds. It also has small amounts of  $\text{Fe}_2\text{O}_3$  (2.8%),  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$  (< 1%) [17].

### 3.2 Materials characterization

#### 3.2.1 Cellulose characterization

##### 3.2.1.1 X-ray diffraction analysis (XRD)

The diffractogram of the bleached cellulose *kraft* pulp is shown in Fig.1a. Two diffraction peaks characteristic of cellulose were observed. The first peak occurred in  $2\theta$  between  $18^\circ$  and  $19^\circ$ , while the second corresponded to  $2\theta$  between  $22^\circ$  and  $23^\circ$ , both of the type I polymorph of native cellulose [23].

##### 3.2.1.2 Scanning electron microscopy (SEM)

Fig.1b shows the micrograph of the bleached cellulose *kraft* pulp. It was possible to observe that the structure of the cellulose was intact, which, possibly, will distribute stresses in the matrix of the composites, increasing the resistance and energy absorption. According to the analysis and direct measurement in the micrograph of the individual fibers of *Eucalyptus urograndis*, using ZEN Lite 2012, an average diameter of  $12.4 \mu\text{m}$  was observed. The length of the eucalyptus fibers, as presented in the literature is between 0.89 and 0.98 mm [24,25].

##### 3.2.1.3 Contact angle analysis

This analysis was done for the first value of the contact angle after stabilization of the water drop on the surface of the sample. The contact angle of the samples with latex was significantly higher in comparison with the pure cellulose sample ( $p < 0.05$ ). The CLH samples had a contact angle

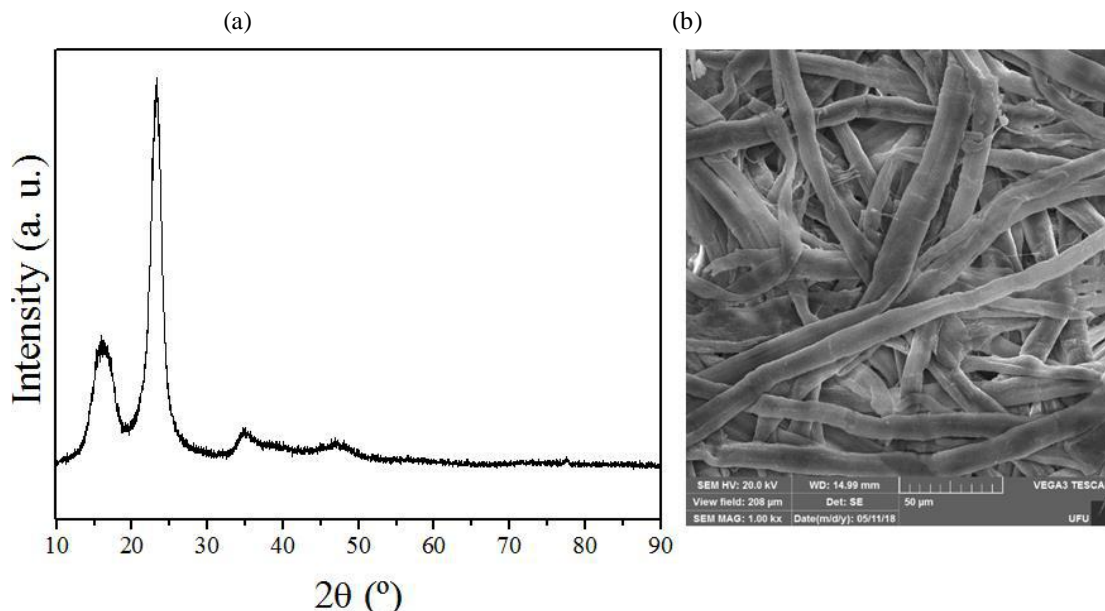


Fig. 1. a) XRD patterns of the bleached cellulose kraft; b) SEM cellulose kraft.

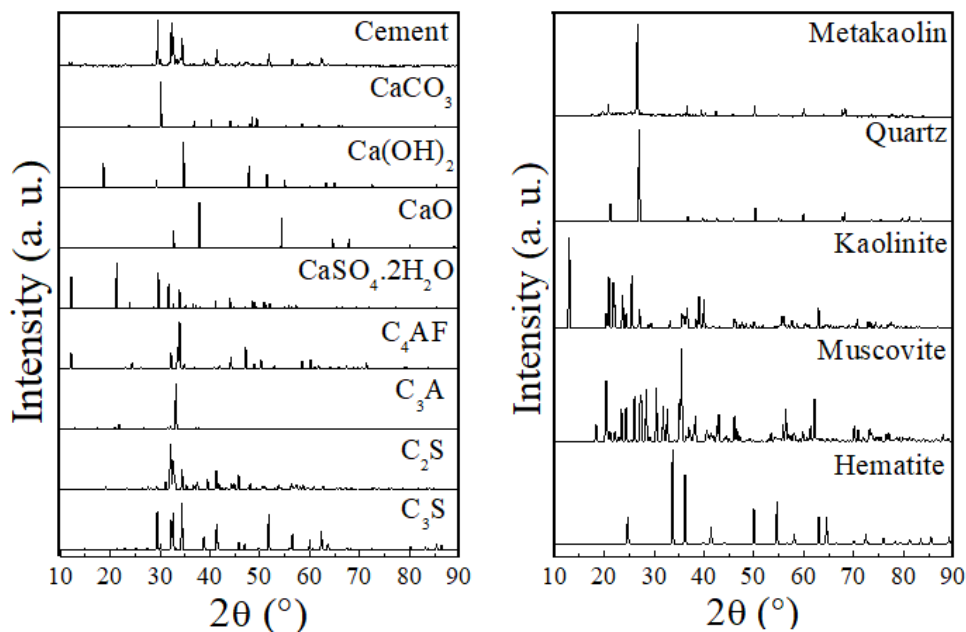
of  $92.56^\circ$  compared to  $73.89^\circ$  for pure cellulose. The pure cellulose presented a rapid dispersion of the water droplets and, consequently, a contact angle of less than  $90^\circ$ , that is, the sample surface is extremely hydrophilic, while the samples with latex addition (CLH) had contact angles higher than  $90^\circ$ , which implies that the latex hydrophobized the sample eventually. This occurred because the latex possibly forms a film that protects the fiber, occupying partially the empty spaces and, consequently, occurring its hydrophobization [26,27].

(a)

#### 3.2.2 Cement, latex and metakaolin characterization

Fig.2a shows of the diffractograms of the CPV ARI cement. It was possible to prove the presence of the main constituents of the CPV ARI cement, such as tricalcium silicate ( $\text{C}_3\text{S}$ ) and dicalcium silicate ( $\text{C}_2\text{S}$ ), whose most prominent diffraction peaks are coincident because they have similar chemical composition. These coincident peaks presented values of  $2\theta$  equal to  $29.5^\circ$ ,  $32.3^\circ$ ,  $33.3^\circ$ ,  $34.4^\circ$  and  $41.3^\circ$  (ICSD 64759 and ICSD 963). The tricalcium silicate also showed values of  $2\theta$  at  $30.1^\circ$ ,  $38.8^\circ$ ,

(b)



(c)

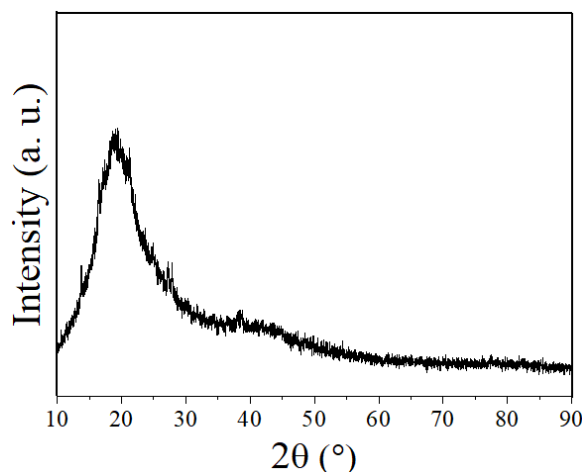


Fig. 2. XRD patterns: a) CPVARI cement; b) Metakaolin; c) Latex (NRL).

45.8° and 51.8° (ICSD 64759), among others.

Figs. 2b e 2c show metakaolin and latex (NRL) diffractograms, respectively. According to Fig.2b, it was possible to prove the presence of the main constituents of metakaolin, such as quartz ( $\text{SiO}_2$ ), kaolinite ( $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$ ), muscovite ( $\text{KA}_2(\text{Si}_3\text{AlO}_{10})(\text{OH})_2$ ) and hematite ( $\text{Fe}_2\text{O}_3$ ). The quartz showed peaks in values of  $2\theta$  equal to 21°, 25.3°, 26.6°, 42.5°, 50°, 59.9° and 68.2° (ICSD 89281). The kaolinite peaks were at 21°, 27.1°, 36.5°, 39.4°, 45.9°, 50°, 54.7° and 67.7° (ICSD 80082), among others, and possibly indicate that the clay did not suffer total calcinations [29].

In addition to the XRD characterization, it is important to note that the metakaolin is a material of great pozzolanic activity because it presents a consumption of 771.2 mg of CaO/g of sample, obtained through the Modified Chapelle method. The limit for considering a

material as low reactivity is 330 mg of CaO/g of sample [17].

According to Fig. 2c, the NRL is an amorphous polymer having a typical diffractogram of this type of material. It presents a wide spreading shoulder centered at  $2\theta$  equal to 19°, attributed to the amorphous regions of the sample and absence of crystalline peaks. [28,29] reported similar results in their studies. In addition, according to the SEM analysis, it was observed that the latex sample presented a continuous, smooth matrix with the homogeneous surface along the length. Fig. 3 shows the stress curves versus deformation for the seven tensile test NRL specimens. It can be concluded that the latex has a low tensile strength and great deformability (ductile) with deformations above 300%. These characteristics are typical of an elastomeric material (Callister, 2000). The NRL specimens had low

Young's modulus and tensile strength, with a mean of 0.64 and 0.19 MPa, respectively.

Table 2. The experimental conditions studied in CCD matrix, with uncoded values of parameters.

E*	Cel (%)	Lat (%)	Mk (%)	MOR (MPa)**	T (kJ/m <sup>2</sup> )***
1	1.5	0.02	4	9.11	0.08
2	1.5	0.02	34	8.85	0.1
3	1.5	0.21	4	7.23	0.07
4	1.5	0.21	34	8.78	0.11
5	8.5	0.02	4	9.1	1.12
6	8.5	0.02	34	7.29	1.03
7	8.5	0.21	4	13.26	1.69
8	8.5	0.21	34	14.42	1.68
9	0.05	0.115	19	6.75	0.04
10	9.95	0.115	19	4.54	0.68
11	5.0	0	19	10.29	0.5
12	5.0	0.249	19	13.73	0.48
13	5.0	0.115	0	10.91	0.29
14	5.0	0.115	40	12.57	0.52
15	5.0	0.115	19	11.42	0.45
16	5.0	0.115	19	12.47	0.47
17	5.0	0.115	19	9.03	0.37
18	5.0	0.115	19	10.93	0.47

\*E: Experiment; \*\*MOR: Modulus of rupture; \*\*\*T: Toughness.

### 3.3 Design of experiments (DOE)

#### 3.3.1 Global statistical analysis - effect of independent variables

Table 2 shows the values of the response variables (modulus of rupture and toughness) for the 18 experiments of the experimental design obtained by the flexural tests.

##### 3.3.1.1 Modulus of rupture

The empirical equation that represents the variation of the modulus of rupture in function of the independent variables was obtained by multiple regression, resulting in equation 5. Each parameter has a significance analyzed according to the probability value (*p-value*). This value tests the null hypothesis that the coefficient obtained for the variable is equal to zero, without effect. Thus, a *p-value* below 0.10 ( $p < 0.10$ ) indicates that the null hypothesis can be rejected and that the variable correlates with the response.

$$MOR(MPa) = 11.69 - 2.48(X_{Cel})^2 + 1.18(X_{Lat}) + 1.65(X_{Cel})(X_{Lat}) \quad (5)$$

Where, MOR is the modulus of rupture.

The quadratic term of percentage of cellulose ( $X_{Cel}$ ), the linear variable of the percentage of latex ( $X_{Lat}$ ) and the

interaction between both ( $X_{Cel})(X_{Lat}$ ) was significant for the modulus of rupture. The value of  $R^2$  of equation 5 was 0.72, that is, the equation significantly represented the modulus of rupture to a confidence level of 90%. Fig. 4 shows the response surfaces for the modulus of rupture. According to Figs. 4a and 4b, with values of metakaolin and latex at the center point, it has been found that there is a maximum value for the modulus of rupture when the amount of cellulose is close to the coded value of 0.5 (approximately 6.75% cellulose in the composite). The increase in the modulus of rupture to cellulose intermediate values possibly proves that, for approximately 6.75% of cellulose in the composite, there is a reduction of cracking and an increase of the performance due to the homogeneous dispersion and fibers adhesion on the matrix. Possibly, for lower quantities, there is a reduction in the modulus of rupture by the insufficient amount of fibers and, for higher quantities, due to the loss dispersion caused by a large amount of fiber. This same trend was observed in studies conducted by [31].

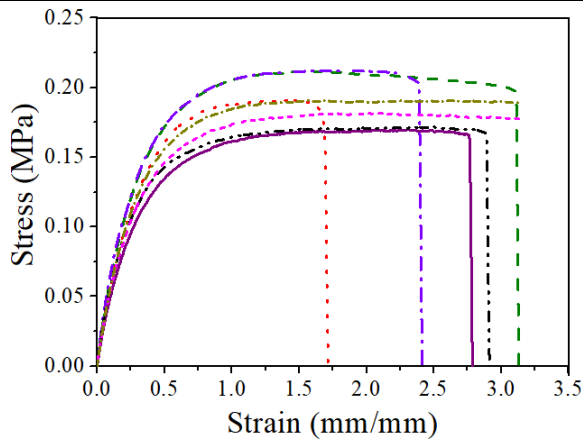


Fig. 3. Stress vs. deformation for the seven samples of the natural latex emulsion.

According to Figs. 4a ( $X_{Mk} = 0$ ) and 4c ( $X_{Cel} = 0$ ) observed that there was an increase in the modulus of rupture for larger amounts of latex in the mixture. [26] also observed an increase in the resistant capacity and attributed this fact to the greater amount of pozzolan adhered to the fibers surface that may have caused a local pozzolanic effect in the fiber-matrix interface. The pozzolanic reaction consumes portlandite and produces hydrated silicates and calcium aluminates that lower local pH and increase the strength and cohesion of the composites. Finally, by the Figs. 4b ( $X_{Lat} = 0$ ) and 4c ( $X_{Cel} = 0$ ), it was observed that the amount of metakaolin does not significantly interfere in the modulus of rupture within the intervals studied.

### 3.3.1.2 Toughness

The equation 6 represents the variation of the toughness in function of the independent variables, obtained by multiple regression.

$$T(kJ / m^2) = 0.56 + 0.51(X_{Cel})$$

(6)

Where, T is the toughness.

According to equation 6, only the linear variable of the percentage of cellulose ( $X_{Cel}$ ) was significant for the toughness, representing significantly the toughness for a 90% confidence level, because there was a dispersion of the data and the composites may present differences in their values ( $R^2 = 0.70$ ). Fig. 5 shows the response surfaces for the toughness.

Observing the Figs. 5a ( $X_{Mk} = 0$ ) and 5b ( $X_{Lat} = 0$ ), it was observed that the highest toughness values are obtained when the cellulose percentage in the mixture increased, independent of the concentrations of latex and metakaolin. This may be possibly explained by greater control of cracks propagation. The higher values of

toughness could possibly indicate a fracture of the composite by pull out fiber due to the higher energy consumption [32].

### 3.3.2 Optimization

#### 3.3.2.1 Optimization and canonical analysis for the modulus of rupture

In order to analyze the response surfaces and perform optimization of the response variables was done the canonical analysis. Thus, response functions of the modulus of rupture were expressed in terms of new variables (canonical)  $w_1$ ,  $w_2$ , and  $w_3$ , and are given by equation 7, for the modulus of rupture.

$$\hat{y} = 10.38 - 2.69w_1^2 + 0.44w_2^2 + 1.05w_3^2 \quad (7)$$

According to the resulting values for the roots of the equation  $\lambda_1$ ,  $\lambda_2$  and  $\lambda_3$ , the stationary point is a saddle point of the adjusted surface because the roots presented different signals ( $\lambda_1$  was negative and,  $\lambda_2$  and  $\lambda_3$  were positive). The values obtained for the stationary point of  $X_I$

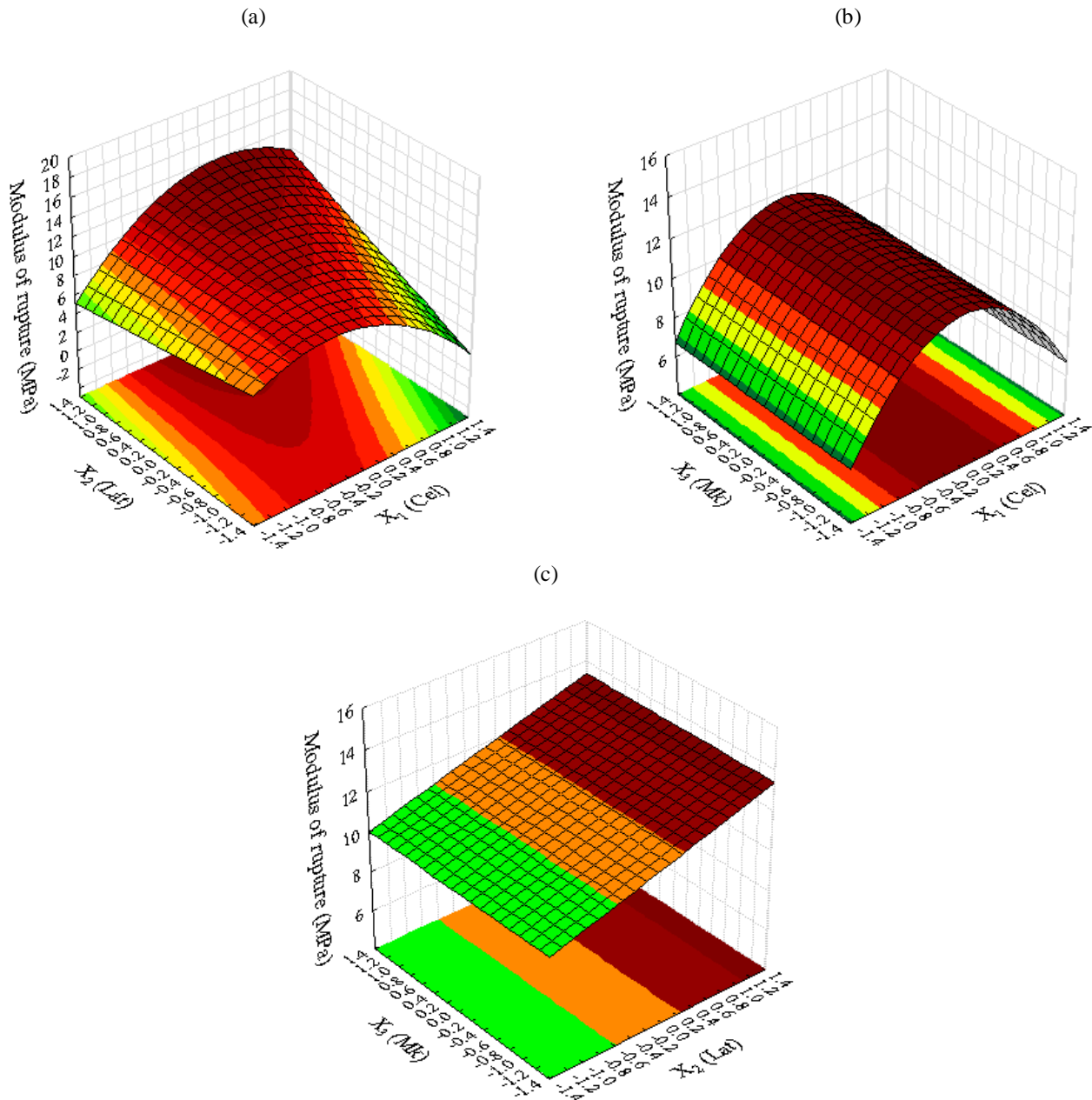


Fig. 4. Response surface of the modulus of rupture: (a)%metakaolin at the central level ( $X_3 = 0$ ); (b)% latex at the central level ( $X_2 = 0$ ); (c)% of cellulose at the central level ( $X_1 = 0$ ).

(%cellulose),  $X_2$  (%latex), and  $X_3$  (%metakaolin) were equal to -0.137, -0.740, and 0.141, respectively, and within the experimental region. That is, they did not exceed the values of  $+\alpha$  (+1.41421) and  $-\alpha$  (-1.41421). These values for the variables  $X_1$ ,  $X_2$ , and  $X_3$  are physically possible to be applied to the mixture, as they result in positive percentages of cellulose, latex, and metakaolin.

Analyzing the coding equation of each variable (equations 1, 2 and 3), the restrictions, for percentage of cellulose, latex and metakaolin were, respectively:

$X_1 \geq -1.429$ ,  $X_2 \geq -1.211$  and  $X_3 \geq -1.267$ . Once,  $X_1 < -1.429$ ,  $X_2 < -1.211$  and  $X_3 < -1.267$  result in physically impossible values, that is, negative amounts of the reagents. By studying the adjusted surface in the canonical form for the modulus of rupture, it was concluded that the response increases in the direction  $w_2$  and  $w_3$  and decreases in the direction of  $w_1$ . As the objective of the analysis is to increase the value of the modulus of rupture, it was chosen to vary the  $w_3$  values because it has a greater influence on the response than  $w_2$  because it has a higher coefficient

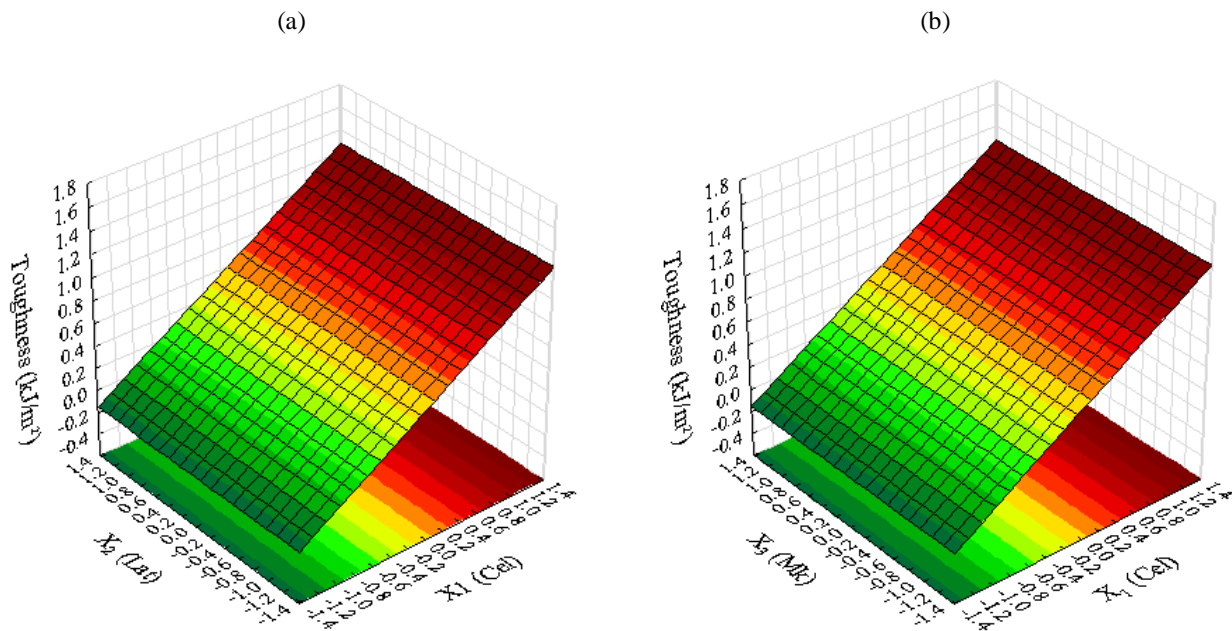


Fig. 5. Response surface of the toughness: (a) %metakaolin at the central level ( $X_2 = 0$ ); (b) %latex at the central level ( $X_2 = 0$ ).

( $\lambda_3 = 1.050$  and  $\lambda_2 = 0.435$ ), and values that resulted in zero for  $w_1$  (negative root) and  $w_2$ . It was possible to relate the canonical variables with the three independent variables ( $X_1$ ,  $X_2$ , and  $X_3$ ), according to equation 8.

$$w = M'(X - X_0) \quad (8)$$

Developing the equation 8, it was obtained the following recurrence equations:

$$\begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} = \begin{bmatrix} 0,3987X_1 - 6,7792 - 0,9014X_2 - 0,1690X_3 \\ -0,3338X_1 + 1,9165 - 0,3143X_2 + 0,8887X_3 \\ 0,8542X_1 - 2,7682 + 0,2979X_2 + 0,4262X_3 \end{bmatrix}$$

With conditions found for  $X_1$ ,  $X_2$ , and  $X_3$  and applying the value of zero for  $w_1$  and  $w_2$ , the various values of  $w_3$  obtained are listed in Table 3. By analyzing the values listed in Table 3, for values of  $w_3 \leq -1.0$ , it can be concluded that the values for  $X_2$  are physically impossible, resulting in negative amounts of the latex according to the restrictions imposed by the coding equations ( $X_2 \geq -1.211$ ).

Therefore, the most appropriate condition, according to acceptable composites characteristics, which optimizes the modulus of rupture, was  $w_3 = 4.0$ , where:

$X_1 = 0.599$ ,  $X_2 = 2.682$  and  $X_3 = 2.077$  (only  $X_1$  is within the studied range). For this optimized condition where  $w_3 = 4.0$ , the percentage of cellulose is 7.097% (within the range studied), latex is 0.370% (outside the range studied) and metakaolin is 50.155% (outside of range studied), resulting in a modulus of rupture of 27.190 MPa. However, it was observed that there are higher optimization results for the modulus of rupture, but for a very large amount of metakaolin in relation to the amount of cement, that, possibly, would generate insufficient hydration products (calcium hydroxide) to be consumed by metakaolin.

By the study of the response surfaces, the maximum value for the modulus of rupture was approximately 14 MPa as shown in Fig. 4a. Through the optimization, it was possible to find a modulus of rupture of 27.190 MPa, for a variable within the studied range ( $X_1 = 0.599$ ). The value experimental obtained was 12.29 MPa. It can be seen that the results were very coherent with respect to the optimization property, that is, the composite to obtain the major modulus of rupture was the one that presented the highest value of MOR among the optimal composites. The optimal value experimental obtained were much lower when compared with the value obtained in the



Table.3: Values of  $w_3$  according to the values of  $X_1, X_2,$  and  $X_3$ .

$w_3$	-2	-1	0	1	2	4	4.5	8	10	11
$X_1$	-0.505	-0.321	-0.137	0.047	0.231	0.599	0.691	1.335	1.703	1.887
$X_2$	-2.451	-1.596	-0.740	0.115	0.971	2.682	3.109	6.104	7.815	8.670
$X_3$	-0.827	-0.343	0.141	0.625	1.109	2.077	2.319	4.013	4.981	5.465

optimization, as was expected, once was much higher than that found in the literature.

### 3.3.2.2 Optimization and canonical analysis for the toughness

The equation 9 represents the surface adjusted for the calculation of the toughness in function of new canonical variables ( $w_1, w_2,$  and  $w_3$ ).

$$\hat{y} = -1.44 + 0.018w_1^2 + 0.09w_2^2 + 0.186 w_3^2 \quad (9)$$

Given the results of the values for the roots of the equation  $\lambda_1, \lambda_2$  and  $\lambda_3$  (all roots were positive), the adjusted surface has a minimum point. Still, any movement in directions of  $w_1, w_2,$  and  $w_3$  will increase the toughness. For the stationary point, it was observed that only the value of  $X_3$ (%metakaolin) was within the experimental region ( $X_3=0.518$ ). The value of variable  $X_1$  (-8.819) is physically impossible because the amount of cellulose in the mixture would be negative (uncoded cellulose value equal to -25.867%). The toughness increases in all directions ( $w_1, w_2,$  and  $w_3$ ), and in order to maximize the response,

the values of  $w_3$  were varied, because it had the largest coefficient, with the highest influence on the final response, determining conditions of  $X_1, X_2,$  and  $X_3$  that zero the values of  $w_1$  and  $w_2$ .

The canonical variables were related to the three independent variables ( $X_1, X_2,$  and  $X_3$ ), according to equation 8. Developing this equation, obtained the following recurrence equations:

$$\begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} = \begin{bmatrix} 0,8348 X_1 + 9,9208 - 0,5464 X_2 - 0,06745 X_3 \\ 0,0063 X_1 - 0,0403 + 0,1318 X_2 - 0,9913 X_3 \\ 0,5505 X_1 + 0,9772 + 0,8271 X_2 + 0,1134 X_3 \end{bmatrix}$$

Based on the recurrence equations, the conditions found for  $X_1, X_2,$  and  $X_3$  and applying the value of zero for  $w_1$  and  $w_2$ , the various values of  $w_3$  obtained were listed in Table 4.

Table.4: Values of  $w_3$  according to the values of  $X_1, X_2,$  and  $X_3$ .

$w_3$	-2	-1	0	1	5	10	15	16.5	19	20
$X_1$	-9.918	-9.368	-8.817	-8.267	-6.064	-3.313	-0.560	0.265	1.641	2.192
$X_2$	2.964	3.790	4.617	5.444	8.751	12.886	17.019	18.260	20.327	21.154
$X_3$	0.277	0.393	0.508	0.624	1.085	1.662	2.239	2.413	2.701	2.816

According to Table 4, for values of  $w_3 \leq 10$ , the values of  $X_1$  are physically impossible, because, by the restrictions imposed, it must be greater than -1.429. Therefore, in order to not extrapolate the limits of the constituents adopted, the condition chosen was  $w_3 = 16.5$ , where:  $X_1 = 0.264$  (within the studied range),  $X_2 = 18.265$ , and  $X_3 = 2.413$ . For this optimized condition, in the decoded values, 5.928% of cellulose, 1.850% of latex and 55.195% of metakaolin were obtained, resulting in a toughness of 48.921 kJ/m<sup>2</sup>. It was possible to achieve higher values for toughness. However, it would be necessary to replace large quantities of cement with metakaolin, which would be impracticable due to the insufficient production of calcium hydroxide to be consumed by metakaolin. The value experimental obtained was 1.08 kJ/m<sup>2</sup>. The optimal value experimental obtained were much lower when compared with the value

obtained in the optimization, as was expected, once was much higher than that found in the literature. As was found for the modulus of rupture, the best result found for the toughness by analyzing the response surfaces was the formulation of experiment 8 (8.5% cellulose, 0.21% latex, and 34% metakaolin). This condition resulted in an approximate value of 1.6 kJ/m<sup>2</sup>.

## 3.4 Composites characterization

### 3.4.1 X-ray diffraction analysis (XRD)

Fig.6 shows the normalized XRD diffractograms of the composites. The ettringite (3CaO.A1<sub>2</sub>O<sub>3</sub>.3CaSO<sub>4</sub>.32H<sub>2</sub>O), the hydrated calcium silicate (C-S-H), the portlandite (Ca(OH)<sub>2</sub>), the calcite (CaCO<sub>3</sub>) and the quartz (SiO<sub>2</sub>) were the main hydrated compounds identified. It was possible to verify the presence of ettringite in the composites whose main peaks were 2 $\theta$  equal to 26.3°, 32.7° and 41.4°

(ICSD 155395). The portlandite identification indicates that there is remaining lime even after 28 days of age. The presence of calcium hydroxide is essential for the determination of

metakaolin reactivity, because, possible, it is responsible for the portlandite consumption in the pozzolanic reactions.

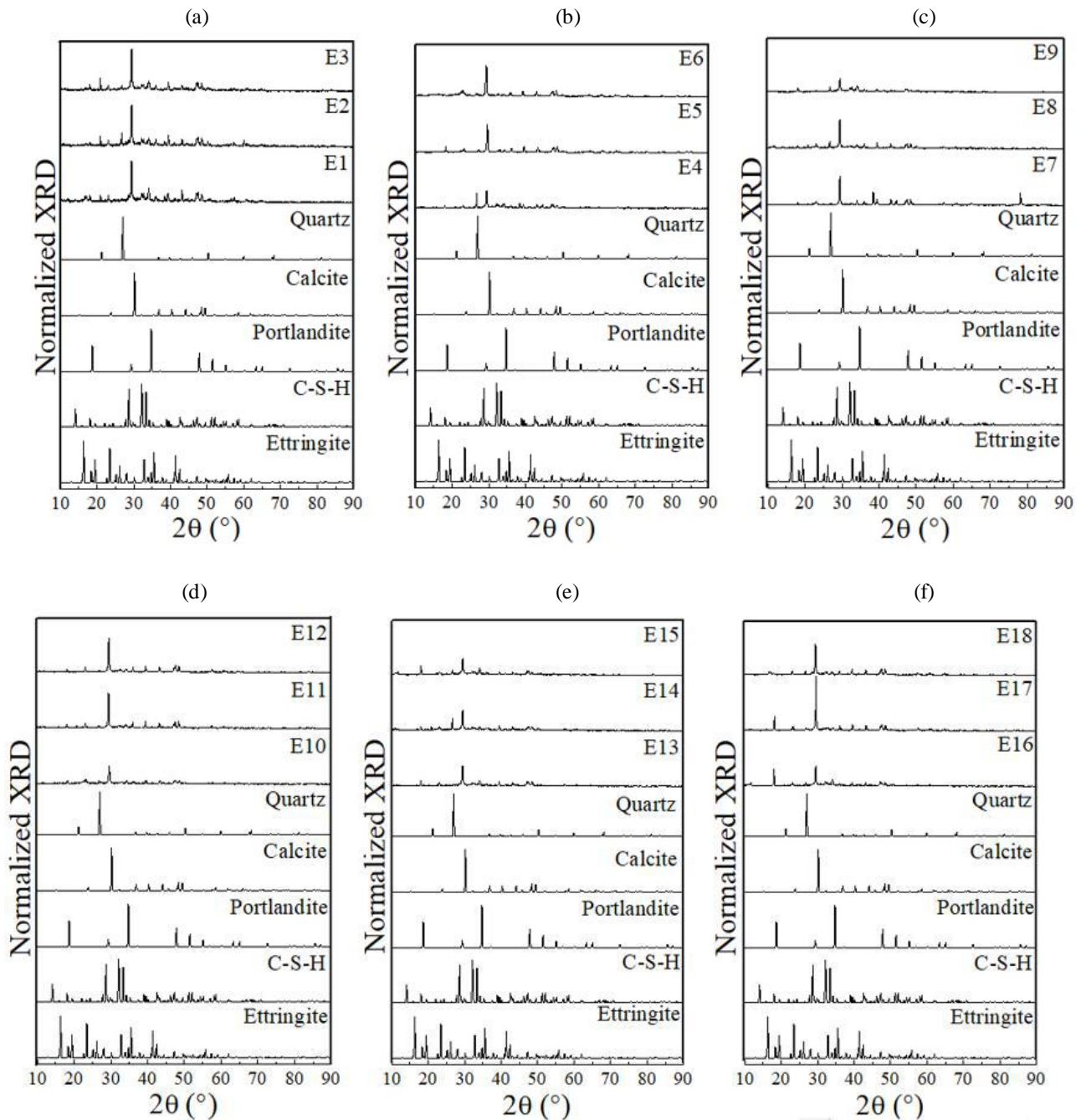


Fig.6. Normalized XRD diffractograms of the composites: a) E1, E2, E3; b) E4, E5, E6; c) E7, E8, E9; d) E10, E11, E12, e) E13, E14, E15; f) E16, E17, E18.

Thus, analysing the main characteristic portlandite peaks in  $2\theta$  equal to  $18^\circ$ ,  $34.2^\circ$  and  $47.7^\circ$  (ICSD 15471), it was observed that the higher the amount of metakaolin in the composites, the lower the intensity of the peaks related to the portlandite. There was a significant reduction of calcium hydroxide for a replacement of 40% of the total mass of cement by metakaolin, which possibly decreased

the matrix alkalinity. The calcite presence in  $2\theta$  equal to  $30^\circ$ ,  $37^\circ$ ,  $44^\circ$  and  $48.4^\circ$  (ICSD 150) indicates that

carbonation reactions may occur during the composites curing period. Still, the calcite can come from the limestone filler that forms the anhydrous cement. Finally, the diffractograms presented the main quartz peak at  $2\theta$

equal to  $26.8^\circ$  (ICSD 89281), possibly from the crystalline structures of metakaolin that did not participate in the pozzolan reaction. The quartz peak was higher in the composites with higher amounts of metakaolin (%metakaolin  $\geq 19\%$ ). Some of the main peaks of ettringite, C-S-H, portlandite, calcite and quartz possibly

could not be identified due to the small amount present in the composite and/or overlap of the peaks. Similar results were reported by [33,34].

### 3.4.2 Scanning electron microscopy (SEM)

Fig. 7 shows rupture sections micrographs of the experiments at 28 days of age.

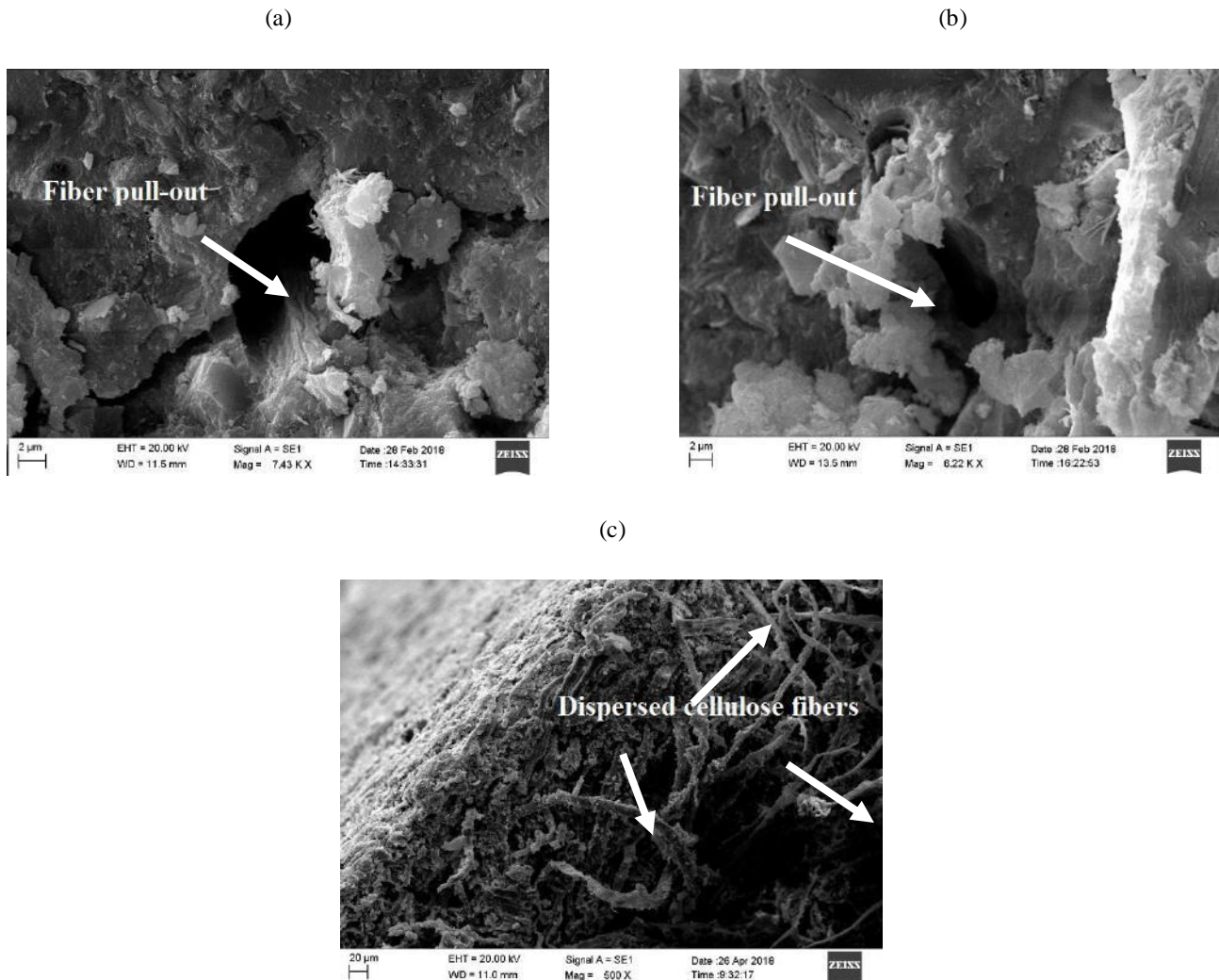


Fig. 7. Rupture sections micrographs of the experiments flexural testes at 28 days of age:

a) Experiment 2; b) Experiment 8; c) Experiment 10.

In general, a dense matrix was observed, with few pores and well adhered to the fibers. It was not possible to note the detachment of the fibers in the interface region that would be provided by the volume variation due to the high water absorption. The fibers were preserved intact even for small pulp contents (<2%), experiment 2 (Fig. 7a), for example, these were pull-out during the flexure test. In the experiment 8 (Fig. 7b), it was observed that the fiber fracture mechanism was by extraction and not by rupture, which possibly provided the highest value of toughness found in the flexural strength tests ( $1.68 \text{ kJ/m}^2$ ) [7,35]. In the analyzed points, a homogeneous dispersion of cellulosic pulp was observed in the whole matrix even for

composites with high fiber contents, for example, in experiment 10 (Fig. 7c), whose fiber percentage was 9.95%. However, it is not possible to affirm the absence of agglomerations that would eventually damage the composite performance, because the value of the modulus of rupture for these experiments (experiment 10, for example, whose modulus of rupture was  $4.54 \text{ MPa}$ ) was lower when compared to the others. The possible deposition of hydration products on the surface of the fibers was observed.

#### IV. CONCLUSION

From the results obtained after the flexural tests and their optimization, it was concluded that the use of NRL in cementitious composites, considering the adopted molding method, was effective because it allowed a possible polymer impregnation in the vegetal natural fibers, hydrophobizing it. Experimentally the optimized formulation obtained a toughness of 1.08 kJ/m<sup>2</sup> with 5.90% cellulose, and in the DOE the experiment 8 presented the best toughness value (1.68 kJ/m<sup>2</sup>) with 8.5% cellulose. The best modulus of rupture was the 12.29 MPa presented by the composite with 7.097% cellulose, 0.37% latex and 50.155% metakaolin. Therefore, with the molding method adopted and considering the limits of constituents used, the reinforced composites with cellulose pulp, latex and metakaolin presented a good performance at 28 days of age.

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# Estimation of Energy Flux and Biomass in Pasture Areas through Remote Sensing Techniques

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**Abstract**— Pasture production is estimated through remote sensing techniques with the aid of models and algorithms. The application with no need for extensive field measurements is one of the advantages of the Surface Energy Balance Algorithm for Land (SEBAL). The objective of this work was to estimate energy fluxes and, subsequently, pasture biomass with the aid of remote sensing techniques. The study area is located on the Experimental Farm of Embrapa Beef Cattle, municipality of Campo Grande, State of Mato Grosso do Sul, Brazil. For the implementation of the SEBAL and estimation of energy fluxes and biomass of the pasture areas, meteorological data and Landsat 5 - TM image were used. It was found that the technique has the potential to be applied to indicate the forage availability and to support decision-making in the planning and management of the extensive production of beef and milk cattle, with economic and environmental sustainability of pasture areas.

**Keywords**— geotechnology, livestock, SEBAL, sustainability, rural planning.

## I. INTRODUCTION

The growing demand for food further reinforces the importance of increasing production with economic and environmental sustainability. Vilela et al. [1] have reported that intensifying and enhancing the efficiency of production systems may help to harmonize these interests. Hence, the sustainable use of pastures is a strategic issue, since most pasture areas are show some indication of degradation. The recovery of these areas may reduce the pressure for the opening of new farming and livestock frontiers, as well as contributing to diminishing the emission of greenhouse gases [2].

According to Dias-Filho [3], the support capacity would be the most flexible indicator to quantify the degradation of a given pasture. Currently, the only official parameter that is related to support capacity is the pasture stocking rate. This parameter has been presented by DIEESE [4],

and it is the result of the division of the number of animals by the area occupied by pastures of a given geographical unit. However, Dias-Filho [5] warns that a priori, it is not possible to guarantee the degradation condition of pasture only by evaluating its instantaneous support capacity (maximum number of animals supported by pasture, with no harm to pasture and to the animal).

Studies such as that carried out by Grigera et al. [6] highlight the potential of remote sensing techniques as a tool to assist in the implementation of systems for monitoring pasture production that makes it possible to identify, for example, the areas that require the adoption of acceptable management practices. Thus, models and algorithms are used to estimate pasture production using remote sensing techniques. One of these algorithms is the SEBAL (*Surface Energy Balance Algorithm for Land*) that was developed by Bastiaanssen et al. [7, 8].

One of the advantages of SEBAL is the flexibility in its structure so that other models can be coupled [9], facilitating the applications in studies carried out at a local and regional scale, with no need for extensive field measurements (Andrade et al. [10]). In order to estimate the above-ground biomass, Bastiaanssen and Ali [11] and Samarasinghe [12], among others, obtained good results by coupling the model of biomass accumulation proposed by Monteith [13] in the SEBAL associated with the model of efficiency use of the radiation that was structured by Field et al. [14]. As a result, the objective of this study was to estimate energy fluxes and, therefore, pasture biomass through the application of remote sensing techniques.

## II. MATERIAL AND METHODS

The study area is located in the Experimental Farm of Embrapa Beef Cattle, municipality of Campo Grande, state of Mato Grosso do Sul, Brazil (Figure 1). According to the climatic classification of Köppen, the region is situated in a transition zone between humid temperate climate with hot summer (Cfa) and tropical climate with

dry winter season (Aw). The average annual temperature is 22.8°C, and the average annual rainfall is around 1,500 mm. The months with the lowest rainfall are June, July, and August. The soil in the study area is Red Latosol

Dystrophic class whose characteristic is a clayey texture, acid pH, low base saturation and high aluminum concentration [15].

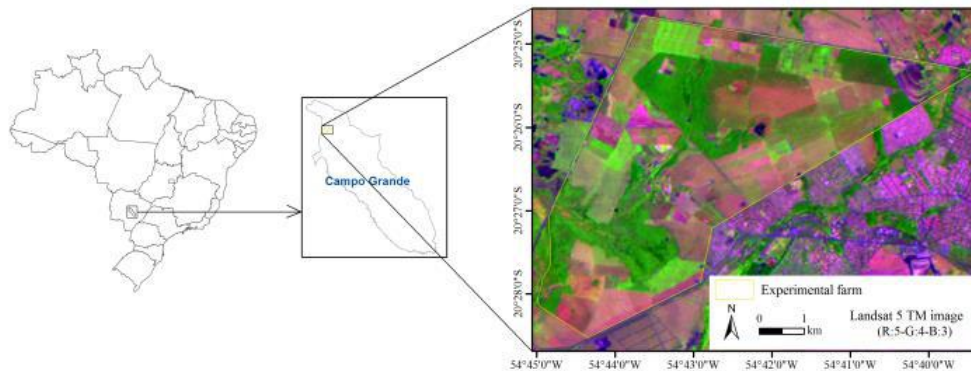


Fig. 1. Visualization of Experimental Farm of Embrapa Beef Cattle, municipality of Campo Grande, state of Mato Grosso do Sul, Brazil.

Meteorological data (air temperature, radiation, and wind speed) from the National Institute of Meteorology were obtained from meteorological station, latitude 20.45°S, longitude 54.6166°W and 530 meters above sea level in the municipality of Campo Grande, state of Mato Grosso do Sul, Brazil and from Landsat 5 - TM image of 12/21/2003 that has spatial resolution of 30 m at bands 1, 2, 3, 4, 5 and 7, and of 120 m in band 6 (thermal), acquired through the image catalog of the National Institute of Space Research - INPE, when accessing the site <http://www.dgi.inpe.br/CDSR/>.

The algorithm SEBAL was applied by using the data to estimate the components of the energy fluxes from pixel by pixel. In this case, the latent heat flux component was estimated as a residue of the other components of the energy balance, according to equation [7]:

$$LE = Rn - H - G$$

Where LE is the latent heat flux, Rn is the radiation balance, H is the sensible heat flux, and G is the soil heat flux, all in W m<sup>-2</sup>. The radiation balance (Rn) was the first variable of the energy balance equation to be obtained. In this case, the equation suggested by Allen et al. [9] was applied:

$$Rn = R_{s\downarrow} - \alpha R_{s\downarrow} + R_{L\downarrow} - R_{L\uparrow} - (1 - \epsilon_o) R_{L\downarrow}$$

Where, R<sub>s↓</sub> is the short-wave incident radiation (W m<sup>-2</sup>), R<sub>L↓</sub> is the longwave radiation emitted by the atmosphere in the direction of the surface (W m<sup>-2</sup>), R<sub>L↑</sub> is the longwave radiation emitted in the direction of the atmosphere (W m<sup>-2</sup>) and ε<sub>o</sub> is the emissivity of the surface (dimensionless), α is the surface albedo (dimensionless). Allen et al. [9] show in detail the procedures involved in obtaining Rn.

After the calculation of Rn, the empirical equation suggested by Bastiaanssen [16] was used to estimate the soil heat flux (G, W m<sup>-2</sup>), given by:

$$G = \left[ \frac{T_s}{\alpha} (0.0038\alpha + 0.0074\alpha^2)(1 - 0.98NDVI^4) \right] Rn$$

Where, T<sub>s</sub> is the surface temperature (°C), α is the surface albedo (dimensionless), NDVI is the Normalized Difference Vegetation Index and Rn is the radiation balance. In order to correct the soil heat flux values for water bodies (NDVI < 0), G = 0.3Rn was considered [17]. Once the value of G was obtained, a new series of steps was started to obtain the sensible heat flux (H).

For the estimation of H, the process started by considering the neutral atmosphere condition. Firstly, the expressions suggested by Allen et al. [9] to obtain the initial roughness parameter (z<sub>om initial</sub>), the initial friction velocity (u\*<sub>initial</sub>), the wind velocity at a height (z) of 100 m (blending height), where it is assumed that the surface roughness effects are negligible) and the initial aerodynamic drag (τ<sub>ah initial</sub>). The roughness parameter (z<sub>om</sub>) obtained as a function of SAVI (Soil Adjusted Vegetation Index) was used in the following steps.

SEBAL uses two pixels termed “anchor pixels” to set boundary conditions for the energy balance. These pixels are denominated “hot” and “cold” and located in the study area. The “cold” pixel can be selected on a well-irrigated crop surface that completely covers the soil with the vegetation or the surface of a pond. In this case, the “cold” pixel was selected on the surface of a lake. The air temperature near the surface and the surface temperature are considered equal for that pixel. Thus, zero value was assumed for the sensible heat flux (H) and the maximum latent heat flux was determined. The “hot” pixel was selected in a dry farming field, with soil exposed or without vegetation, where the zero value was considered for the latent heat flux (LE) and thus, maximum sensible heat flux was obtained [9, 18].

The correlation coefficients a and b were used with the aid of the anchor pixels to obtain dT in each pixel. Because in the cold pixel dT = 0, that is, there is a system

with two equations and two unknowns, which enabled the calculation of a and b and then the initial sensible heat flux ( $H_{initial}$ ) was obtained. The next step was to consider the condition of atmospheric stability, making corrections in the values of H in the iterative process. Therefore, the Monin-Obukhov similarity theory (L, in m) was applied to know the stability condition of the atmosphere, that is, whether it is unstable ( $L < 0$ ), stable ( $L > 0$ ) or neutral ( $L = 0$ ). In sequence, through the formulations suggested by Allen et al. [9]), it was possible to obtain the values of the stability corrections for the transport of momentum ( $\psi_m$ ) and sensible heat ( $\psi_h$ ) and the friction velocity ( $u^*$ ) was estimated considering the atmospheric condition [9, 18]:

$$u_* = \frac{k u_{100}}{\ln\left(\frac{z}{z_{0m}}\right) - \psi_{m(100m)}}$$

By using the corrected value of  $u^*$ , the aerodynamic drag ( $r_{ah}$ ) corrected for the stability conditions of the atmosphere was obtained:

$$r_{ah} = \frac{\ln\left(\frac{z_2}{z_1}\right) - \psi_{h(2m)} + \psi_{h(0.1m)}}{u_* k}$$

After that, the temperature difference function (dT) was recalculated by repeating the procedures mentioned above until stability in the successive values of dT and  $r_{ah}$  for the hot pixel was observed. Finally, the latent heat flux (LE) was obtained as a residue of the classical equation of the energy balance.

The components of the energy balance were used to estimate the evaporative fraction ( $\lambda$ ) [9, 10]:

$$\lambda = \frac{LE}{LE + H} = \frac{LE}{Rn - G}$$

The evaporative fraction was used to estimate plant biomass. For this purpose, the photosynthetically active radiation (PAR,  $W m^{-2}$ ) and the fraction of the intercepted PAR ( $F_{PAR}$ ,  $W m^{-2}$ ) were estimated using the equations [11]:

$$PAR = 0.48 K_{daily}^{\downarrow}$$

$$F_{PAR} = -0.161 + 1.257 NDVI$$

Where,  $K_{daily}^{\downarrow}$  is the incident solar radiation on a daily scale, given in  $W m^{-2}$ .

After the estimation of PAR and  $F_{PAR}$ , PAR absorption by vegetation ( $APAR$ ,  $W m^{-2}$ ) can be determined using the equation [11]:

$$APAR = F_{PAR} \times PAR$$

At this point, when the scalar water availability (W) was replaced in the model proposed by Field et al. [14]. By the evaporative fraction ( $\lambda$ , [19]) it was possible to estimate the efficiency of the use of radiation ( $\epsilon_f$ ) by:

$$\epsilon_f = \epsilon_f^* T_1 T_2 \lambda$$

Where,  $\epsilon_f^*$  is the maximum efficiency of the use of the radiation, equal to  $2.5 g MJ^{-1}$  [20, 21]; and  $T_1$  and  $T_2$  are temperature scales. Afterward, the above-ground plant biomass was obtained through the model proposed by Monteith [14] and applied by Bastiaanssen and Ali [11] and Teixeira et al. [22]:

$$Bio = \epsilon_f (APAR(t))$$

Where Bio is the plant biomass in the period t ( $kg m^{-2}$ ).

### III. RESULTS AND DISCUSSION

Figure 2A shows the estimated albedo map for the pasture areas of the Experimental Farm of Embrapa Beef Cattle. It is observed that the albedo was higher than 0.35 in pixels of the image highlighted in orange and red, probably in places with soil exposure, dry vegetation or post-grazing period (residual grass). On the other hand, albedo values in green shades, ranging from 0.21 to 0.28, are located in areas of wet (darker) soils or better vegetation vigor. Andrade et al. [23] obtained, for cultivated pasture area, an average albedo value of 0.225. However, in places of soil exposure or dry vegetation, albedo values between 0.30 and 0.40 were observed. In a study of Moura et al. [24], in pasture areas in the Amazon region, values of average albedo hours of 0.197 and 0.204 were observed for the rainy and dry seasons, respectively.



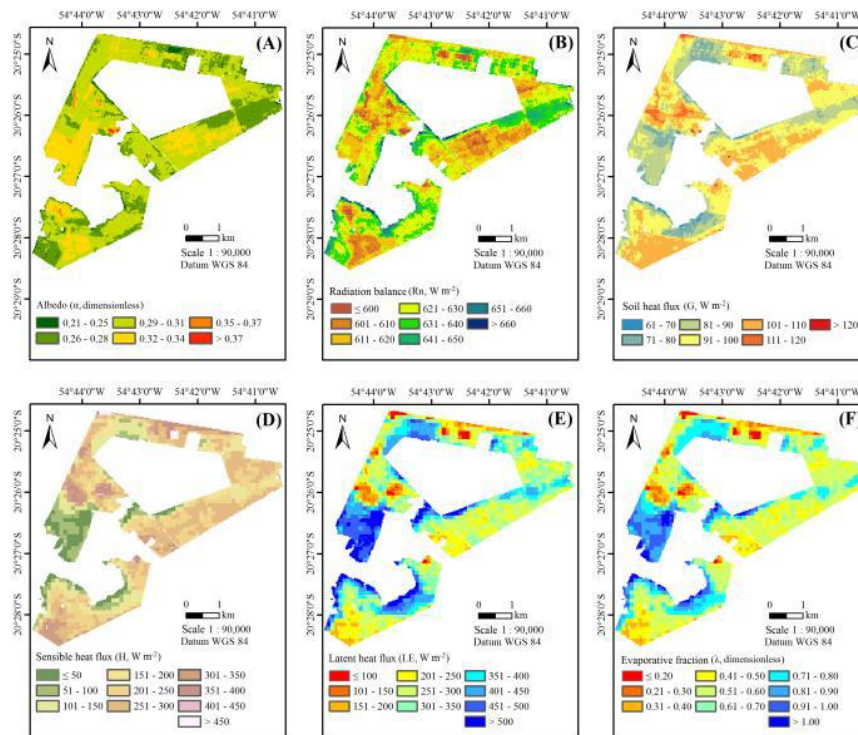


Fig. 2. Visualization of the maps generated from the application of the SEBAL algorithm and TM – Landsat 5 to estimate: (A) albedo ( $\alpha$ , dimensionless), (B) radiation balance ( $R_n$ ,  $W m^{-2}$ ), (C) soil heat flux ( $G$ ,  $W m^{-2}$ ), (D) sensible heat flux ( $H$ ,  $W m^{-2}$ ), (E) latent heat flux ( $LE$ ,  $W m^{-2}$ ) and (F) evaporative fraction ( $\lambda$ , dimensionless) of the pasture areas of the Experimental Farm of Embrapa Beef Cattle, Campo Grande, state of Mato Grosso do Sul, Brazil.

The radiation balance ( $R_n$ ) of pasture areas, in most of the area, varied between 610 and 650  $W m^{-2}$  (Figure 2B). However, significant spots of  $R_n \leq 600 W m^{-2}$  were found in pasture areas with a predominance of exposed soil or water deficit and values of  $R_n > 660 W m^{-2}$  in areas of dense vegetation and with no water restrictions. In a study by Santos et al. [25] in the Amazonian biome using MODIS images and SEBAL algorithm combined with data of micrometeorological tower in the pasture area, obtained  $R_n$  values for the geographic location of the tower varying from 475.10  $W m^{-2}$  to 599.44  $W m^{-2}$ .

In relation to the soil ( $G$ , Figure 2C), sensible ( $H$ , Figure 2D) and latent ( $LE$ , Figure 2E) soil heat fluxes, it was found that pasture areas with water deficit or soil exposure showed, as expected, higher components of  $G$  and  $H$  and lower for  $LE$ . However, an inverse condition was observed when analyzing these components of energy fluxes in pasture areas with dense vegetation or with no water restrictions. In this case, it was found values of  $G \leq 90 W m^{-2}$ ,  $H \leq 150 W m^{-2}$  and  $LE > 350 W m^{-2}$ . By using the Bowen's ratio method, Biudes et al. [26] observed that, on average, pasture areas had  $LE$  of 319.7  $W m^{-2}$  and 259.7  $W m^{-2}$  in rainy and dry seasons, respectively. For the  $H$  component, the authors observed the average values of 239.4  $W m^{-2}$  and 159.3  $W m^{-2}$ , for rainy and dry seasons, respectively. In relation to the heat flux in the soil ( $G$ ), Biudes et al. [26] verified average values of 41.4  $W m^{-2}$  and 37.6  $W m^{-2}$  in rainy and dry

seasons, respectively. In our study, values of  $G$  predominated in the range of 61  $W m^{-2}$  to 120  $W m^{-2}$ . In this case, Galeano et al. [27] estimated the maximum value of  $G$  within this range of variation (106.4  $W m^{-2}$ ).

Figure 2F shows the evaporative fraction ( $\lambda$ , dimensionless) estimated for pasture areas. It is observed that the greater evaporative fraction of pasture areas is represented in shades of blue ( $\lambda > 0.70$ ). According to Figures 3A and 3B, vegetation indices ( $NDVI \geq 0.5$  and  $IAF \geq 2.0 m^2 m^{-2}$ ) indicate good vegetation development in these areas. For pasture areas, Rubert et al. [28] observed an annual average value of the evaporative fraction of 0.71, with minimum and maximum values of 0.54 and 0.89, respectively.

Figure 3C shows the map of the biomass availability estimate (Bio,  $kg/ha$ ) of the pasture areas after the application of the SEBAL algorithm and TM – Landsat 5 image. It is observed that on pastures with the predominance of exposed soil (brown class) the Bio was below 1000  $kg ha^{-1}$ . On the other hand, in some pasture areas, represented on the map in shades of blue, the Bio was above 7000  $kg ha^{-1}$ . Barbosa et al. [29] obtained a biomass availability of *Panicum maximum cv. Mombaça* of 7200  $kg ha^{-1}$  in the summer and 2400  $kg ha^{-1}$  in winter. Carnevali [30] analyzed the availability of this forage in pre- and post-grazing submitted to combinations of grazing intensities and frequencies in rotational stocking observed variation between 4300 and 8900  $kg ha^{-1}$  in pre-

grazing. Nevertheless, the observed values oscillated between 1400 and 4920 kg ha<sup>-1</sup> in the post-grazing according to the height of the residue and time of year. In a study carried out by Iwamoto et al. [31] to evaluate the production of Tanzania grass under different nitrogen rates and discontinuous grazing, biomass availability at the highest dose (450 kgN ha<sup>-1</sup>) was 2970, 4160 and 4600 kg ha<sup>-1</sup> in the fall, spring and summer, respectively. Even

so, Yet, Barbosa [15] studied the Tanzania grass in the Experimental Farm of the Embrapa Gado de Corte, obtained biomass availability ranging from 3650 to 7490 kg ha<sup>-1</sup> in the pre-grazing. However, in the post-grazing, the observed values varied between 2000 and 4300 kg ha<sup>-1</sup>, according to the height of the residue and time of the year.

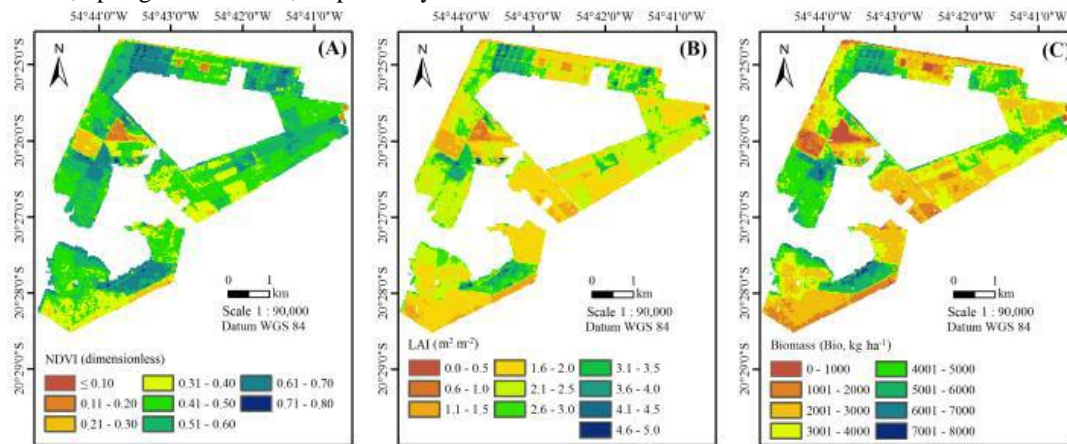


Fig. 3. Visualization of the maps generated from the application of the SEBAL algorithm and TM – Landsat 5 to estimate: (A) normalized difference vegetation index (NDVI, dimensionless), (B) leaf area index (LAI, m<sup>2</sup> m<sup>-2</sup>) and (C) aboveground plant biomass (Bio, kg ha<sup>-1</sup>) of the pasture areas of the Embrapa Experimental Beef Cattle Farm, Campo Grande, state of Mato Grosso do Sul.

Figure 4 shows the comparison of the average biomass availability data observed by Barbosa [15] together with the average data estimated with the aid of SEBAL and TM – Landsat 5 images for experimental pasture area in 15 pickets with Tanzania grass in 6 treatments (25/100; 25/95; 50/100; 50/95 and 50/90) in intensity combinations (residues from 25 to 50 cm) and frequencies (90, 95 and 100% light intercepted by the canopy) of monitored defoliation based on the predetermined condition of the canopy structure over the evaluation period. The average value observed for the 15 pickets with Tanzania grass was 4009 kg ha<sup>-1</sup>. However, the average value was estimated at 3689 kg ha<sup>-1</sup>, with an average difference between the observed and estimated values of 320 kg ha<sup>-1</sup> (8.68%) (Figure 4). Figure 5 shows that the estimated average values had a coefficient of determination (R<sup>2</sup>) of 0.7108. In this case, the adjustment between the observed and estimated average data is considered reasonable.

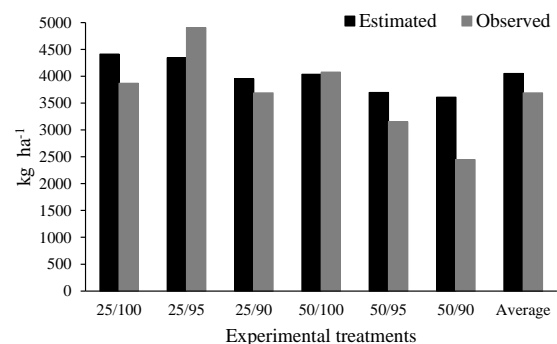


Fig. 4. Average biomass data (kg ha<sup>-1</sup>) observed and estimated for the 15 pickets with Tanzania grass under different treatments (residue/ light interception: 25/100; 25/95; 25/90; 50/100; 50/95 and 50/90 – according to Barbosa [15]).

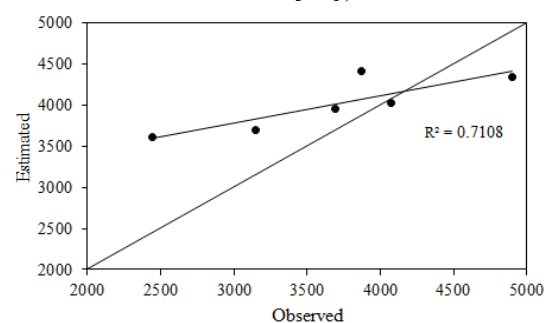


Fig. 5. Visualization of the adjustment between the observed and estimated average biomass data (kg ha<sup>-1</sup>).

It should be emphasized that, in complementary studies, it is interesting to use high spatial resolution images (such as Geoeye, Rapideye, Worldview, among others) for estimating the biomass and thus to evaluate the adjustment between the observed and the estimated data. However, since these images do not have a thermal band for SEBAL application, the SAFER (*Surface Algorithm For Evapotranspiration Retrieving*) algorithm appears as one of the alternatives [22]. It is worth mentioning that there is also the possibility of using Unmanned Aerial Vehicle (UAV), which can be boarded with cameras for the imaging of surface targets in visible (RGB), near-infrared (NIR) and thermal bands, generating data in which the algorithms and models can be later applied to extract information of the targets of interest with very high spatial and temporal resolution, for example, in the estimation and monitoring of the biomass and hydric conditions of pastures on a picket scale.

#### IV. CONCLUSION

In general, it is concluded that the application of remote sensing techniques associated with models and algorithms, appears as a relevant alternative for estimation of biophysical parameters and indicator of forage availability in different time and space scales. These geotechnical tools also stand out for the possibility of performing several types of monitoring that can assist the farmer in making decisions regarding the planning and management of the extensive production of beef cattle and milk, taking into account, for example, analyses of indicators related to the economic and environmental sustainability of pasture areas.

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# Basic Sanitation in Porto Velho: the worst Brazilian Capital in this Area

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**Abstract**— Basic sanitation, consisting of water supply, sanitary sewage, stormwater drainage and solid waste management, is fundamental for the quality of life of the population, reduction of public health expenditures, as well as contributing to the attraction of investments. In Brazil, the progress of these services to reach the goal of universalization is modest and Porto Velho, capital of Rondônia and located in the Brazilian Amazon, is against this advance. Its indicators show that among the 100 largest Brazilian cities in terms of population (including all capitals), its ranking of sanitation is the worst of all. This paper presents several data on sanitation in Porto Velho, comparing the evolution of its sanitation ranking and its Gross Domestic Product (GDP) ranking from 2003 to 2016, the consequences of the deficiency of these services and analyzes of current investments compared to the goals established for the universalization of sanitation in the municipality. Driven in recent years, mainly by the construction of two large hydropower plants, the population and its GDP grew, but sanitation did not follow this evolution as it should. The conclusion was that there are several problems due to the deficiency of sanitation in the city and the investments planned will not be enough to reach the goal of universalization, needing to raise more resources and prioritize the effective execution of the works contracted.

**Keywords**— sanitation, Porto Velho.

## I. INTRODUCTION

Sanitation, according to the World Health Organization [1], is the control of all factors of man's physical environment, which exert or can exert harmful effects on physical, mental and social well-being. Basic sanitation was defined by Law 11.445 [2], which establishes the basic guidelines for sanitation in Brazil, such as the set of services, infrastructures and operational facilities of: drinking water supply, sewage, urban cleaning, waste management drainage and storm water management. One of the fundamental principles of sanitation services is universalization.

Basic sanitation services are fundamental for the improvement of people's quality of life and in accordance

with the Brazilian Constitution [3], article 21, it is the responsibility of the Union to establish guidelines for urban development, including housing, basic sanitation and transport. The promotion of basic sanitation is a common competence of the Union, States and Municipalities, according to article 23. Finally, article 30, says that it is the responsibility of the Municipality to organize and provide, directly or under a concession or permit system, public services of local interest, which are essential, such as basic sanitation.

Investments in basic sanitation in cities should be one of the priorities of the public administration, aiming to provide adequate housing conditions for its inhabitants and attract more investments of industries, services and commerce. According to [4], for each US\$ 1 invested in the sanitation sector, the Brazilian economy would have an increase of US\$ 11,8 in the gross value of domestic production. Notwithstanding the fact that the economy is accounting for health expenditures due to diseases caused by lack of basic sanitation. According to the WHO, this ratio is as follows: for every US\$ 1 invested in water and sanitation, US \$ 4,3 in health costs are saved in the world [5]. A population that does not have sanitation is ill. From 20% to 30% of Brazilian households are precarious urban settlements and there are cases of waterborne diseases such as hepatitis, diarrhea, cholera, among others [6].

In Brazil, according to the latest diagnosis of water and sewage services in 2017, published by the Ministry of Cities [7], 83,5% of the population has access to a drinking water network and 52,4% of the population has network services sewage collector. Of all sewage generated, 46,0% was treated. The total investments in 2017 in the country were of US\$ 2,86 billion in water supply and sewage. In relation to GDP - Gross Domestic Product, this represents only 0,16% of the national GDP calculated at US\$ 1,74 trillion in 2017 [8].

ABRELPE - Brazilian Association of Public Cleaning and Special Waste Companies published in its latest survey of solid waste in Brazil in 2017, that the collection of municipal solid waste reached 91,2% of the total generated, which corresponds to almost 78,4 million tons.

Of this total collected, 59,1% are destined to landfills, 22,9% for controlled landfills and 18% for landfills [9].

According to the latest diagnosis of the 2017 rainwater service published by the Ministry of Cities [10], 51.8% of the municipalities have drainage systems only, and only 16.2% have urban public roads with solutions for natural drainage. In relation to rainfall drainage, [11] reported that losses due to floods in urban drainage in Brazilian cities have increased exponentially, reducing quality of life and value of properties. This process is due to the urbanization and consequent sealing together with the plumbing runoff.

The Brazilian National Sanitation Basic Plan established that the universalization of water and sewage services be accomplished by 2033. And for that, it was estimated that investments of US\$ 80 billion over 20 years would be equivalent to US\$ 4 billion per year [12].

With a current estimate of 520 thousand population [8], the municipality of Porto Velho, according to the diagnosis of water and sewage services in 2017 [7], practically did not treat its sewage, only the insignificant 1,54% of all sewage generated was treated. Only 3,39% of the sewage generated was collected by public networks. Almost all sewage goes to sinkholes or drains into streams, streams and rivers that cut through the city. Only 33,5% of the population was served with a water network [7]. Regarding solid waste collection, according to the diagnosis of solid urban waste management in 2017 [10], the waste collection rate was 98%, however, the city did not yet have a landfill for adequate disposal collected. According to the diagnosis of drainage and storm water management in 2017 [13], in the years from 2013 to 2017, 12.327 population were displaced due to floods, with 40 events occurring in 2017 and 26,1% of households were at risk of inundation. Only 18,2% of the public roads had rainwater drainage networks.

In view of this scenario, this paper aims to show how perceptible it is that instead of following the modest evolution in the development of basic sanitation in Brazil, Porto Velho is going against the grain, making it the worst capital of the country in this aspect, despite its economic growth in recent years.

## II. METHODOLOGY

This work is a case study on sanitation in Porto Velho. The methodology used for the elaboration of this work was the data collection through bibliographical research on the indicators and facts related to basic sanitation in Porto Velho, besides an economic indicator of the municipality, GDP - Gross Domestic Product.

After obtaining this data, we performed:

- Analysis of the ranking of basic sanitation in comparison with that of the economic indicator;

- Description of the main problems in the basic sanitation sectors: water supply, sewage, urban drainage and solid waste;
- Analysis of the future scenario, based on the projection of the necessary investments for the universalization of the services and the current investments.

## III. RESULTS E DISCUSSION

### 3.1. Place of study: Porto Velho

The municipality of Porto Velho, capital of the state of Rondônia and located in the Brazilian Amazon, has a population estimated at 519.531 population for the year 2019, and in 2000 the population was 334.661 population. Average geometric growth of 2,34% per year, mainly due to the construction of two large hydropower plants: Santo Antônio HPP (3.568 MW of installed capacity and cost of US\$ 6 billion) and Jirau HPP (3.750 MW of installed capacity and cost of US\$ 8 billion) started in 2008. While in Brazil, the average growth was 1,12% per year in the same period. It has an area of 34.096 Km<sup>2</sup> - the largest Brazilian capital in territorial area (more extensive than countries like Belgium and Israel). The city began in the middle of the nineteenth century, in the first movements to build a railroad that made it possible to overcome the slope of the river Madeira (about 380 Km) and give vent to the rubber produced in and in the region of Guajará-Mirim, Santo Antônio do Madeira, in the province of Mato Grosso. It was the chosen location for the construction of the port where the rubber would be transshipped to the ships, then going to Europe and the United States of America. Difficulties in the construction and operation of a river port, in front of the rocks of the Santo Antônio waterfall, made builders and ship owners use the small Amazon port located 7 Km below, in a much more favorable place, where the village began. Created by Pathfinders around 1907, during the construction of the Madeira-Mamoré Railway, it became a municipality in 1914, when it still belonged to the State of Amazonas. In 1943, it became capital and, together with the municipality of Guajará-Mirim, it became the Federal Territory of Guaporé, which in 1956 was renamed Rondônia, and was elevated to status only on January 4 of 1982 [8].

The sanitation in Porto Velho began with the construction of three water boxes (considered a postcard of the city), also called Três Marias. They were designed and built by the American company Chicago Bridge & Iron Works, in the square that is in the center of the city, which bears the same name. Its purpose was to provide water supply to the families of the construction coordinators of the Madeira-Mamoré Railway. The first water tank was erected in 1910, and the other two in 1912. The capacity of each reservoir is 200.000 liters, which until 1957

supplied the capital, functioning by gravity. No less important than the Madeira-Mamoré Railway, the construction of the three Water Boxes was a milestone in the history of engineering in Rondônia. The construction was erected based on the information contained in cast iron plate, nailed to the pilasters of each one of them. There are three cylindrical shaped tanks, covered with conical shaped metal plates, and the base in a concave shape. Each tank is raised from the ground by four iron columns made of latticework over concrete foundation. They are surrounded at the height of the bulge, by a catwalk with a metal truss of railing, with access by stairs [14].

Following, with regard to the historical context of the basic sanitation of the municipality of Porto Velho, the following facts stand out [15, 16]:

- In 1924, the city received the first water distribution network;
- In 1950, the first Plan of the city was drawn up;
- In 1972, a new Plan was drawn up called the Immediate Action Plan;
- In 1978, the Road Plan was developed with the aim of increasing accessibility throughout the city;
- In 1983, the Special Project for Medium-sized Cities was drawn up;
- In 1987, a Master Plan was drawn up, concerned with land invasions and with the objective of organizing the areas of the city in zones;
- In 1989, Main Road Plan was elaborated, where urban drainage was still considered one of the main problems;
- In 1990, a new Master Plan was drawn up, where the urban infrastructure network was still one of the precarious points of the city;
- In 2004, a review of the Master Plan was carried out;
- In 2008, the Master Plan was revised again;
- In 2009, the Municipal Sanitation Basic Plan was elaborated;
- In 2013, the City Hall promoted the I Journey for Integrated Planning, where the Basic Sanitation Plan, Macro Drainage Plan and the National Solid Waste Plan were discussed;
- In 2014, the Complementary Law was drawn up, establishing the regular and selective collection in the municipality;
- In 2015, a review of the Municipal Sanitation Basic Plan was carried out.

Currently, basic sanitation is a responsibility of the Municipal Government, which directly manages solid waste management and storm drainage services. The water supply and sewage services were transferred through a Cooperation Agreement and Program Contract to CAERD - Water and Sewage Company of Rondônia, for 30 years, according to the Ordinary Law 1.803/2009.

### 3.2. Ranking: sanitation x GDP

The evolution of the municipality of Porto Velho over the years 2003 to 2016 was compared through the ranking of sanitation, published annually by the Instituto Trata Brasil, and the GDP (Gross Domestic Product) ranking published by IBGE - Instituto Brazilian Geography and Statistics, as shown in Fig. 01.

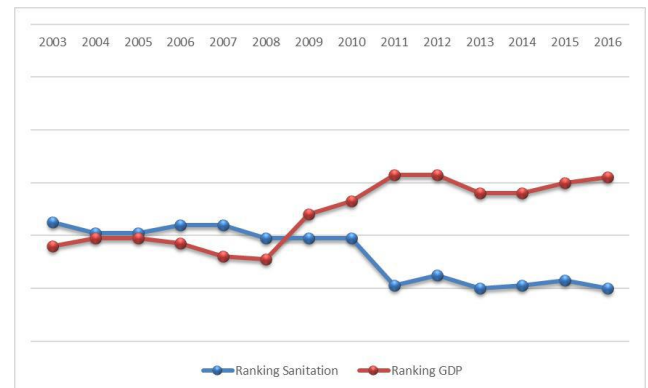


Fig. 1: Ranking Sanitation x Ranking GDP - Porto Velho.

It was observed that the GDP ranking improved over time, mainly from 2008 (coinciding with the start date of the construction of the two hydroelectric plants on the Madeira River), showing an economic growth of the municipality, while the sanitation ranking was contrary to this tendency, worsening over time, especially in 2010, where there was a significant increase in population due to the fact that the construction of hydroelectric dams and infrastructure for water supply and sewage remained practically the same since the 1970s.

What was expected would be just the opposite: the better the ranking of GDP, the better the ranking should be in sanitation, since if the municipality was improving its ranking in GDP - consequently it was in better financial condition and could invest in sanitation, improving its ranking in sanitation, which did not happen.

### 3.3. Water supply

The main problem of water supply is the shortage of service to the population of this service, with almost 400 thousand inhabitants without access to drinking water by public network. The consequence is the drilling of thousands of private wells to supply the buildings. However, according to the study [17], the aquifer Jaciparaná, which is located under the city and was widely exploited by the local population for water supply, was already contaminated by sinks constructed with an average depth of 2 meters. disposal of domestic waste, a reflection of the lack of sewage collection networks.

Another study of [18] on a spatial assessment of groundwater quality in the urban area of Porto Velho concluded that the water from the water table of the wells drilled in the city had high levels of bacteriological contamination, indicating the presence of fecal coliforms

and of total coliforms, that is, unfit for human consumption and in some cases even for other uses.

### 3.4. Sanitary sewage

The main problem is the lack of sewage collection service. This fact has two serious consequences: (a) drilling of sinks for the disposal of sewage generated in buildings, which contaminate groundwater, mainly with coliforms - as mentioned previously; (b) several places with sewage running in the open, contaminating the urban streams and proliferating diseases, especially with the occurrence of floods.

To illustrate this proliferation of diseases, a study published by [19] on the relationship between lack of sanitation and the occurrence of diarrhea, dengue and leptospirosis, showed that, in the period from 2007 to 2015, the 10 worst cities in the sanitation ranking (among them Porto Velho) had about 4,06 times more hospitalizations of diarrhea than the 10 best cities; 4.04 times more dengue hospitalizations; and 5,3 times more hospitalizations of leptospirosis.

The igarapés, which for 30 years were places of leisure, are now pollution points. Although it did not have a study that verifies the pollution of the seven igarapés of the city, a significant amount of rubbish and rubble thrown in its 40 kilometers was verified. This situation worsens during the drought. The adverse effects are most evident in the dry season, when the natural water flow is very small and insufficient to dilute the waste and waste that were improperly disposed of, according to a study carried out by the Amazon Protection System [20].

### 3.5. Urban Drainage

There are several studies that show that there are several areas at risk of flooding in the city, and are even repeatedly mentioned in the master plans elaborated. The city is located at an average altitude of 85m in the valley of the Madeira River between the Amazonian plain and the Brazilian central plateau. Therefore, the city does not have large variations of relief, which makes difficult the construction of urban drainage, being necessary the construction of deep galleries to allow the flow. The solution, so far, has been the use of the urban igarapés as macro drainage of the city [16]. However, the urban occupation on the banks of these igarapés were reducing their gutter, in addition to the contamination factors for the discharge of sewage and solid waste, according to the studies presented below.

According to a study carried out by [21] on the classification of risk in areas subject to flooding in the urban basins of the Big and Santa Bárbara streams, the annual recurrence precipitation presented intensity of 48 mm / h, with a precipitation of less than 14 mm / h is sufficient to cause flooding. This rainfall intensity is exceeded by 10% of the events recorded each year. In addition, three critical points were identified, which

presented rainwater impoundment, requiring intervention with engineering works, that is, scaling of the respective manholes.

In the study developed by [22], on the areas with potential flooding in part of the surroundings of the city of Porto Velho, the author reported in his conclusion that they occurred with the intensification of anthropic actions in potentially floodable places, soon unsuitable for housing and reinforced the importance of adopting properly planned and implemented territorial planning policies for sustainable development, thus seeking to avoid irreversible effects over time.

Another study, carried out by the Amazon Protection System (SIPAM) in partnership with the City Hall, showed that the capital of Rondônia has 16 areas at risk of flooding. The objective was to identify flood-prone areas and help the public authorities to plan strategic actions at these sites. Of the 27 points analyzed, 16 were subject to a rise in water level. Based on the scientific knowledge of these areas and the periodicity of the floods, the city may take structural measures, such as the expansion of manholes and bottlenecks in the streams. In the long term, the product can also be applied in the design of areas of APPs - Environmental Protection Areas - urban and urban land use planning [20].

According to the Flood Vulnerability Atlas [23], in Porto Velho, along the Madeira River, 37 flood areas were identified, of which 20 are highly vulnerable, which means a high risk of damage to human life and significant damage to essential services, public and residential infrastructure and facilities. In this sense, it is worth noting the recorded flood of the Rio Madeira in 2014. Considered the largest of them, Rio's maximum quota reached 19,69m (the historical peak previously recorded was 17,44m), and the quotas provided by the agencies competent, before this flood, were: 15,00 m for the attention quota, 16,00 m for the alert quota and 17.00 m for the flood quota. The maximum flow rate was 58.920 m<sup>3</sup>/s (the historical maximum flow registered previously was 48,565 m<sup>3</sup>/s), being more than 63 days with flows above 50,000 m<sup>3</sup>/s. In this flood of 2014, more than 100 thousand families were reached and more than US\$ 1,3 billion needed to heal the damages caused [24]. According to a report issued by the Federal Comptroller General's Office [25] on the situational diagnosis of the Madeira River flood in Porto Velho, the extent of the damage and the application of the resources made available by the Federal Government to assess the areas affected by the flood, totaling a volume of US\$ 1,7 billion.

### 3.6. Solid waste

The construction of a municipal landfill has been postponed and the estimated initial investment in 2014 was US\$ 14,6 million for the construction of the Waste



Treatment Center, which includes landfill, sorting center, composting plant and construction industry [16].

The selective collection serves only 25.74% of the population. There is an association of collectors of recyclable materials and more diverse collectors who do not belong to it. The recovery rate of recyclables compared to the generated waste is only 0,86% and the volume of 4,26 kg per inhabitant per year [10], while in Brazil the average recycling was 13% of waste generated [26].

Regarding the solid waste of the civil construction, the city hall does not have a suitable place for the destination of the same ones. Recently, held the First Symposium on construction waste whose purpose was to clarify that the City was regulating the management of this waste. There was only one company that did this recycling service and the city hall wanted to prepare the construction sector so that it could actually manage its waste [16]. According to [27], in Brazil, 90% of the waste generated by the works is recyclable and taking into account its continuous generation, the recycling of Civil Construction Waste is of fundamental environmental and financial importance in the sense of that the said residues return to the work in substitution for new raw materials that would be extracted from the environment. It is an activity that must be carried out in the very first place, but which can also be carried out outside it.

The management of the waste from the health services, from the collection to the final adequate disposal, is under the responsibility of its generators who must prepare the Health Services Waste Management Plan, as determined by Complementary Law 136/2001. For waste generated in public establishments, the city has an incinerator to carry out the appropriate disposal of the same.

Hazardous waste follows the requirements of Complementary Law 138/2001, which established the municipal environmental code, and its generators are responsible for everything from collecting, transporting to final destination. There are specialized companies in the city that carry out the collection of this waste and transport it to appropriate and legalized landfills in other states.

### 3.7. Future scenarios for basic sanitation in Porto Velho

The goals established in the PLANSAB - National Plan for Basic Sanitation [28], for the North region or specific for the state of Rondônia, are shown in Table 01.

Table.1. Basic sanitation goals for Rondônia or North region.

Year	Water supply*	Collect sewage*	Treatment sewage	Collects waste*	Select Collections	Floods
2010	84%	22%	62%	89%	5%	33%
2018	90%	47%	75%	93%	12%	--
2023	94%	63%	81%	96%	15%	--
2033	100%	94%	94%	100%	22%	6%

\* Specific target for Rondônia.

Source: PLANSAB - National Plan for Basic Sanitation [28].

According to the study carried out by the PMSS - Program for the Modernization of the Sanitation Sector specifically for the planning of water supply and sewage services in the state of Rondônia [29], referring to CAERD - Water and Sewage Company of Rondônia, which has the Porto Velho water and sewage services concession, the executive summary concluded that CAERD is in a vulnerable financial situation, requiring action on several fronts, requiring several strategic actions, among: (a) commercial policy focused on collection and search of customers with low implementation costs; (b) financial negotiation of the high indebtedness observed, which has a high degree of articulation with the governmental spheres; (c) increase, in a short period of time, the productivity of the main factors and production inputs - electricity, chemicals and personnel, with the purpose of reducing operating costs; (d) prioritize investments, at a first stage, with a high cost-benefit ratio, in order to generate the bases for a self-sustaining financial expansion; (e) combating delinquency, since the accumulation of uncollected and unpaid bills has been high.

With these shortcomings presented by the CAERD, one of the consequences for the municipality of Porto Velho was the absorption of the costs of other municipalities' systems and, thus, presenting low performance indicators, as reported in the conclusion of the aforementioned PMSS study.

In the study of [30] on the economic benefits of the expansion of sanitation in Rondônia, the investment necessary in 30 years for the universalization of water and sewage services throughout the state was US\$ 940 million, equivalent to 12,7 % of GDP in the state of Rondônia. According to the study's estimate, with the universalization of sanitation in Rondônia, there would be a total gain of US\$ 2,29 billion over 30 years, considering

as a consequence of the universalization: (1) gain with reduction of hospitalization costs; (2) reduction of loss of work; (3) increase in productivity at work - current generation and the new generation; (4) real estate valuation; (5) tourism. The final balance, considering the gains (US\$ 2,29 billion) minus the investment (US\$ 947 million), would be a positive balance of US\$ 1,34 billion over the 30 years considered.

In order to universalize all basic sanitation services in Brazil (water, sewage, waste and drainage) would require US\$ 133,7 billion from 2014 to 2033, according to PLANSAB - National Plan of Basic Sanitation [28].

Due to the lack of more in-depth studies on the real need for investments in Porto Velho for the universalization of basic sanitation, a simplified estimate was made: the per capita cost for Brazil was calculated (total investments / current population), reaching a value of US\$ 631/inhabitant. Considering the current population, it is estimated a total value of US\$ 329 million necessary for the universalization of basic sanitation services (water, sewage, waste and drainage).

Investments in water and sewage services in the city depend on external resources, since CAERD does not have the financial capacity to contribute them. Consulting the available data on PAC's website - Growth Acceleration Program (PAC in Portuguese), the federal government identified 10 projects that received funding from the PAC in Porto Velho to improve basic sanitation in the municipality, totaling US\$ 204,2 million, excluding there were 2 projects that did not have their values divulged due to the possibility of using the Differential Contracting System [31]. Summed up the investment disclosed for the construction of the landfill, initially estimated at US\$ 14,6 million [16]. However, many of these works were started and not completed.

Therefore, investments made in basic sanitation for Porto Velho totaled US\$ 218,8 million in recent years, but many of them with unfinished works, which corresponds to approximately 66% of the investment calculated to universalize basic sanitation services.

The indicator of investment in Porto Velho was only US\$ 1,57 per inhabitant in 2017, the lowest of all Brazilian capitals. While in Brazil, the total investment in the last 13 years was equivalent to US\$ 16,00 per inhabitant per year [32]. That is, an investment equivalent to only 9,8% of the average Brazilian value.

#### IV. CONCLUSIONS

Independently of the plans elaborated on the basic plan for the city of Porto Velho; despite the population growth in the last 19 years, above the Brazilian average; despite economic growth, GDP results in recent years - a proportional growth at least double that of the new city of the country; basic progress index in Porto Velho and in

the comparison of the GDP ranking, since, in comparison with the ranking of GDP improved and ranking of sanitation worsened.

Growth water indicators have declined over time - due to lack of investment and population growth; and yet since the mid-1970s the water supply network was practically the same - concentrating on the center of the capital. With regard to sanitary treatment, the extraction of water, water and water contaminate the average levels of water in the form of contaminated water. The urban drainage deficiency generates an urban pollution, and yet, there are several points of flood in the city, spreading waterborne diseases. The selective collection was done inappropriately, the selective collection was completed only 1/4 of the population and only 0,86% of the waste generated.

Considering the goals of universal sanitation established by PLANSAB - National Plan of Basic Sanitation, if there is no change of course and priorities, in addition to a strong investment action in the sector, the trend will be that the capital will not reach these goals until 2033. The current investments, if actually applied, will minimize the situation, but will not be sufficient to remove it from this serious situation in relation to basic sanitation, since they are equivalent to approximately 2/3 of the estimated investments required for universalization of the services in the capital of Rondônia, still missing the capture of 1/3 of the investments.

And finally, investing in basic sanitation reflects on the improvement of the quality of life of the population and economic gains for the municipality, as has already demonstrated numerous studies on the subject. Porto Velho, in the last decades, has always been against this strategic action. It is now time to change the course to eliminate the deficit generated, together with the new future demands with adequate technical solutions and effective actions within the deadlines established in the goals.

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# Physical and chemical analysis of *Cynoscionstriatus* fillets immersed under different saline concentration

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**Abstract**—The aim of this work was to accomplish an investigation post-treatment in *Cynoscionstriatus* fillets, using different concentrations of sodium tripolyphosphate and blends containing sodium tripolyphosphate and sodium chloride, and evaluate the weight of loss and their influence on the content of total protein, moisture and phosphate. Samples underwent four treatments: sodium tripolyphosphate solutions (TPFS) 2% and 10% and blends containing sodium tripolyphosphate with sodium chloride (NaCl) 2% and 10%. 148 fillets were immersed in each treatment for 2 hours and weighted individually at three moments: prior to immersion, post-immersion and post-defrosting. Gravimeter results showed weight gain in all treatments ( $p > 0.05$ ). When TPFS 2% (0.28%) and blend 2% (8.38%) were compared, samples immersed in  $Na_5P_3O_{10}$  revealed a weight gain ( $p > 0.01$ ). In treatments TPFS 10% (12.48%) and blend 10% (9.19%), the samples with only TPFS had weight increase ( $p > 0.01$ ). Solution with TPFS 10% within the context of the four treatments had the greatest weight in immersion (12.48%) and the lowest loss of water in defrosting (3.72%). Physical and chemical analyses for moisture, total proteins and phosphate had differences in weight for the four treatments ( $p > 0.01$ ), with the exception of the treatments blend 2% and blend 10%. The four treatments did not exceed the standard established by the Ministry of Agriculture (until 0.5% TPFS for every 100 g of fillet).

**Keywords**— blend, *Cynoscionstriatus*, freezing, gravimeter, striped; sodium tripolyphosphate.

## I. INTRODUCTION

Fish commercialization in Brazil is generally limited to fresh fish, which is composed about 60 to 80 % of water. The quality of the end-product is directly related to handling, storage and transport conditions (Santos, 2006),

and fish preservation methods are significant factors for the maintenance of the product's quality for the consumption.

Since water loss occurs in fish from capture to industrial processing, hydration and moisture retention of fish is highly recommended through the addition of phosphate as a guarantee of quality. Water loss during industrialization and storage is significant to determine the products quality and its shelf-life (Suñe et al., 2009). Sodium tripolyphosphate (TPFS) is one of the most employed phosphates in fish industry, since it is a compound that maintains moisture (FDA, 1993). Phosphates increase the capacity of retaining water, protect the product from oxidative rancidity, enhance quality and warrant improvement in taste (Marujo, 1988).

After capture, the myofibrillar proteins of fish deteriorate fast, at a refrigeration temperature of 5 °C and may lose 80 % of their water-retaining capacity in up to 5 days. If the proteins remain unprotected, significant loss occurs causing a lower net weight, with economical liabilities for the fish industry (Lampila, 1992; Schnee, 2004). The consumer is directly affected when fish loses great quantities of water, which involves loss of weight and quality, and may alter texture, color and tenderness of the fish fibers and, consequently, a low-quality product is obtained.

Phosphates restore the capacity of the proteins water retention, since they keep the products natural moisture and minimize loss by drip loss during freezing storage, defrosting and cooking. Sodium chloride (NaCl) presents an important role in increasing water retention capacity, reduces drainage and, together with phosphate, has a synergic effect. However, water retention capacity by fish fibers and TPFS activities at different concentrations has not yet been successfully explained. According to Castro

(2007), water retention capacity is directly related to the tenderness of processed products and decrease in size and tastiness is related to water loss during the products storage and cooking. According to the Brazilian legislation (BRASIL, 1970), up to 0.5 g of TPFS is allowed for every 100 g of fillet.

Based on the current problematic, the aim of this work was to accomplish an investigation post-treatment in *Cynoscionstriatus* fillets, using different concentrations of sodium tripolyphosphate and blends containing sodium tripolyphosphate and sodium chloride, and evaluate the weight of loss and their influence on the content of total protein, moisture and phosphate.

## II. MATERIALS AND METHODS

Fish fillets came from an industry from Porto Belo City, Santa Catarina State, Brazil. When fish was hauled up at the industrial premises, filleting was processed and 37 samples of fresh striped weakfish (*Cynoscionstriatus*) were retrieved for each of the four treatments: TPFS 2%; TPFS 10%; blend 2% (TPFS + NaCl) and blend 10% (TPFS + NaCl), with a total of 148 fillets.

All fillets were identified with a numbered tag and weighed individually on an analytic scale. They were weighed again after immersion and after defrosting. Weight gain was given in percentage (% w/w) as water absorbed after immersion (drained weight) and calculated according to Equation (1).

$$WG (\%) = \frac{\text{net weight} - \text{initial weight}}{\text{initial weight}} \times 100 \quad (1)$$

After weighed each one, fillet samples were immersed during 2 hours. After resting for 30 minutes to drain waste water, they were weighed again. Chemical analyses for protein, moisture and phosphate for each variable were undertaken for each treatment.

Samples were fast frozen in a freezing tunnel at -38°C after immersion. After a 22 day freezing, the fillets were thawed for 24 h at room temperature and samples were collected for physical and chemical analyses. Seven samples were collected at random from each of the four treatments. Three distinct instances were taken into account for physical and chemical analyses: fish fillet without any immersion; fish fillet after 2 h of immersion; thawed fish fillet after 22 days in a freezing chamber. Total proteins, moisture and phosphate rates were analyzed according to AOAC (1999).

Statistic SPSS 17.0 was used for statistical analysis. Data analysis was based on parametric descriptive statistics whereas Student's t test was used for dependent samples at significance level up to  $p < 0.05$ .

## III. RESULTS AND DISCUSSION

Table 1 shows that fish fillets immersed in a solution of TPFS 2% increase in weight, from T0 to T1, or rather,

from 60.73 g to 66.60 g. In T2 the same fillets lost weight, reaching 61.53 g. In spite of losing weight in T2 (thawing), weight rates were higher (61.53 g) than those at T0. Weight rates of fish fillets varied between 41 and 97 g. Results for immersion in TPFS 2% on Table 1 demonstrated that weight gain was significant when T0 and T1 were compared at significance level ( $p < 0.01$ ). Weight gain between T0 and T2 and between T1 and T2 was also significant ( $p < 0.05$ ). Results of fish fillet immersion in TPFS 10% (Table 1) showed T0 weight average at 58.26 g, whilst mean of T1 revealed a higher rate (65.46 g). Weight mean 63.06 g was reported in T2. Rates of fillet weight ranged between 43 and 92 g in the treatment. Results for solution TPFS 10% revealed that weight gain of fish fillet was significant when T0 and T1 and when T0 and T2 were compared ( $p < 0.01$ ). There was significant difference in weight between samples ( $p < 0.01$ ) when T1 and T2 were compared.

Table 1. Descriptive statistics of fish fillets immersed in solutions TPFS 2% and 10%, in grams.

	TPFS 2%				
	N	Minimum	Maximum	Means	DP
T0	30	41.00	90.00	60.73	11.66
T1	30	46.00	97.00	66.30	12.32
T2	30	42.00	94.00	61.53	11.99
	TPFS 10%				
	N	Minimum	Maximum	Means	DP
T0	30	43.00	85.00	58.26	12.64
T1	30	48.00	97.00	65.46	13.87
T2	30	46.00	92.00	63.06	13.60

T0 – initial weight (fish in natura) of fillet; T1 – weight after immersion process of fish fillet; T2 – weight after defrosting of fish fillet.

Higher aggregation of water in fish fillets in solutions TPFS 2% and 10% is probably due to the fact that, in the production of frozen products, phosphates solubilize proteins which help in the water retention of the fillets. Phosphates, therefore, decrease loss of juice with proteins during thawing, resulting in a tenderer, tastier and more succulent product (FANI, 2009).

According to Table 2, Blend 2% (TPFS + NaCl) revealed that mean weight of fish fillets at T0 was 54.93 g, whereas T1 provided a higher rate (59.36 g), which is different from T2, with 55.20 g. Weight rates of fish fillet in this treatment ranged between 40 and 88 g. When differences between T0 and T1 and between T0 and T2 are taken into account, it may be stated that weight gain of fish fillets was significant ( $p < 0.01$ ).

Table 2. Descriptive statistics of weights T0, T1 and T2 of fish fillets immersed in Blend 2% and 10%, in grams.

Blend 2%					
	N	Minimum	Maximum	Means	DP
T0	30	40.00	83.00	54.93	12.50
T1	30	43.00	88.00	59.36	12.77
T2	30	40.00	82.00	55.20	12.08
Blend 10%					
	N	Minimum	Maximum	Means	DP
T0	30	41.00	94.00	59.60	13.88
T1	30	46.00	101.00	65.00	14.79
T2	30	43.00	98.00	62.36	14.64

T0 – initial weight (fish in natura) of fillet; T1 – weight after immersion process of fish fillet; T2 – weight after defrosting fish fillet.

Table 2 shows results after treatment on fish fillets immersed in Blend 10% (TPFS + NaCl). T0 provided weight 59.60g and T1 65 g. As in all treatments, T2 with 62.36 g had the lowest weight when compared to that of T1. Weight rates of fillets varied between 41 and 101 g. Results showed that weight gain of fish fillets was significant ( $p < 0.01$ ) when T0 was compared to T1 and T0 was compared with T2. Weight gain in T1 occurred in the four different solutions. According to Fani (2009), the above was due to the fact that myofibrillar proteins, myosin and actin constituted a significant volume of the muscle. In fact, changes in the retention capacities of water in the muscles occur because of water retention in the myofibrils. It is precisely the high capacity of protein water retention in fish muscles that provides fish meat with its typical succulence. The enzymes activity in fish after death, may have affected the aggregation of water in the muscle fibers. Due to the activity of tissue proteases and lipases, autolysis softens fish meat (Tavares et al., 1988). Meat softening means the loosening of muscle fibers and the increase of the space between, which provide more space for the incorporation of water among the muscle fibers.

There was a weight loss in T2 for all treatments with regard to T1. Figure 1 shows that, when fish is frozen, freezing nuclei do not lie among the myofibrils but among the muscle cells. As ice crystals increase, water is removed from the myofibrils and cells are condensed. Freezing causes the condensation of fibers and myofilaments become closer (Figure 1). Since fish was already frozen when stored for 22 days, interactions among the myofilaments might have occurred. Water does not return to the cells during thawing and extracellular spaces are left. Some water may actually be lost by drip loss and thus loss of moisture (Fani, 2009). Crystal formation during freezing also deforms the cell membrane with subsequent dehydration and atrophy of the muscle tissue. During thawing, cell liquid is lost with

a consequent undesirable texture and taste when compared to the in natura prime matter (Chevalier; Le Bail; Ghoul, 2000).

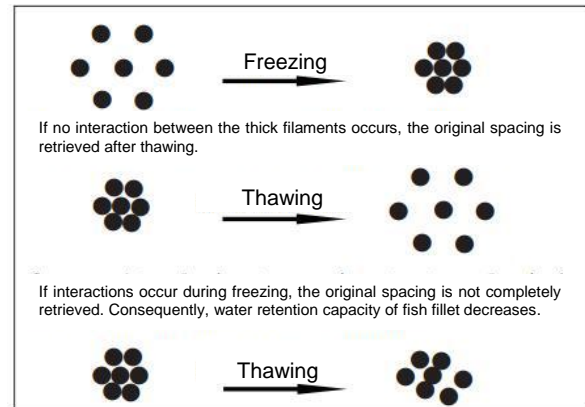


Fig.1: Interaction of filaments of myofibrils during the freezing process.

Source: Fani, 2009.

Weights compared treatments with TPFS and Blends 2% in immersion. Comparisons were undertaken by the differences between gains and losses of weight between T0 and T1; T0 and T2; T1 and T2 (Figure 2).

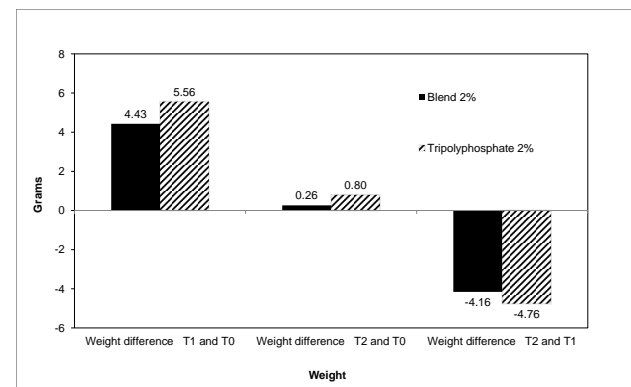


Fig.2: Weight differences between immersion in blend and sodium tripolyphosphate 2%.

Figure 2 demonstrates that treatment with TPFS 2% provides the highest weight gain when the differences between T0 and T1 and between T0 and T2 are compared, with their respective rates 5.56 g and 0.80 g in weight gain. Treatment with Blend 2% revealed very low differences in weight gain, with rates 4.43 g and 0.26 g. Contrastingly, when T1 and T2 were compared, TPFS provided the highest loss (4.76 g), whereas Blend 2% lost 4.16 g. Significant differences in weight gain occurred between T0 and T1 ( $p < 0.01$ ). TPFS had the highest weight gain between T0 and T1 and between T0 and T2, respectively 7.02 g and 4.80 g, when treatments of concentrations TPFS and Blend 10% in immersion solutions were compared (Figure 3). Concentration of Blend 10% had the highest weight loss (2.63%) between

T1 and T2. Significant differences in samples weight gain were registered between T0 and T1; T1 and T2; T0 and T2 ( $p < 0.01$ ).

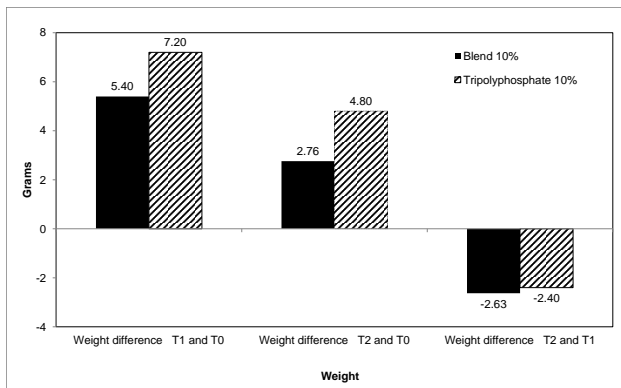


Fig.3: Weight differences between Blend and TPFS 10% immersions.

Actually TPFS 10% treatment caused highest weight gain and the lowest water loss rate. High percentage concentration in TPFS solution may have affected directly the final result. Maki (1987) reported that a significant increase of total and sarcoplasmic proteins of muscle fibers occurred when only phosphates were added to the immersion solution of meat products, with an improvement in their softness. In a study on turkey sausages, Teicher (1999) observed that phosphates made them more succulent when compared to control. Results showed the efficiency of TPFS when water is aggregated to fish fillets. The theory by Brasil (2003) that there was significantly less protein loss during defrosting with TPFS in the meat has been thus corroborated

Table 3 presents the results of moisture percentage of fish fillet.

Table 3. Moisture percentage of fish fillet immersed in treatment TPFS and Blends 2% and 10%.

Treatment	Post-immersion (% w/w)	Post-defrosting (% w/w)	Difference (% w/w)
TPFS 2%	83.28	81.20	2.08
TPFS 10%	84.20	83.01	1.19
Blend 2%	83.01	80.70	2.30
Blend 10%	84.05	82.10	1.95

Moisture percentage is directly related to the amount of water available in fish fillet. Moisture rates are weight losses of fillet when heated and water is removed. Moisture percentage in fish ranged between 60% (w/w) and 85% (w/w) (Ogawa & Maia, 1999). After TPFS treatments, moisture rates 83.28% (w/w) and 84.20% (w/w) were reported for concentrations 2% and 10%, respectively. Moisture rates 83.01% (w/w) and 84.05% (w/w) were respectively registered for treatments with Blends 2% and 10% (Table 3). On the other hand, fresh

fillets *in natura*, revealed a moisture rate of 81.74% (m/m). All moisture percentages in all treatments in current assay were higher than those *in natura* when moisture rates of fresh fish, without immersion, were compared. Lampila (1992) reports that the moisture rate of commercial fillet is expected to be lower than 80%, and rates above 80% indicate pre-treatment of fillets. Current results partially agree with those by Lampila (1992), since moisture of fresh fillet revealed rates above those in the literature. Results on moisture rates may have been affected by the temperature of the buffer and environment humidity, with changes in the final percentage.

All treatments showed decrease in moisture levels for weights in the post-defrosting period (Table 3). In experiments with shrimps immersed in TPFS, Garrido (2005) reported lower rates in post-defrosting weight than those in post-immersion weight. Moisture loss in the post-defrosting period may show that TPFS and Blends tended to retain water in fillets. Gonçalves (2005) registered that freezing might decrease moisture rates in shrimps and might affect their acceptability by consumers. Dehydration and atrophy of the muscle tissue was common since defrosting caused the loss of much cell liquid (Chevalie; Le Bail; Ghoul, 2000). Moisture rates in fillets were thus decreased (Table 3).

Table 4 shows that protein rates increased in the four treatments when compared with post-immersion and post-defrosting weights.

Table 4. Protein rates in fish fillets immersed in treatments with TPFS and Blends 2% and 10%.

Treatment	Post-immersion (% w/w)	Post-defrosting (% w/w)	Difference (% w/w)
TPFS 2%	15.19	15.72	3.37%
TPFS 10%	14.8	15.49	4.45%
Blend 2%	15.05	15.57	3.34%
Blend 10%	15.43	16.09	4.10%

Results contrast the theory that the quality of frozen meat products was affected by moisture loss during freezing, with a decrease in succulence and other changes due to protein denaturation (Gonçalves, 2005). The defrosting system failed to decrease the protein rates, probably due to the phosphates cryoprotectant activity. Research with treatments involving immersion of phosphate with shrimps and with chicken sausages also showed higher post-defrosting protein rates (Gonçalves, 2005). Lampila (1992) showed that phosphates warranted cryoprotection to fish fillet proteins. Table 4 actually shows that phosphate immersions of fillets have greater differences in the increase of protein rates after defrosting. Table 4 demonstrates that, when treatments with phosphates in



immersion are compared, treatments with high rates of TPFS 10% had the highest increase in protein quantity, with an increase of 4.45 % (w/w), with regard to post-immersion and post-defrosting weight difference. According to Varnam& Sutherland (1995), phosphates ruptured protein structures, decreased the interaction of proteins and increased protein solubility. In other words, water was incorporated owing to the protein's electric unstableness with polyphosphates owing to an increase of the product's moisture rate. TPFS is employed as a quality-improving agent in fish fillet processing (Cui; Cai; Xui, 2000).

Table 5 demonstrated that amount of TPFS in the post-immersion weight of fish fillet was directly proportional to the concentration of the immersion solution. The higher the solution's concentration, the higher TPFS rates were absorbed in fish fillets. Difference in post-immersion and post-defrosting weight in the four treatments was low (Table 5). Loss of TPFS in post-defrosting weight occurred in all treatments. In his experiments with shrimps, Gonçalves (2005) found that defrosting after immersion maintained the same TPFS rates in the two weightings.

Table 5. Phosphate percentage in fish fillets immersed in treatments TPFS and Blends 2% and 10%.

Treatment	Post-immersion (% , w/w)	Post-defrosting (% , w/w)	Difference (% , w/w)
TPFS 2%	0.30	0.32	0.02
TPFS 10%	0.41	0.39	0.03
Blend 2%	0.32	0.30	0.01
Blend 10%	0.38	0.36	0.02

The four treatments, including treatment with immersion solution TPFS 10%, revealed phosphate rates within the allowed limits, or rather, 0.5% phosphate established by BRASIL (1970). Rodrigues (2005) treated conger fillets with phosphates, albeit with different solution concentrations and immersion time (TPFS 5% for 60 minutes; Blend 10% for 30 minutes) and provided phosphate rates below 0.5%, complying with Brazilian legislation. In his studies on pre-cooked de-shelled mussels immersed in the same concentrations and times, following Rodrigues (2002), Rech (2005) reported phosphate rates lower than 0.5% in the end-product, after defrosting, or rather, within MAPA standards.

#### IV. CONCLUSION

Results in current study showed that: treatments with TPFS 10%, Blend 2% and Blend 10% provided significant weight gain ( $p>0.01$ ). Treatment with TPFS 2% also had a significant weight gain at 5% significance level. Comparison of immersed treatments at 2% showed

that TPFS had higher significant weight gain ( $p>0.01$ ). Samples with immersed treatments at 10%, with only TPFS, showed greater weight at significance level  $p>0.01$ . Although NaCl had a synergic activity with TPFS, it did not show the same efficiency in weight gain when compared to solution with TPFS only. Solution with TPFS 10% had the highest weight gain in immersion and lost less water in defrosting, when compared to all the other treatments. Moisture and total protein analyses revealed significant difference ( $p>0.01$ ). The freezing process affected the number of protein through the phosphates cryoprotection activities. Phosphate quantity analyses also showed significant alterations ( $p>0.01$ ), with the exception of treatment with Blends 2% and 10%. All four treatments demonstrated phosphate rates within standards, namely, up to 0.5% of sodium tripolyphosphate per 100g of fillet.

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# Analysis of the Method for Estimating the Hip Joint Centre for determination of the Hip and Knee Joint Angles

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**Abstract**— *The study of the human gait through the joints angles is an important branch of the biomechanics. The joints angles define the behavior of a segment in relation to another and, consequently, the overload on the tissues. The hip joint centre (HJC), regression equations system based on pelvic anatomy, is a parameter frequently used as reference point to determinate the hip and knee angles, therefore, is considered in the literature as an important factor in the kinematics analysis of the human gait. Two analytical methods are recognized in the HJC estimation, the predictive method uses the difference between the anatomical points of the human body in the data collect, and the functional method uses a sphere adjustment approach. In the present research, it was used kinematics data from seven volunteers, collected by Qualisys® system on a treadmill, and through algorithms developed in MATLAB®, the HJC were estimated by two predictive method systems (Bell and Davis) and one system of the functional method (with sphere adjustment approach based on the StarArc movement) and the joints angles which describes the flexion/extension movement of the hip and the knee were determined. Finally, a study was carried out on the influence of the methods for HJC estimation in the determination of hip and knee joints angles. The errors presented in the HJC estimated by the three methods were documented, but did not present significant influence in the values found by the angles of the joints.*

**Keywords**— *Human gait; Biomechanics; Hip joint centre; Joints angles.*

## I. INTRODUCTION

In studies involving movement analysis of the lower members during human walking, the hip joint centre location (HJC) is an important variable used to define the femoral anatomical frame and a reference to estimate the hip muscle momentum, which affects extensively the kinematics and kinetics analysis of hip and knee joints [1-3]. Unlike prominent bony landmarks, such as the superior iliac spines, the HJC cannot be palpated, and thus its estimated. Errors in the location of the HJC can propagate down the limbs in the kinematic and kinetic analysis [4,5].

The HJC can't be taken for modeling purposes, its location must be estimated [6]. Different methods based on anthropometric measurements and regression equations are proposed in the literature to estimate the HJC positions in adults [7]. Considering non-invasive methods available in the movement evaluation laboratories two of them stand out, predictive and functional methods [2, 6]. The functional method is divided in two types: with sphere adjustment approach and with transformation techniques [6]. The predictive methods use regression equations based on experimental data from imaging tests. In this condition, two systems are recognized for this method, one developed by Bell et al., 1990 and another by Davis et al., 1991 [6]. The method developed by Davis et al., 1991 [8] should be used cautiously in dynamic analysis, as the error can be considered clinically significant. The method developed by Bell et al., 1990 [1] presents good performance with differences in the threshold of clinical significance [5]. The functional method with sphere adjustment

approach was developed by Gamage and Lasenby, 2002 [9], uses the StarArc movement, (combination of the Star movement, 7 movements of flexion/extension, abduction/adduction combined of neutral position, and the Arc movement)[2].

When capturing the movement of volunteers during the walk using reflexive markers positioned in the bony protuberances, and estimating the HJC position, it is possible to draw a coordinate system for each segment in analysis, which represents the segments position over time. The Cardan method application allows the determination of a rotation matrix which represents the movement of one limb in relation to another dependent on the rotation sequence [10, 11].

In this way, the objective of this research is to compare different methodologies to determine the HJC, in order to estimate the variation that can be observed in different techniques.

## II. METHODS

In an attempt to verify the influence of the location the HJC in kinematics analysis of the human gait of lower limbs, this research proposes the application of the prediction methods selected in different volunteers. The values obtained referring to HJC were used as reference points to the coordinate system of the thigh, simulating, through algorithms implemented in MATLAB®, the flexion/extension movement of hip and knee joints.

We compare the joint positions of the HJC obtained by the three methods and verify the position difference in each one of the planes in each one of the methods.

The kinematic data collection was approved by the ethic committee of Friedrich-Schiller- Universität Jena (0558-11/00). The clinical examination was carried out in the KIP-Labor of the Friedrich-SchillerUniversität Jena, Germany. All volunteers signed the consent form for the test. [12, 13]

For the analysis of the movement of lower limbs, 20 reflexive markers were placed in the bony protuberances of the lower limbs, as specified by the International Society of Biomechanics (ISB) [14]. The volunteers were subjected to a walk on a treadmill, with controlled speed of 4,5 Km/h. The two-dimensional data of the limbs were captured by 8 infrared cameras, processed and converted in three-dimensional through of the algorithms of the Qualisys system. To collect, we calibrate the Y axis as antero-posterior, X as mid-lateral and Z as proximal-distal.

Participated in the study seven volunteers, with age range between 21 to 31 years old, corporal mass, height, body mass index (BMI), and variables PW (pelvic width), D (anterior- posterior component of the distance (mm) from the ASIS to HJC in the sagittal plane) and L (leg length), belongs to the Equations of predictive methods to the HJC estimation, are represented in Table 1.

Table.1: Subject details with variables PW, D and L, measured through coordinates of the markers positioned in bony protuberances

Voluntary	Age	Mass (Kg)	Height (m)	BMI (kg/m <sup>2</sup> )	PW (m)	D (m)	L (m)
1	30	79,4	1,77	25,34	0.265	0.071	0.871
2	21	77,4	1,68	27,42	0.281	0.074	0.904
3	29	93,3	1,79	29,11	0.256	0.069	0.923
4	31	77,5	1,72	26,206	0.253	0.068	0.896
5	22	61,7	1,57	25,034	0.239	0.067	0.786
6	25	55,3	1,65	20,31	0.234	0.072	0.849
7	24	66,8	1,71	22,84	0.204	0.057	0.843

The average coordinates of the left and right HJCs (  $x$ ,  $y$ ,  $z$  ) for each subject were calculated using two predictive methods and one functional method with widespread use in clinical gait analysis (Table 2). Method I developed by Bell et al., (1990) [1] using PW (distance between the ASIS). Method II developed Davis et al., (1991) [8], using PW,  $L$  ( given by the difference between the ASIS and the MM) and  $D$  ( given by the distance between an approximated point of the hip joint

centre and the ASIS). Method III, functional method system with sphere adjustment approach was used the system developed by Gamage and Lasenby (2002) [9], with performing of the StarArc movement. Where,  $m$  is the position vector of the hip joint centre,  $r^p$  is the radius of the sphere defined by  $p$  marks,  $M$  is the number of marks,  $N$  is the number of frames and  $v_k^p$  is the mark position  $p$  in the instant  $k$  [2, 4].

Table.2: Equations from the literature for estimation of the hip joint centre (HJC) coordinates in the pelvis.

	Method I	Method II	Method III
HJCx	-0,19PW	-095D + 0,031L - 4	$f(m, r^p) = \sum_{m=1}^M \sum_{k=1}^N \left[ (v_k^p - m)^2 - (r^p)^2 \right]^p$
HJCy	-0,30PW	-031D - 0,096L +13	
HJCz	0,36PW	0,5PW - 0,055L + 3	

From the coordinates of the bony protuberances and the HJC, it was possible to define a coordinate system for each of the lower limbs. The limb movement in relation to another can be represented by a rotation matrix defined by Cardan Method. The rotation sequence established for the determination of the angles by the Cardan method was defined: flexion / extension movement ( $\alpha$ ) in x, adduction / abduction ( $\beta$ ) in y and internal / external rotation ( $\gamma$ ) in z.

Ten points were analyzed per volunteer, and the mean value, for each coordinate, was used to compare the methods and their magnitude differences were presented. Subsequently, using the HJC, the flexion / extension

angles of the hip and knee were determined for each volunteer. Finally, the significance of the differences found between the methods and their respective angles was evaluated.

### III. RESULTS AND DISCUSSION

Subject details with variables PW, D and L, measured through coordinates of the markers positioned in bony protuberances are listed in Table 1. The Table 3 presents the HJC coordinates of the right leg in neutral position, by the three methods. The coordinates presented have as local reference the hip symmetry centre. Only the volunteers 1, 2, 3 and 7 performed the StarArc movement.

Table.3: Coordinates of the HJC of the right leg.

Voluntary	Method I			Method II			Method III		
	x (mm)	y (mm)	z (mm)	x (mm)	y (mm)	z (mm)	x (mm)	y (mm)	z (mm)
1	95,69	-50,5	-79,74	91,98	-45,29	-82,92	76,03	-42,52	-68,51
2	101,31	-53,47	-84,43	97,97	-50,28	-86,77	83,85	-61,85	-79,86
3	92,22	-48,67	-76,85	84,28	-41,26	-87,18	88,86	-41,97	-73,38
4	91,43	-48,25	-76,19	84,66	-41,4	-84,37	-	-	-
5	86,39	-45,59	-71,99	83,76	-43,83	-83,41	-	-	-
6	84,41	-44,55	-70,34	77,52	-46,97	-71,17	-	-	-
7	73,07	-38,57	-60,89	72,4	-36,68	-65,3	75,12	-49,98	-78,62

The estimated HJC values pointed a mean difference between the methods of about 8,85mm. Comparing the values found for the HJC by the predictive methods, Method I and Method II, it was found a mean absolute difference of 4,56mm for the x coordinate, 5,25 for the y coordinate and 5,81mm for the z coordinate, pointing to a mean difference of 5,21mm. Comparing Method I and the Method III, it was observed a mean absolute difference of 10,63mm for the x coordinate, 8,62mm for the y coordinate and 9,25mm for the z, with a mean difference of 9,5mm. Finally, Methods II e Method III presented a mean difference of 10,18mm, with a mean absolute difference of 9,34mm for the x coordinate, 9,09mm for the y coordinate and 12,11mm for the z coordinate. The values found have low divergence and are within the range proposed by [4], shows absolute errors of HJC estimated by regression equations for fins equal to 31mm.

With the bony protuberances coordinates and the HJC coordinates, the coordinate system for the pelvis, thigh and leg was defined for each of the three methods separately. From the rotation matrix of one segment in

relation to the other, through the Cardan method, it was possible to find the angles related to the flexion / extension movement of the hip and knee. The flexion/extension movement was used in the analysis because it had a greater magnitude than the others.

The flexion / extension movements of the hip and knee found using the three methods are shown in Figure 1. Curves similar to those presented in the literature are observed for both joints [15]. For the hip movement, Figure 1(A) shows that the flexion movement stands out in two peaks, the first to 3% of the gait cycle, which represents the initial contact of the foot on the ground, and the second peak, 92% in the final balance. And the maximum extension of the hip is represented by minimum amplitude, to 53% of the gait cycle, corresponding to the pre-swing phase. The knee movement, Figure 1(B), was characterized by two flexion peaks, the first peak at 18% in the load response phase and the second at 76%, at the end of the mean balance phase, the maximum extension of the knee movement occurs at 39% of the gait cycle, in the mean phase of support.

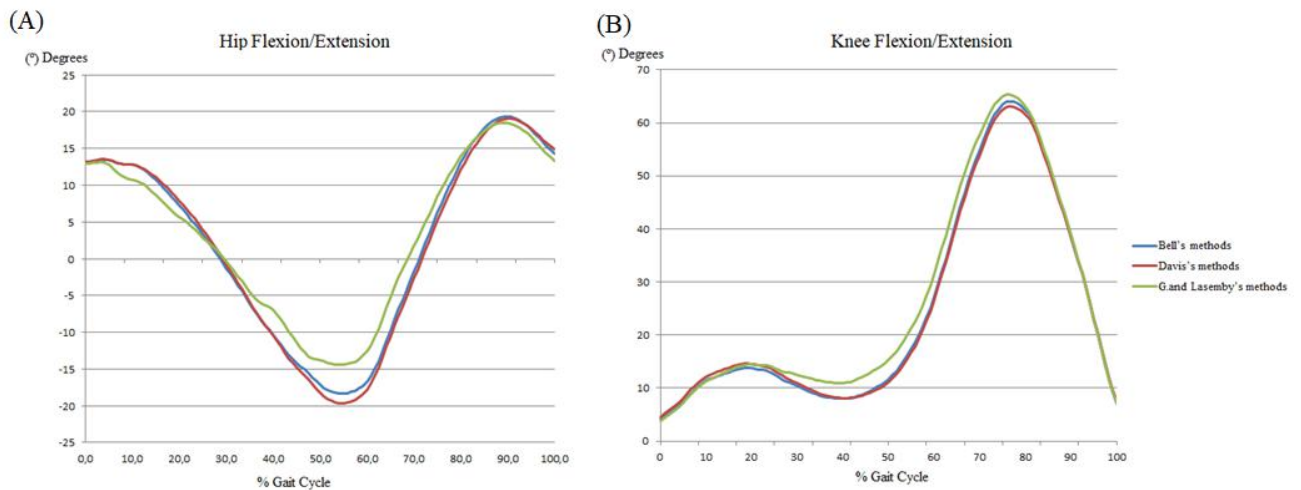


Fig. 1: (A) Hip flexion/extension by the three methods of HJC estimation, (B) Knee flexion/extension by the three methods of HJC estimation.

The mean values of maximum and minimum amplitude calculated from the HJC to the hip flexion/extension movement, for each individual, by the three methods are arranged in Table 4.

Table.4: Amplitude of hip angles flexion/extension from HJC methods.

Voluntary	Method I		Method II		Method III	
	Minimum amplitude	Maximum amplitude	Minimum amplitude	Maximum amplitude	Minimum amplitude	Maximum amplitude
1	-17°	19°	-18,3°	18,8°	-15,1°	19,4°
2	-17,9°	18,4°	-18,5°	18°	-13,7°	18,2°
3	-18,2°	18,6°	-19,3°	17,8°	-15,9°	18,3°
7	-18,1°	19,2°	-18,3°	18,3°	-15,1°	19,2°

In Table 4 is observed that the flexion movement, maximum amplitude, found from the hip jointcentre by the three methods, presented similar values with an absolute maximum difference of 0,9°. Comparing the values found for the extension movement, a greater absolute difference of 4,8 was observed when Method II was compared to Method III. This behavior implies in reducing the total movement amplitude of the hip movement for the functional method and, consequently, a decrease in stride length. This greater variation in relation

to the other methods during the preliminary data phase was expected. However, even though deviations during the preliminary analysis would remit to a possible inconsistency during the simulation, the result did not diverge enough to discard the Method III.

The mean values of the minimum and maximum amplitude of the angles of the knee flexion/extension movement for each voluntary, defined from the three HJC estimation methods, are represented in Table 5.

Table.5: Amplitude of Knee angles flexion/extension from HJC methods.

Knee	Method I		Method II		Method III	
	Minimum amplitude	Maximum amplitude	Minimum amplitude	Maximum amplitude	Minimum amplitude	Maximum amplitude
Voluntary						
1	65,2	6,7	64,3	7,1	64,3	6,2
2	62,1	4,8	61,5	4,6	62,4	3,8
3	59,6	5,8	60,4	5	59,7	5,5
7	63	4,8	62,2	4	62	4,4

It was observed for both the flexion movement and the extension movement a maximum absolute difference between the methods, of 1°, and the variation occurred

between the volunteers that did not follow a pattern throughout the comparison between the values found for each method.

#### IV. CONCLUSION

Analyzing the predictive determination techniques of the HIC coordinates and their implication during the simulation of the angular movement of the joints, it was found some variations, mainly regarding the Gamage and Lasemby method. However, this difference did not lead to a great divergence in the determination of joint angles, since the values presented for the flexion/extension movement of the hip and knee were maintained at similar amplitudes for the volunteers, thus minimizing clinical conclusions that may be divergent.

Analyzing the interference in the hip, it was observed that the values found for the functional method, during the analysis of the human walk, caused less total amplitude for the hip flexion/extension movement, restricting in approximately  $4,8^\circ$  the movement of extension for this articulation. Also, for the knee analysis, it was observed that the curve presented close amplitudes, and did not critically interfere in the movement of the joint to the point of discarding some method, although the Davis and Bell methods presented responses more consistent and close to each other.

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# The Fishing Productivity Assessment Upstream and Downstream of Tucuruí Hydroelectric Dam, Tocantins-Araguaia basin, Brazil

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**Abstract**— *The Tocantins-Araguaia basin is the second largest in Brazil and the most extensive in the drainage area totally placed in Brazilian territory. A time series of fishery production of more than 30 years of Tucuruí Hydroelectric dam, between 1981 and 2016, in low Tocantins, in ten landing harbor (five upstream and five downstream) was analyzed to compare productivity and indicate suggestions for better planning and public policies focused on the fishery resources in this basin. After analyzing over 16,000 landing data, CPUE (kg/day) indicated that after an exponential growth upstream in the first 15 years of the dam, there was a decline trend in fish stocks up to 2016, mainly upstream. The biodiversity of the ichthyofauna was higher downstream and Mapará *H. marginatus* was the main species captured. It is concluded that the maintenance and accessibility by society of a program to monitoring landings in the region, as well as studies of population dynamics in order to better plan the fishing effort, is fundamental. It should also be emphasized that environmental education should focus on the involvement of fishing communities, alerting public managers about the importance of knowledge about productivity and that the decline trend of upstream stocks should be considered in the formulation or incentive of policies aimed at development of artisanal fisheries on Tocantins-Araguaia basin.*

**Keywords**— *artisanal fisheries, CPUE, fisheries data, inland.*

## I. INTRODUCTION

Since the Industrial Revolution, citizens' quality of life and the economic competitiveness of countries have been strongly influenced by the advent of electricity generation. Considering a global market and growing concerns about the environment, this influence stands out more and more as decisive. (Tolmasquim et al., 2007). The hydroelectric potential estimated in the Brazilian territory is about 43 thousand MW (Eletrobras, 2017), and there are still heavy investments in this field, either in UHEs (Hydroelectric Dams) and / or Small Hydroelectric Plants (PCH). The

first Brazilian UHE Marmelos-MG) has begun activity in 1889. Since then, they have been multiplying in national territory due to the great hydro potential. In the Tocantins-Araguaia basin, UHE - Tucuruí was the first to be built, inaugurated in 1984. According to the National Water Agency-ANA (2009), the Tocantins-Araguaia basin (2nd largest Brazilian basin) requires a withdrawal flow of 95 m<sup>3</sup>/s, the main use being irrigation, with 57 m<sup>3</sup>/s (60% of the total), followed by animal consumption (16 m<sup>3</sup> / s) and, thirdly, human consumption (13%). This basin still has the second largest hydropower potential installed with 11,573 MW (16% of the country), Tucuruí (8,365 MW), the largest generation capacity of a national plan. The UHE-Tucuruí interrupted the natural flow of the Tocantins River, forming upstream an artificial lake of 2,875 km<sup>2</sup>, with a maximum depth of 75 m and an average of 17.8 m, covering seven municipalities in the state of Pará (ELETRONORTE, 1987). The installation and operation of a hydroelectric dam provoke great environmental impacts altering the ecological processes fundamental for the maintenance of biodiversity and of the fishing stocks (Agostinho et al., 2008; Agostinho et al., 2007), producing a significant amount of greenhouse gases by deforestation and flooding of the remaining forests (Kahn et al., 2014). Also, artisanal fishing in the area of influence of the Tucuruí Hydroelectric Power Plant has high social and economic importance for the municipalities upstream and downstream of the dam (Cintra et al., 2007) and about 25 thousand fishermen are affiliated with surrounding colonies et al., 2004). With the formation of the lake, it is estimated that around 200 thousand people depend on the fishing productive chain, being 70%, exclusively in the fishing activity (Aviz, 2006). The characteristics of artisanal fishing in this region are not different from the Brazilian or Latin American scenario, which includes the diversity of species and catch strategies, low capital involved, intense labor, high seasonality in the number of active fishermen, low bargaining power in the commercialization and lack of infrastructure for fisheries (Salas, et al., 2007). In this sense, fishing productivity is a



socioeconomic and environmental indicator aimed at subsidizing better public policies aimed at this productive chain. It should be remembered that the production of fish immediately after the formation of the UHE Tucuruí lake quintupled in nine years (1984-1992) from 472 T to 2,318 Tons and in the following ten years production doubled from 2,648T (1991) to about 5,000 Tons (Juras, et al., 2004), indicating an initial process of stability. However, it is necessary to consider the fishing effort employed in the region that increased significantly with the formation of the UHE lake. This work aims assess at comparing the productivity and the composition of the catch upstream and downstream of the Tucuruí UHE, also indicating suggestions for a better management of fishing resources and better planning for the sustainable development of the fishing productive chain in the region.

## II. MATERIALS AND METODS

### 2.1 Study area and data source.

We compiled fishing landing data from Tocantins-Araguaia Basin, more specifically in the area of influence of the Tucuruí UHE. This basin is the second largest in Brazil and the most extensive in a drainage area totally inserted in Brazilian territory (Figure 1). This basin is the scene of a dynamic process of socioeconomic development that is expected to intensify in the coming decades due to the national and international demands for commodities (BRASIL, 2009 ANA). In total, ten landing ports had sampled production data, grouped by region of landing, five upstream (Marabá, Itupiranga, Santa Rosa, Porto novo and Km Onze) and five downstream (Tucuruí, Baião, Mocajuba, Limoeiro Ajuru and Cametá) of the dam (Figure 1), all located in the state of Pará. The fishing landing regions upstream of the UHE are within the limits of the Mosaic of Units of Conservation of the Lake of Tucuruí, created in 2002. The fishery production, by species or group of fish, was recorded monthly between 2005 and 2016. The data are part of the Fishing and Ichthyofauna Program of ELETRONORTE. Other past data, from different sources, were used in order to give more breadth and understanding to historical and productivity trends. However, only annual total volume data were available (Table 1). The data were from 1981, through the closure of the dam 1984 until 2005 (CINTRA et al., 2007, CET, 1989, INPA, 1986, Colart, 1986; Ribeiro et al., 1995, considering five municipalities upstream (Marabá, Jacundá, Itupiranga, Goianésia do Pará and Tucuruí) and five downstream (Tucuruí market, Baião, Mocajuba, Limoeiro do Ajuru and Cametá) (Juras, et al., 2004; Cintra et al. al., 2007). The main index of abundance used for productivity was Capture per Unit of Effort - CPUE (in kg/day), this being an important indicator and

widely used for evaluations of fish stocks and for estimating trends and abundance of fisheries (Nicholas, et al., 2018). The productivity data between 1984 and 2001 were considered at upstream sites, since the cited literature reported only the increase the production after dam closure in 1984 (Juras, et al., 2004). Due to the fishing dynamics in the Tocantins Araguaia basin, whose fishing expeditions are limited to the autonomy and the carrying capacity of the vessels (Silva and Farias, 2017), an average fishing effort of 20 days per month was considered. For the analysis of the catch composition, only the period between 2005 and 2016 was considered, whose robustness of data per species is greater.

## III. RESULTS AND DISCUSSION

We analyzed 16,107 CPUE data and catch composition between 2006 and 2015, while between 1981 and 2005 we analyzed only the total annual volume whose CPUE was estimated by dividing the total by 12 months and then by 20 days. Considering the grouping of landing regions, the exponential increase of CPUE upstream was evident in the first 15 years after the dam closure, with peaks in 1991 (11,000 kg/day) and 2003 (32,212 kg/day) (Figure 2). This increase was mainly due to the expansion of the fishing area and increase of primary productivity, with a direct effect on the food supply along the trophic fish chain (Juras et al., 2004). From 2004, CPUE showed a decreasing trend until 2015, from 24,500 to 16,700 kg/day, indicating a decline in productivity. According to Cintra et al. (2011), the perception of the artisanal fishermen of the Tucuruí lake is that the stocks of fish of economic interest are in decline due to a series of factors like the disrespect to the closed season, lack of inspection and use of illegal gill nets. However, CPUE downstream, which was higher before the dam closure, at 4,950 kg/day (1981), declined until 1986 (770 kg/day). Between 1999 and 2004 there was a slow growth from 1,829 to 5,325 kg/day, when it fell again, stabilizing from 2006 onwards in the range of 4,000 kg/day (Figure 2). Although there is stability of the CPUE downstream, we should consider that this fact can be a trap caused by the increase in the number of fishermen, which also increases the effort on fishing (Camargo & Petrere Jr 2004).

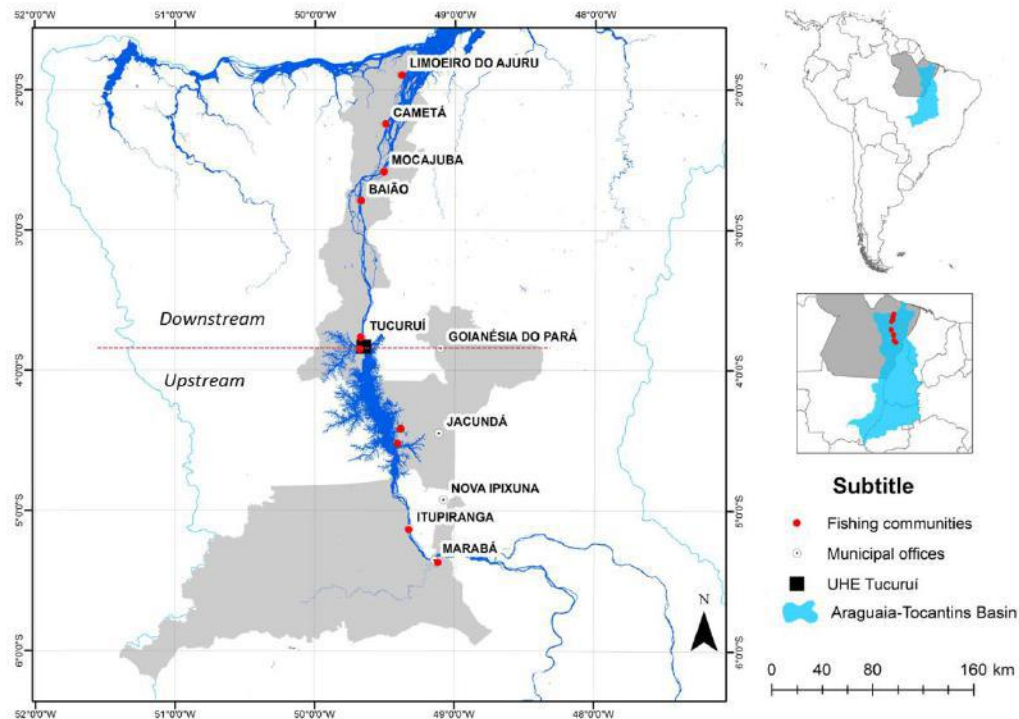


Fig.1: Location of landing ports and their respective municipalities downstream and upstream of Tucuruí UHE, Pará, Brazil.

Table.1: References used for annual data of fishery production in the surroundings of UHE-Tucuruí, Pará, Brazil.

UHE position	Year	Data basis	Reference
Downstream and Upstream	2006 a 2015	Total Catch by specie/month/harbour	<i>Eletronorte (This study)</i>
Downstream and Upstream	2001 a 2005	Annual Total Catch	<i>Cintra et al, 2007</i>
Upstream	1989 a 1992	Annual Total Catch	<i>Juras et al., 2004</i>
Upstream	1981, 1986, 1987 e 1988	Annual Total Catch	<i>CET, 1989; Ribeiro et al.,1995</i>
Downstream	1981	Annual Total Catch	<i>Collart, 1986.</i>

Between 2006 and 2015, which is a more continuous period and it was possible to distinguish productivity in more detail, CPUEs both upstream and downstream are accompanied respectively by their total productions (Figure 3). However, the downward trend indicates a warning that the fishing effort is beyond what fish stocks support, in other words, overfishing. Camargo & Petreire Jr. (2004) already warned about the depletion of fishing in the region of Lake Tucuruí and indicated that fishery production would decline in 2001 and overfishing in 2005. This can be explained by a combination of factors such as (i) an increase in the number of fishermen and an easy access to fishing resources;(ii) the increase or permanence of the fishing effort employed in previous years whose production was exponential due to the formation of the reservoir; (iii) the non-implementation of the fishery management plan in the reservoir in the initial years and

(iv) the gradual reduction of the length of the species captured during this period, which compromises the reproduction and recruitment of young fish. In the downstream region, CPUE and total production are on average 5 times lower than upstream (Figure 3), but with no indication of decline. It is important to emphasize that the downstream region is directly influenced by the alteration of the hydrological cycle by the river dam and the operational procedures of the UHE Tucuruí, which causes mortality of eggs, larvae and fingerlings, thus compromising the recruitment and replenishment of fish stocks (Juras et al., 2014). Another important issue regarding the sustainability of fishing in the region is the social role and representativeness of fishermen in the context of the productive chain in the UHE Tucuruí. Only in the upstream region is estimated in 2000 year, more than 2,600 fishermen registered in fishing Colonies and

another countless non-associated contingent (Juras et al., 2004). In 2018, the Institute of Forestry and Biodiversity of the State of Pará (Ideflor-Bio), registered 4,769 fishermen, fish buyers and intermediaries using the fishery resources of Tucuruí lake. However, although artisanal fishing depends on collective social capital to promote the sustainability of fishery resources, it is well known that artisanal fisheries representations generally have a low degree of governance, especially in developing countries (Kosamu, 2015). Governance here is understood as shared decision-making between government, whether national and/or local, and other institutions interested in maintaining fishery and fisheries resources, which may include users of fishery resources, local communities, environmental organizations, non-governmental organizations (NGOs) and scientists (BOWN et al., 2012). The top-down policies of fisheries management, commonly observed in Brazil, need to be gradually redirected towards participatory management, focusing on the rights and responsibilities of fishermen and their communities (Grafton, 2005). Upstream of the Tucuruí UHE, there are no fisheries agreement initiatives, which have been evaluated as an important tool for local governance for the maintenance of fishery resources (Castello 2007). However, downstream of the UHE, initiatives of fisheries agreements were initiated from 2001 (PDA, 2006), as well as initiatives of co-management of the fishing (Silvano et al., 2014). The measures taken downstream have contributed to a better representation of

the fishermen in the decision-making processes with the public authority (Vilhena 2017), as well as an increase in the abundance of fish in managed lakes (Silvano et al., 2014). A total of 95 species were cataloged in this study, which corresponds to approximately one-third of the 300 species cataloged in the Tocantins -Araguaia Basin (Santos et al., 1984). For the composition of the catch, 85% of the catches (12,908 landings) were considered whose species were identified by scientific name. The remaining 15% were not identified because they were declared at the landing as "mix", "miscellaneous" or "others". It has been noted that downstream species diversity is on average 30% higher than upstream between 2006 and 2015, but in the last year of monitoring (2015) the number almost equals (Figure 4). This fact may have the following explanations: (i) the greater effort and volume captured upstream increases the chances of catchability and depletion of the species existing therein as already indicated in figure 3; (ii) there is no UHE downstream to the mouth of the Tocantins River, consequently during the flood season, a greater diversity of fish climbs the river to spawn, as the mouth of the Tocantins flows into the Guajará bay complex, river Pará, Guamá and the fluvial group of the Amazon river (Almeida, 2010) and (iii) downstream of the UHE there are initiatives for sustainable fisheries management through co-management and fisheries agreements, which has resulted in improved quality and quantity of fish at downstream (Silvano et al., 2014; Vilhena, 2017).

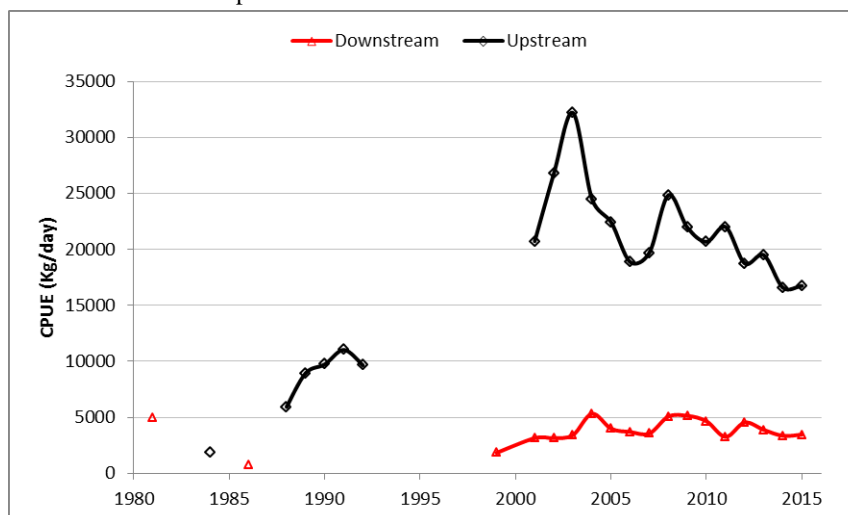


Fig.2: CPUE Variation between 1981 and 2015, upstream and downstream of Tucuruí UHE, Pará, Brazil.

It is worth noting that even with greater diversity downstream, the rapid lowering of water in the headwaters and marginal lagoons (caused by the dam) causes intense mortality of eggs, larvae and fingerlings (Juras et al., 2004). In addition, the dam interrupted the

flow of migratory fish, which reproduced exclusively upstream of the flooded area, such as Curimatá (*Prochilodus nigricans*), which has a low production recorded after the dam closure (Mérona et al., 2010).

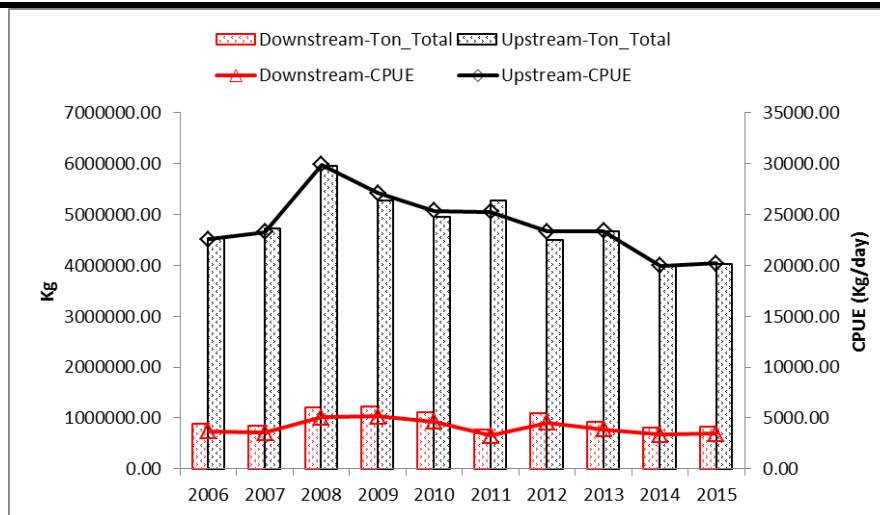


Fig.3: CPUE oscillation and total production (kg) between 2006 and 2015, upstream and downstream of UHE Tucuuruí, Pará, Brazil.

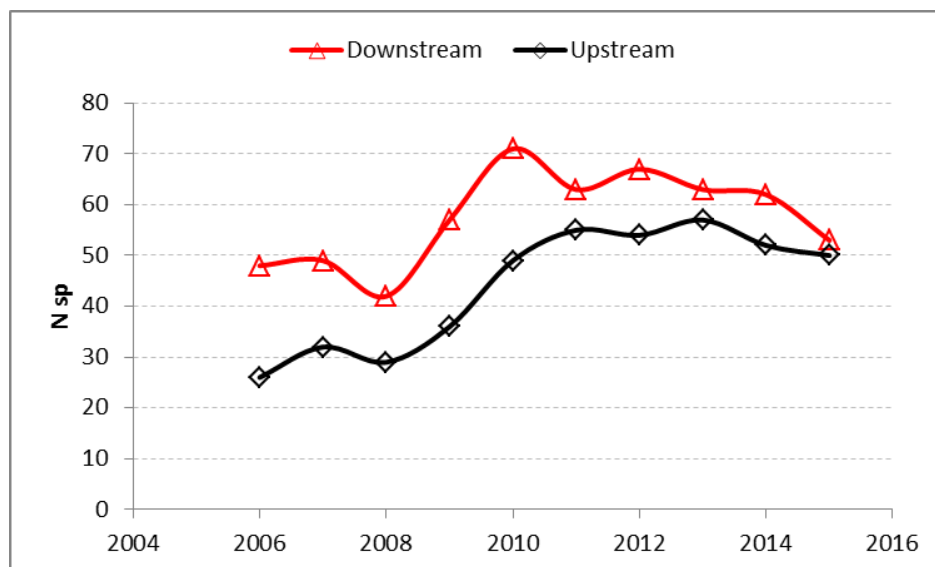


Fig.4: Variation of the diversity of the ichthyofauna exploited by the fishing and downstream of the Tucuuruí UHE, Pará, Brazil.

As for the species, the 10 most caught in volume (kg), both downstream and upstream, together, accounted for more than 95% of the total. *Hypophthalmus marginatus*, regional called "mapará", was the most captured both upstream and downstream, representing 50 and 36% of the catches, respectively (Figure 5). The mapará has great economic importance for fishing in the Amazon basin and Tocantins-Araguaia, its fast growth and high natural mortality (Cutrim and Batista, 2005). The second most caught fish was *Plagioscion squamosissimus* (Pescada-branca), with 15% (downstream) and 30% (upstream) of the catches. The tucunarés (*Cichla* sp) appear as the third species most captured mainly upstream and is also captured with lines and hooks in specific places (Alves

and Barthem, 2008), being also an important resource for sport fishing (Santos and Santos, 2005). The landings analyzed between 1992 and 1998 in Tucuuruí and Marabá, the same tendency of our study was presented, being the mapará, pescada-branca and the tucunarés the most captured species (Camargo & Petrere Jr 2004). In the low Tocantins, the most abundant species recorded in landings of a temporal series were pescada-branca and mapará (Hallwass 2015). These data show that these species have still been subject to selective fish pressure, which is largely to serve the export market (Camargo & Petrere Jr, 2004). However, in the absence of proper management, the trend is for fishing to collapse.

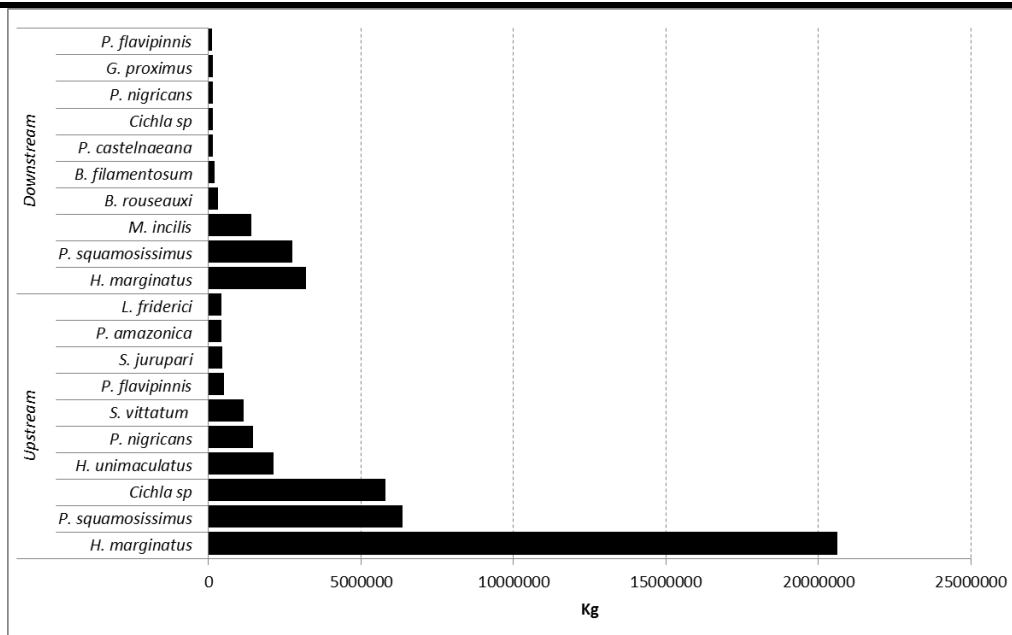


Fig.5: Main species captured downstream and upstream of Tucuruí UHE, Pará, Brazil.

#### IV. CONCLUSIONS

After a historical analysis of some tendencies and the catch composition of artisanal fishing downstream and amount of Tucuruí UHE, we can consider:

✓ Maintaining a land monitoring program is essential, highlighting the effort and fish stocks, especially in the face of a declining trend between 2006 and 2015, and making this information available to society at all times;

✓ Studies on population dynamics are also important to identify if the average size of the main species caught is being compatible with the fish effort employed, minimizing the effects of overfishing or stock collapse;

✓ Fishery management actions should not only consider total catch volumes but the effort employed in fisheries as well as number of users;

✓ Environmental education as a focus on community involvement, alerting public managers about the importance of knowledge about fishing productivity in the Tocantins-Araguaia basin and promoting a broad and inclusive debate with society about the future of fisheries resources and;

✓ Finally, the upward trend of upstream stocks should be considered in the formulation or incentive of policies aimed at the sustainable development of artisanal fisheries.

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# Analysis of the Impacts of Decentralized Production on Distribution Grids

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**Abstract**— This paper presents an analysis of the impacts of decentralized production on electrical distribution grids. The impact on power flow and the impact on the values of currents in case of the fault are presented. The study has been applied to the IEEE 9 bus for testing the effects of the distributed generator connected to the distribution grid. Four default types are simulated in order to obtain sure results; also different scenarios are varied to show the influence of the power injected by distributed generator DG and the influence of the fault location according to DG. The presented results show that the short-circuit current increased at the injection points of DG and the direction of the power flow became bidirectional if the injected power is greatest.

**Keywords**—Decentralized generation, Distribution grid, IEEE test grid, Power flow, Short circuit.

## I. INTRODUCTION

Decentralized generation DG has an increasingly important role in the infrastructure and the electrical system market. It is defined as the development of a set of sources of electrical energy connected to an existing energy distribution infrastructure. To meet the increase in annual energy demand, there is a significant increase in the integration of decentralized generation. As a result, part of the energy demand is provided by the centralized

generation and another part is produced by decentralized generation [1].

The integration of distributed generators, based on renewable energies, into the MV distribution network is currently the trend followed in the energy sector. This integration brings economic and energy interests. These generators are smaller than traditional generators and are closer to customers, resulting in lower transmission and distribution costs, and sometimes fewer power losses, but they can create technical and safety issues. It is therefore essential to evaluate the technical impacts of DG in distribution grids in order to have high quality operation [2].

In this paper, the data of IEEE test grid and the simulation scenarios are presented in the second section and the results are shown in the third one. This study focused on the impact of decentralized production on the power flow and on the short-circuit current in terms of the injected power and the localization of default according to DG. Finally, the last section contains a conclusion.

## II. IEEE Test Grid

The simulated system includes three synchronous generators, three loads with 315 MW as total active power and 115 MVar as total reactive power, three transformers and six lines. The topology of this grid is presented in Fig. 1.

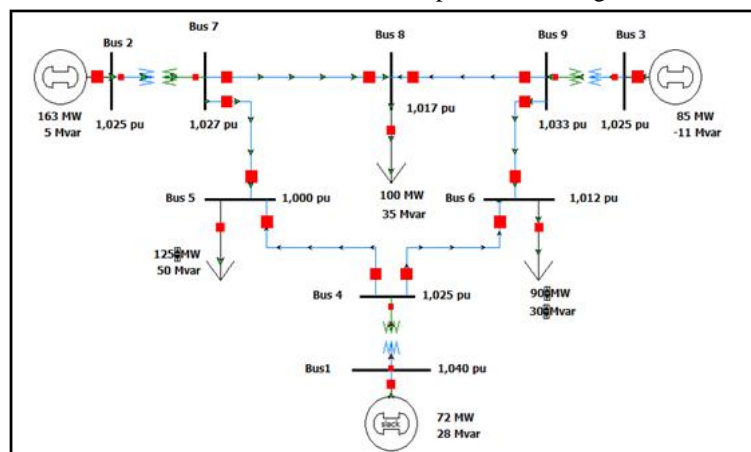


Fig. 1 – Topology of IEEE 9 bus test grid



The characteristics of generators and loads are presented respectively in Tables 1 and 2. The distribution lines are characterized by the distance between the phase conductors and their impedances. The impedance values and other configuration parameters are presented in Table 3.

Table 1: Characteristics of the generators

Bus	U [kV]	S <sub>G</sub> [MVA]	PF	X <sub>d</sub> ' [pu]
1	24	512	0,9	0,2
2	18	720	0,85	0,185
3	15,5	125	0,85	0,134

Table 2: Load characteristics

Bus	P <sub>i</sub> [MW]	Q <sub>i</sub> [MVar]
5	125	50
6	90	30
8	100	35

Table 3: Characteristics of lines

N°	From bus	To bus	R [Ω/km]	X [Ω/km]	B [S/km]
1	4	5	0,01188	0,008062	5736,89.10 <sup>-6</sup>
2	4	6	0,002021	0,010912	5148,99.10 <sup>-6</sup>
3	5	7	0,003850	0,019203	9943,04.10 <sup>-6</sup>
4	6	9	0,004713	0,020771	11619,96.10 <sup>-6</sup>
5	7	8	0,001009	0,006826	4858,119.10 <sup>-6</sup>
6	8	9	0,001418	0,01197	6807,29.10 <sup>-6</sup>

In the short-circuit modeling, the transient and subtransitory impedance sequences of the synchronous generators, integrated into the network, were necessary [4]. The parameters are summarized in Table 4 and the four different cases that are chosen to study the impact of decentralized generation on the short-circuit level of the distribution network are presented in Table 5 [5].

Table 4: Parameters of synchronous generators

5-10MVA 13,8 kV	R <sub>a</sub> [pu]	X'd [pu]	X''d [pu]
4	0,00	0,250	0,134

To obtain valid and sure results, different scenarios are varied. The simulation involved examining the occurrence

of four types of three-phase, single-phase, two-phase and two-phase isolated fault (3ph, LG, LL and LLG) at three different buses 4, 5, 8 respectively. The bus selection where the fault can occur has been made in the middle and at the end of the network to deal with all possible cases.

Table 5: Different scenarios to examine

Scenarios	Condition
Scenario 1 (S1)	Without DG
Scenario 2 (S2)	DG connected to bus 6 of 5 MVA
Scenario 3 (S3)	DG connected to bus 6 of 10 MVA
Scenario 4 (S4)	DG connected to bus 8 of 5 MVA
Scenario 5 (S5)	DG connected to bus 8 of 10 MVA

### III. RESULTS OF THE SIMULATION

In this study, we are only interested in the impact of power flow and the impact of the DG on the values of the short-circuit current. It will be assumed that the voltage plan is not infected by the integration of the decentralized generation and that the voltage is within the allowed limits.

#### 3.1 Impact on Power Flow

Distribution networks are passive electrical circuits in which active and reactive powers flow from HV to LV, relying on a unidirectional energy exchange [6]. With the introduction of distributed generation in these networks, they become active electrical circuits in which energy flows can, under certain conditions, pass from the distribution network to the transmission network.

In order to see the effects of dispersed power generation on power flow, we simulated the test grid with and without DG. The power transits on the network without the distributed energy generation are shown in Fig. 1. It will be noted that the energy flows in one direction, from the network to the loads. The connection of a DG at node 5 of 45 MVA power and a DG at node 6 of the same power on the network, modifies the power flow as shown in Fig. 2. The power flow flows in both directions and thus becomes bidirectional.

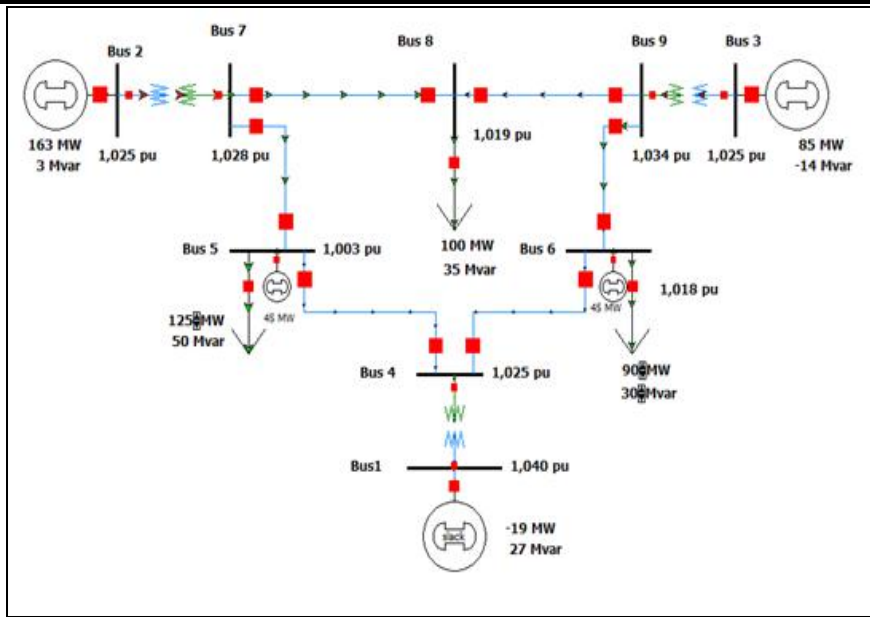


Fig. 2 –Power flow with two DGs connected to node 5 and 6.

In general, if DGs are significantly integrated into the distribution network, it is possible that energy can flow back to the transmission networks. This bidirectionality must therefore be taken into account when managing the network. It must also be verified that the transit capacity of the network is respected because the injected power by the DGs can lead, in certain branches of the network, to higher power flows than the electrical resistance of the equipment (lines, cables, etc.) , which may lead to faster aging, or even defects in this material related to heating [7].

3.2 Impact on the Short-Circuit Current

The connection of the distributed generation to the network changes its overall impedance, which influences the values of the short-circuit current and the short-circuit power. This modification of the short-circuit current may cause the protection equipment to malfunction. In the event of default, the fault current may exceed the allowable limit of network elements because of the inserted producers.

The simulation results for the short-circuit current analysis examining the four fault types for the different scenarios are shown in Table 6.

Table.6: Results of the simulation of short circuit currents in [kA]

Location of fault	3-Phase Fault				
	S1	S2	S3	S4	S5
Bus 4	64,33	66,73	68,84	64,85	65,29
Bus 5	43,28	44,07	44,74	43,75	44,16
Bus 8	45,22	45,72	46,13	49,40	53,57
	Line to Ground Fault				
	S1	S2	S3	S4	S5

Bus 4	45,55	48,14	50,16	45,98	46,32
Bus 5	30,35	31,13	31,71	30,73	31,03
Bus 8	32,67	33,16	33,51	37,40	42,02
Line-to-Line Fault					
	S1	S2	S3	S4	S5
Bus 4	55,71	57,79	59,62	56,16	56,54
Bus 5	37,48	38,16	38,75	37,89	38,25
Bus 8	39,17	39,59	39,94	42,78	46,39
Line-to-Line Ground Fault					
	S1	S2	S3	S4	S5
Bus 4	58,54	60,89	62,94	59,03	59,45
Bus 5	39,37	40,14	40,78	39,82	40,19
Bus 8	41,31	41,79	42,18	45,39	49,49

3.1.1 Influence of Type of Default

The three-phase fault occurrence presents the highest impact on the short-circuit level in the five different applied scenarios. It is then followed by the isolated two-phase fault. Conversely, the single phase fault presents the lowest impact in comparison with the other three evaluated types of fault.

3.1.2 Influence of the Injected Power from the DG

The short-circuit current variation between the scenarios without and with the DG is an index that gives an idea of how the DG influences the planned protection devices for a network without these production units [2].

Figures 3-6 show the short-circuit currents in different scenarios for the four types of fault, it is noticed that there is a slightly narrow change in the results shown for the short-circuit current values in case of scenarios 2, 3, 4 and

5 (DG connected) in comparison with scenario 1 (without DG).

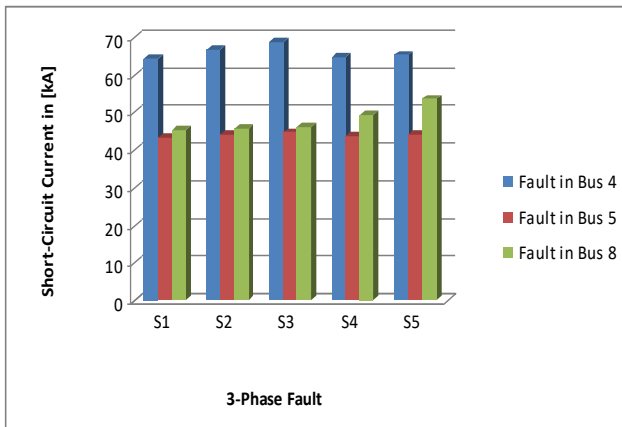


Fig. 3 – Short-circuit currents in the different scenarios for the three-phase fault

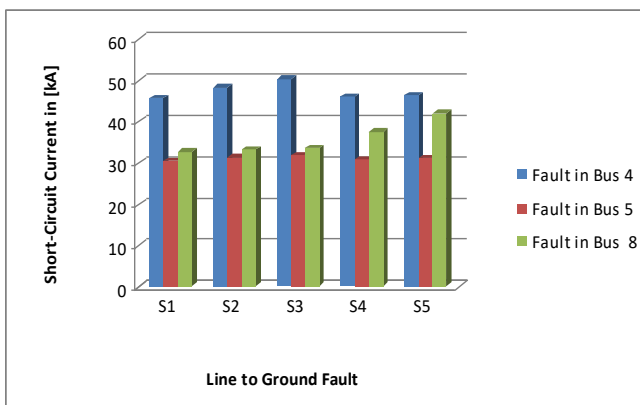


Fig. 4 – Short-circuit currents in different scenarios for single-phase fault

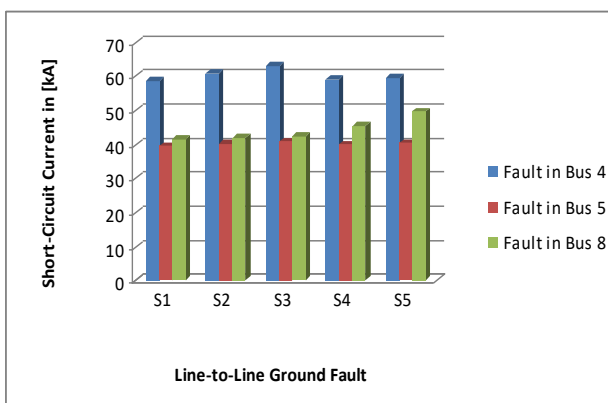


Fig. 5 – Short-circuit currents in the different scenarios for the two-phase fault

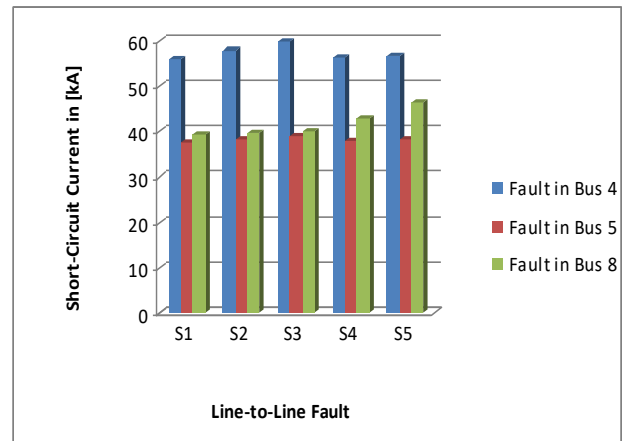


Fig. 6 – Short-circuit currents in different scenarios for isolated two-phase fault

The simulation results show that the integration of a generator into the distribution network, in the event of a fault, has an influence on the values of the short-circuit currents [8]. It can be seen that the values of the short-circuit current are important for the scenarios S2 (DG connected to bus 6 of 5 MVA) and S4 (DG connected to bus 8 of 5 MVA) in comparison with S3 (DG connected to bus 6 of 10 MVA) and S5 (DG connected to bus 8 of 10 MVA) and this for all types of faults, which explains why the higher the power of the dispersed energy generation, the short-circuit current increases. It can be concluded that the connection of the DG to the distribution network causes, in case of default, an increase in fault currents directly related to the injected power.

### 3.1.3 Influence of the Location of the DG

The increase in short-circuit current depends on the location of the fault according to the DG as shown in Table 7.

Table 7: Three-phase short-circuit current simulation results

Fault location	B4	B6	B7	B8	B9
Short-Circuit Current in [kA]	65,34	38,45	58,35	45,43	51,54

When there is a fault in the bus 4, the value of the short-circuit current is smaller in the bus 8 (S4, S5) than in the bus 6 (S2, S3) because the distance between the bus 4 and 6 is shorter than the distance between bus 4 and 8. This is the same case if there is a fault in bus 8, the value of the short-circuit current is greater in the bus 8 because it was both the fault point and injection of the DG. Then the buses connected to the DG and which are closest to the fault bus, have the largest short circuit current values. In general, all the generators of a network participate in the current of the fault. The participation of each generator

depends on the electrical distance that separates it from the fault [9].

However, the variation of the short-circuit currents can become more important in these three cases:

- If the power of the DG increases.
- If the fault is of three-phase type.
- If the DG injection point is closer to the default point.

#### IV. CONCLUSION

Currently, the trend is the massive insertion of decentralized production, based on renewable energies, into the electricity grid, which is due to a sharp increase in the annual demand for energy. In order to support future developments in the energy sector, it is necessary to study the impacts of this production on electricity distribution networks, more specifically, analyze the impact on power flows and study the evolution of current values when the DG is introduced into the network. That's why we did a simulation on a standard 9 bus IEEE distribution network.

The simulation results showed that short-circuit currents increase in the presence of DG, which has a significant impact. It is also noted that the amplitude of the short-circuit currents increases with the injected power and depends on the location of the fault, with respect to the DG. From this, it can be deduced that the connection of decentralized generation units in MV distribution networks has consequences for the operation of the protection relay and for selectivity, which may accelerate the aging of the network equipment.

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# Business and Virtual Collaborative News Model

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**Abstract**— *This paper aims to demonstrate a business model and management for a virtual collaborative news environment (VNCE), which is being implemented at the Northern Fluminense State University - UENF, in the Postgraduate Program in Cognition and Language. The difficulty of the journalistic business in surviving, in view of technological changes, the growth of the digital environment, the predominance of intangible wealth, the valorization of intellectual capital, among other variables, has raised the question of the real possibility of a journalistic organization surviving in this scenario. Interdisciplinary environment involves research in the area of communication, information system, administration and accounting and seeks to meet the demands of generation, storage, retrieval, processing and transmission of information in this digital era. An increasingly intelligent, collaborative environment with the active participation of all the agents involved, that is, with the total interaction of the reader-user of the internet. A business and management model that has as main differential the recognition of the intangible wealth, besides the traditional tangible gains, in an era of new economy, where the digital business prevails and the primacy of the intangible wealth, recognized in the expectation of future gains of these companies. Governed by the logical intelligence of a control system whose purpose is the congruence of objectives of the agents that form the business, able to measure the contribution of each agent, generating their respective monetary*

*recognition. Through a cyclical process of creation, delivery and capture of value by all the agents involved that allows planning, control, feedback and replanning, the proposed model is supported by a goal congruence control system that will enable management of this environment, ensuring its continuity and expansion of scope.*

**Keywords**— *Industry Journalism, Business Model, Management Model, Intangible Wealth.*

## I. INTRODUCTION

Trends to changes in political, economic and social scenarios have spoken out with increasing intensity and at breakneck speed. Society is constantly changing and adapting, and this process of transformation is partly a reflection of technological changes, especially influenced by the Internet, cyberspace and cyberculture, which have been important disruptive moments since the 1990s.

The transformations that have been taking place in a fast and multifaceted way are influenced by the diverse possibilities offered by a common digital language in different fields, due to its ease of creating interfaces between technological fields that generate, store, retrieve, process and transmit information, in real time or not.

This boiling technological changes, especially influenced by digital media, led to paradigm shifts in the way the information was and / or are treated, generating a

big impact in the business world and, even more incisive and direct way, business-related journalistic organizations.

With this scenario of digital influence, journalistic organizations have been adapting and reinventing themselves, especially after the transformation suffered in their means of distribution and circulation after the popularization of the Internet and the emergence of cyberspace. Through data from the Verifier Institute of Communication - IVC, the National Association of Newspapers - ANJ, the Internet Management Committee - CGI, among others; it is possible to prove the change in the journalistic scenario in Brazil and in the world, so that these organizations now have the following characteristics: migration from print to digital transmission; difficulties in maintaining revenues in print and the need to change the way revenue is generated in the digital environment; interactivity, in which former media consumers have become producers and consumers at the same time; the need to master various media; predominance of the generation of value in intangibles, generating the need to prioritize investments in intellectual capital; a large difference between the book value and the market value of the companies.

This scenario has required the development of new business models and management for digital journalism (COSTA, 2014), since the virtual environment leads us to look at the media business in a new way, which requires innovative businesses that help navigate better in this convergent world (OSTERWALDER, 2011; JENKINS, 2009).

Faced with this reality, where the medium of circulation is no longer printed to be digital, it is believed that an efficient business and management model for journalistic organizations in this digital age becomes increasingly relevant, emphasizing the importance of rethinking what form should be the management in the journalistic organizations of this digital era, aiming its existence and continuity.

To this end, the Center for Research in Communication, Administration and Information Technology (CATI) was created, linked to the Postgraduate Program in Cognition and Language of the Northern Fluminense State University (UENF), which is part of the Education Studies Group, Communication and Information Technology - GETIC, registered at CNPq.

GETIC / CATI has as a research proposal the development of environments and tools that seek to meet the demands of generation, storage, retrieval, processing and transmission of information (news) in this digital era. At the moment a research is being developed to implement a virtual collaborative news environment (VNCE).

In an interdisciplinary way, the implementation of this VNCE involves concepts from the areas of communication, information system, administration and accounting, involving three research fronts: rethinking the logic of news production, structuring a platform that is collaborative and defining how it should be a management and business model that can give sustainability to this environment.

In this paper the objective is to demonstrate how the business and management model should be for a virtual collaborative news environment, since the way of producing information has changed, and the monopolization of the distribution that previously belonged to the journalistic industry no longer belongs, and practically, any individual can produce and distribute information (COSTA, 2014).

A new type of collaborative journalism emerges where citizens or groups of citizens actively participate in the process of collecting, reporting, analyzing and disseminating news and information (BOWMAN and WILLIS, 2003) at all times through social networks.

In this way, in this new era, wealth is no longer centered solely on physical benefits; but mainly in intellectual capital and intangible assets, which generates the need for a business and management model that considers this intangible wealth in the value creation of the journalistic organizations of this digital era.

## II. THE DISRUPTION IN THE JOURNALISM INDUSTRY IN TIMES OF CYBERSPACE AND CYBERCULTURE

It was around 1990 with the popularization of the Internet, which made possible the interconnection of computers in a network, that the term Cyberspace became better known and was defined by Lévy (1999, 94) as "the communication space opened by the interconnection world of computers and the memories of computers, "which already made him predict the revolution that would cause

“This new medium has the vocation to put in synergy and interface all the devices of information creation, recording, communication and simulation. The perspective of the general digitization of information is likely to make cyberspace the main channel of communication and memory support of humanity from the beginning of the next century” Adapted (LEVY, 1999, p. 95)

This new space, called cyberspace, influenced all the dynamics of the newspaper industry, changing mainly the whole process of printing and distribution of news.

With the Internet and cyberspace, the expenses with printing, circulation and distribution of the news

practically disappeared and this generated the need for a new design of business model in the journalistic industry, as clarified by Costa (2014)

“The old way of producing information has changed, the monopolization of distribution, which belonged to an industry called journalistic, no longer belongs. Anyone can now produce and distribute this information. What is happening is a combination of media and communication, thus giving birth to the overdistribution” adapted (COSTA, 2014, p.54).

This new space, called cyberspace, allows a greater interaction between people, deepening social relations and enabling the formation of communities, to what Levy (1999, p.17) calls Cyberculture, that is, "a set of techniques and intellectual, practices, attitudes, modes

of thought and values that develop along with the growth of cyberspace."

For Santaella (2013, p. 136) Cyberspace is a space with its own existence, of a mobile, fluid and liquid nature, where "information circulates in the blink of an eye" and "everything moves in connection", which ended up giving origin of a new form of culture, called cyberculture.

In times of constant technological changes, it is likely to interrupt the normal path of some process, are the so-called disruptive moments. Increasingly it is possible to perceive an acceleration of occurrence of disruptive events for the journalistic industry. These events did not come to optimize journalistic production activity, but they have altered, and are changing, the essence of what to do, transforming this industry completely. This acceleration can be seen in the figure below:

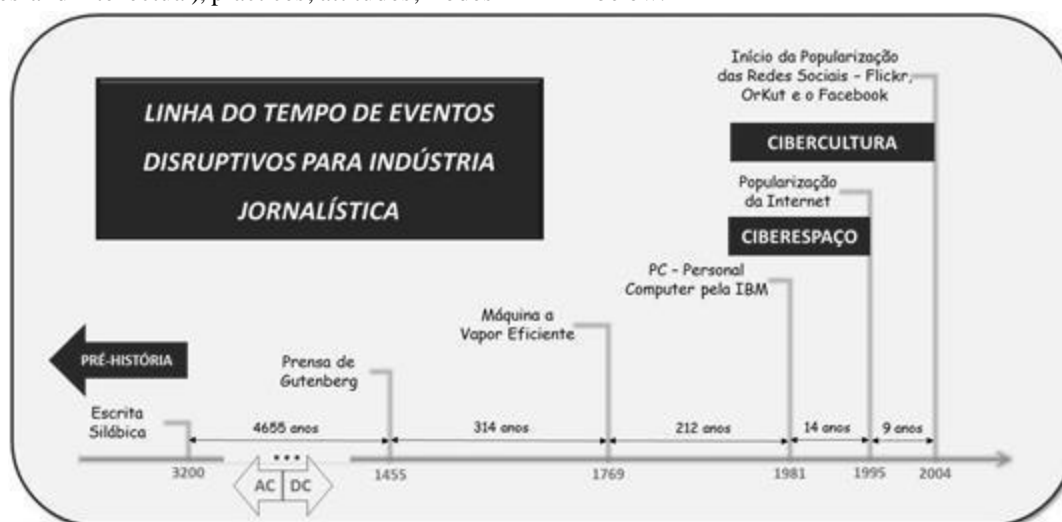


Fig.1: Timeline of Disruptive Events for the Newspaper Industry. Source: Rodrigues (2017)

Costa (2014) points out that the journalistic industry took much more time to understand the disruptive momentum it experienced than other industries such as telecommunications, music or retail, for example.

In this context, the phenomena caused by the insertion of the Personal Computer, the intensive use of the Internet and the popularization of Social Networks, have altered the relations in the journalistic business, as well as the way of measuring the wealth of the companies in this industry, (Kayo, 2002, p.14) as "a structured set of knowledge, practices and attitudes of the company that, interacting with its tangible assets, contributes to the formation of business value".

Oliveira (1999) points out that the formation of intangibles becomes the center of companies that use the logic of the knowledge economy, where creativity, information processing capacity, knowledge, human capital and other intangibles have the capacity to generate wealth much faster.

### III. THE MEASUREMENT OF RESULTS IN ORGANIZATIONS OF THE DIGITAL AGE

With the evolution of the businesses whether or not they are linked to communications, as a result of this technological development, there has been a great increase in the capacity to obtain economic results, which has required the constant development of business and management models capable of helping in managing the different generated wealth in this digital era.

Pereira (in Catelli, 2001, p. 75) explains that the economic result of any company is formed by the results of the areas that compose it, each area being responsible for certain activities, which need to consume resources, which are called costs or expenses depending on the origin of this expense, always with the intention of generating products and services that will enable the constitution of revenues. The comparison between revenues and expenses is that the economic result of a business is determined.

Accounting is the science responsible for this task, because as a science specially designed to capture, record, analyze and synthesize the facts that occurred in the company (IUDICIBUS, 2005), it is through its techniques that it will be possible to determine the economic outcome of the organization, as explained by Iudícibus (2005)

The ability to capture, first, an occurrence of events that impact a particular state of wealth, after a prerequisite, finally, to communicate its strengths, is a challenge to an Accounting is not only preferentially, but of fact, able to face, always relying on related disciplines such as Law, Quantitative Methods and Information Science. (IUDÍCIBUS ET AL, 2005, p. 8)

Constant change has created a dynamic and competitive environment for Iudícibus (2010), where wealth is no longer focused solely on physical benefits but on intellectual capital and intangible assets, which means that managers need to produce better and better results.

In the business world, the fusion of knowledge and available technologies generates intangible benefits, also known as Intellectual Capital. The positive point of this concept is that it represents the junction of the knowledge of its bearer with the materialization of this knowledge in the form of trademarks products and processes. The negative point is that the concept of Intellectual Capital is relatively arbitrary, because because it is intangible, it also represents a gap between the value of the company as a whole and its real financial value (ANTUNES, 2006).

Organizations that have stopped acting alone to act in "synergy, partnership, with the capacity to bring together companies from diverse sectors to generate an independent business" (NASSIF, 2000, p.11) are considered the "new economy". From the 80's with the emergence of the computer and the 90's with the popularization of the internet, Cyberspace and

Cyberculture emerged, definitive for the transformations that occurred in the journalistic industry and for the establishment of the concept of "new economy".

According to Siqueira and Crispim (2012, page 11), the term "new economy" can also be called the digital economy, internet economy or web economy, where "digital networks and communication infrastructures provide a global platform from the which individuals and organizations interact, communicate, collaborate and gather information. "

"New Economy" is the new concept of doing business in the digital age, where the currency is information and the great beneficiary is the customer. Based on the real-time concept of the internet, where distances do not exist and almost everything is a click away, you need to review company-customer relationship policies.

According to Tapscott (1997), the technological revolution that the world has been experiencing does not only encompass new internet technologies, since it is an era of network interconnection, but also encompasses human beings, organizations and societies.

It is in open and porous environments that the living existence of virtual communities can germinate, as well as the more recent views of the meaning of organizations, which is defined as "organic and dynamic processes in which new elements constantly come into play" ( SANTAELLA, 2010, p.278).

#### IV. THE DIFFERENT RICHES IN THE ORGANIZATIONS OF THE "NEW ECONOMY"

In times of New Economy organizations how to measure business wealth, since a portion of wealth is tangible with its quantifiable assets and another great part is intangible as its brands, prestige, reliability and knowledge. It is considered important to analyze wealth in two aspects: Tangible and Intangible.

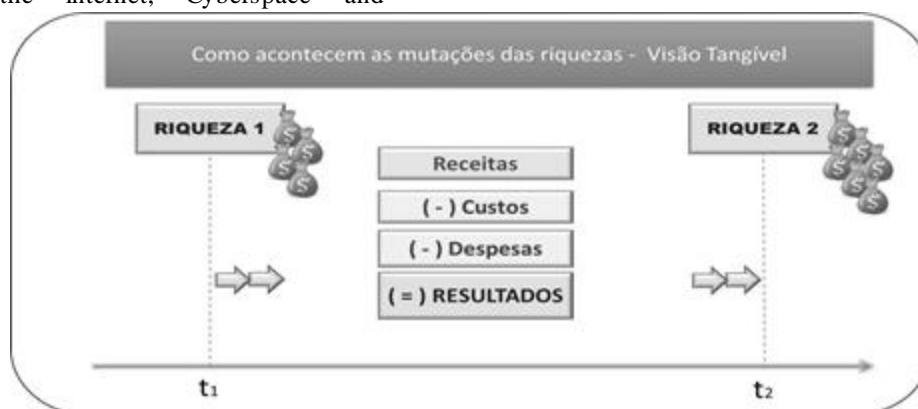


Fig.2: Wealth Mutation in tangible vision

Source: Rodrigues (2017)



Tangible wealth is represented by the traditional comparison of revenues, costs and expenses of a given period, where the result of a certain period is obtained that directly changes the wealth of the business. Such behavior of mutation of the riches can be visualized in the Fig 02:

At a given initial period  $t_1$  one has the initial wealth  $R_1$ . With the development of the activities by the organization is the comparison between the revenues (sales / services) and the costs and expenses acquired in a given period, which is called the result. This economic outcome will change the wealth to a later time  $t_2$  generating wealth  $R_2$ .

Intangible wealth is the value added to the knowledge of the company about a product or process, and in this conception of business, knowledge has greater value than physical patrimony. With the advent of the digital age, the intangible becomes the most valuable part of a company (KAYO, 2002).

In this context, where companies need to seek new ways of generating value, which will define the effective value of the company, it is the best interaction between tangible and intangible assets, since it is difficult to dissociate one from the other. (PEREZ and FAMÁ, 2006).

Authors such as Kayo (2002), Lev (2001), Stewart (1998) and others have stated that wealth generation in companies would be directly related to intangible assets, as these assets would be responsible for higher economic performances and for generating shareholders, and also that a greater presence of unaccounted intangible assets could explain the gaps between the market value of the companies and the amount reflected by traditional accounting, a term known as goodwill.

In this new digital world, there are many examples of companies with this profile to be cited: Instagram that was acquired by Facebook for a billion dollars in 2012, with only 13 employees (FERNÁNDEZ,

2017), Snapchat, refusing to offer US\$ 3 billion and Facebook, buying Whatsapp for US\$ 19 billion (COSTA, 2014).

According to Moreno (2016), AirBnB, an online community marketplace for people to advertise, discover and book accommodations around the world, is raising money to make new investments and pursue new growth opportunities, after becoming the third most valuable startup in the world, \$ 30 billion dollars, according to The New York Times, behind only Uber and Xiaomi.

Mamona (2014) cites in the magazine's review report entitled 20 companies traded above the equity value on the stock exchange, the survey done by Ativa Corretora that shows which companies are worth much more than their equity value. The result of this survey confirms that the market pays far more than the companies are worth, as is the case of Cielo in which the equity value of the share is US \$ 2.24, while the market value is US \$ 36.92 , worth 16.5 times more.

Quantifying this intangible value, which is the gap between the balance sheet of a company and its market value, goodwill is one of the great challenges of our time, especially for companies that hold high technical knowledge, as explained Catelli (2001) :

It is the goodwill that constitutes, mainly, the capacity of the company, as subsystem, to interact effectively as the macro-system environment. It is this capacity that leads to the right decisions, by which the company, already in the present, anticipates in some way the future creation of value, increasing the value of its patrimony. (CATELLI, 2001, p.31).

Such behavior of wealth and value mutation is represented by the future flow of benefits that can be visualized in Fig. 03

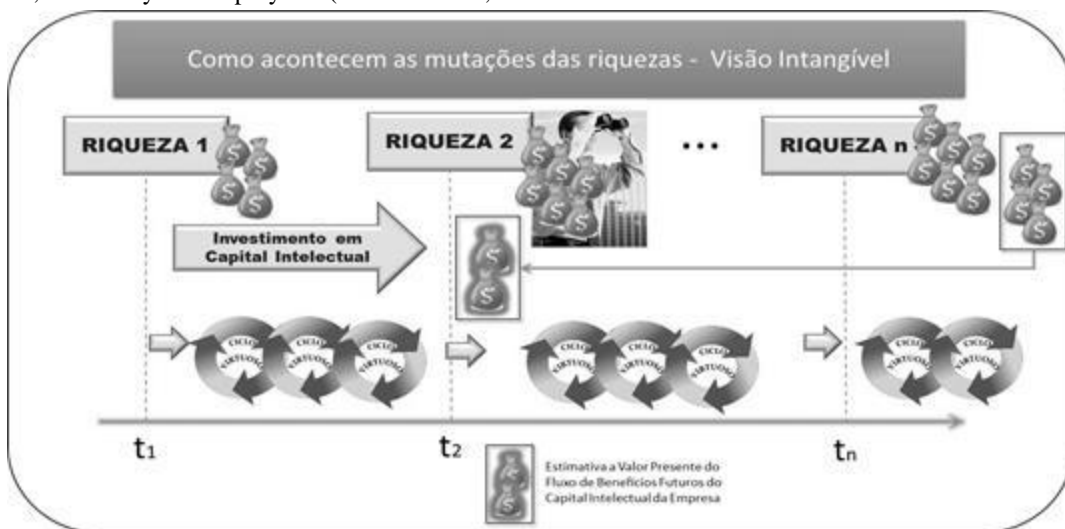


Fig.3: Mutation of Wealth in the intangible vision

Source: Rodrigues (2017)

Fig. 3 describes the tangible ( $t_1 \times t_2$ ) and intangible ( $t_2 \times t_n$ ) richness variations of a supposed organization that already engaged in the scenario of the organizations of the new economy systematically makes investments in its intellectual capital, which gives it in a vision medium-term growth of tangible wealth.

Considering intellectual capital as a set of intangible benefits that add value to organizations, with the capacity to generate future profits, what is important to highlight is that at some future time it will be converted into monetary value (MARTINS and ANTUNES, 2002).

In this context, migration of economic results generated through tangible assets that happens to occur through intangible assets, stands out the journalistic industry that originally as a traditional organization had its wealth change based on large tangible assets of its industrial (revolving), moving to the use of low-value tangible assets (computers in networks) through cyberspace and cyberculture. With this, it has acquired a great capacity of distribution and circulation, which receives to it an intangible asset of extreme potential of generation of future benefits, to which we call wealth.

This new form of wealth has revealed the need to rethink the business of the journalistic industry, which is already occurring in a timely manner throughout the world, as there are innumerable changes in journalism arising from the new digital era: rapidity in production and advertising spread and content collection, loss of paying readers, among others (PENA, 2008).

The journalist Caio Túlio Costa, in his postdoctoral research at the Columbia University Graduate School of Journalism, confirms that there is this need for change, since what he attended to the printed product no longer serves the digital: "newspapers need to shake their way relate to people and respect the new ways they consume related information and services" (COSTA, 2014, 55).

The new value chain in the news industry is totally different from the traditional value chain. One must understand that the traditional way of doing journalism has changed. Costa (2014) even recognizes some attempts at change, however, based on the old value chain of the journalistic industry:

Its executors only transposed to the digital media the old Gutenbergian form, the same model of the business. First, they published on their websites the very production of journalistic content. Second, they filled

this production with advertising (or what was left of it) and, third, the distribution of the product began to be made through the commercialization of digital signatures (COSTA, 2014, 54).

In the new value chain of the digital environment, it is necessary to share distribution and advertising. Costa (2014) still points out that journalistic organizations need to transform themselves into technology companies as well, as the new model breathes in with social networks. For him, the issue is not just being on Facebook or Google, is knowing how to be in each of these networks, in each of the digital platforms, and for this there is technique, that is, you have to modulate for each network; and this is what he calls the superdistribution (COSTA, 2014).

## V. CONCEPTUAL BASIS FOR MANAGEMENT AND CONTROL OF VNCE

The way organizations seek to generate value, also called a business model, has undergone numerous transformations due to the technological disruptions that have occurred in the last decades. For Osterwalder and Pigneur (2011, p.15), the business model shows "the logic of creation, delivery and capture of value by an organization", that is, how to create value for all its stakeholders, be they stakeholders or shareholders. The authors further explain that the business model "is a scheme for strategy to be implemented through the organizational structures of processes and systems" (OSTERWALDER, 2011, p.15).

On the other hand, the management model defines the logical and rational form of the process of transforming the objective into result, by setting priorities and setting goals, going beyond the numbers, valuing agents and people and providing convergence to business goals (KUGELMEIRER, 2014 ).

In order to delineate a business model and management for a collaborative virtual news environment, an interactive view of the planning, execution and control process is considered important. Planning and control are inseparable and only differently distinct, both integrated by feedback (OLIVEIRA, 1999, p.162).

According to Catelli (1999, p. 128), "the process of economic management is, in reality, a great process of control, aimed at ensuring business efficiency". For the model proposed here, management control is extremely

important, in view of its purpose, which is to influence the behavior of the members of a formal organization.

In a systematized model it is necessary to observe the actions of the people, since it is a system of human activities. To be effective a management model and its control system focused on achieving economic results, it is much more necessary to motivate people to achieve organizational goals than simply to ascertain what is currently occurring.

A control system seeks to promote an identity between the goals of the organization's members (individuals as well as groups) and the goals of the organization as a whole. Unfortunately complete congruence is hardly achieved. Thus the goal of the control system is to increase the degree of Goal Congruence (FLAMHOLTZ, 1979).



Fig.4: Partial Goal Congruence Scheme

Source: adapted from (Flamholtz, 1979)

Maximizing the likelihood that people are motivated to achieve organizational goals is the main

purpose of Goal Congruence, which through Flamholtz's (1979) approach deals with the issue of the influence of systems on the behavior of those involved.

In this way, a business and management model for journalistic organizations of the "new economy" needs to use Logical Intelligence of Goal Congruence in defining the roles of all agents involved in the business. Through Flamholtz's (1979) approach to the issue of system influence on stakeholder behavior, Goal Congruence's main purpose is to maximize the likelihood that people will be motivated to achieve organizational goals.

It is also considered important that this business model and management use a method of solving problems, which will be adopted here the PDCA cycle, a management tool that promotes the maintenance and continuous improvement of processes, through a circuit of four actions : Plan , Do, Check and Act (CAMPOS, 1992a).

The PDCA Cycle can be used to maintain and improve the "control guidelines" of a process, from two perspectives: maintenance (viable and sustainable goals) and improvement (the goals are challenging). Through the PDCA cycle it is possible to control whether the efforts are actually delivering the expected results.

Fig. 05 seeks to harmonically demonstrate the main concepts of the business area, considered the most appropriate to create a business model and management that helps in the management of a virtual collaborative news environment.



Fig.5: Concepts used in business model and management for VNCE

Source: Adapted from Rodrigues (2017)

Through the management model, the strategy to be implemented, defined by top management, based on the attributes of scenarios and markets, is established. For the implementation of this strategy and the scope of the competitive advantage, the model is used of the organizational structure, mediated by the actions of planning and control of the Controllershship. Controllershship, in their measurement models, defines the decision support variables, which aim to guide the convergence of the business objective and its transformation into competitive advantage.

- ✓ Logic of creation, delivery and capture of value by the organization;
- ✓ Increase in tangible and intangible wealth as value;
- ✓ Integration and convergence of agent objectives through Goal Congruence;
- ✓ Management control system through the PDCA cycle;
- ✓ Establishment of a virtuous cycle;
- ✓ Growth through a range improvement cycle.

**VI. ASSUMPTIONS OF THE BUSINESS MODEL AND MANAGEMENT FOR THE VNCE**

From the new scenario outlined for the journalistic organizations of the "new economy", the most appropriate concepts were identified to control this new way of generating value in journalistic organizations of the "new economy", in order to make its existence feasible and continuous. In this way, six premises were outlined that are the basis of the business model and management for a collaborative virtual news environment:

When defining a business model, you have to keep in mind that this business needs to create value for someone, deliver that value to someone, and also capture the monetary value to keep it running. This is the logic of Osterwalder and Pigneur (2011) and was used to operationalize the business.

In this way, with the first premise, the agents that form this environment, here called Portal de Notícias (reader, publisher, advertiser and the portal itself) were defined, as well as the function performed by each one of them and their relationships, a process of creating, delivering and capturing value.

*Table.1: agents forming the new journalistic business*

BUSINESS AGENTS			DESCRIPTION
FORNECEDOR	WAY	Publisher	Responsible for generating the reports that will be made available to clients (readers).
	ENDING	New Portal	It will act as responsible for providing advertising spaces for customers (advertisers, large news portals and e-commerces).
PRODUTO	WAY	Report	Responsible for the connectivity of the client (reader) to the portal.
	FIM	Portal - Advertising Space	Responsible for the receipts of the client (advertiser) regarding the use of advertising space of the portal.
		Portal - Digital Shopping *	Responsible for the customer's (advertiser) receipts regarding the use of Shopping Digital* advertising space and commissions on sales originated in the portal.
		Advertising Portal Portal for Affiliates	Responsible for the receipts of customers (large news portals and e-commerces) referring to commissions on sales originated in the portal.

CLIENTE	WAY	Reader	Responsible for the use of the Product (reports) which, through the frequency of connectivity, will provide an intangible wealth increase to the business.
	FIM	Anunciantes	Responsible for the use of the product (advertising space of the portal).
			Responsible for the use of the Digital Shopping product.
		Great News Portals and E-commerces	Responsible for the use of the product (advertising space for affiliates) where their products and ancillary services are displayed.

Source: Rodrigues (2017)

Fig. 06 demonstrates the logic of creating, delivering and capturing value, by the agents that form the business and their respective actions, both in the MEIO process and in the tangible wealth consolidator process.

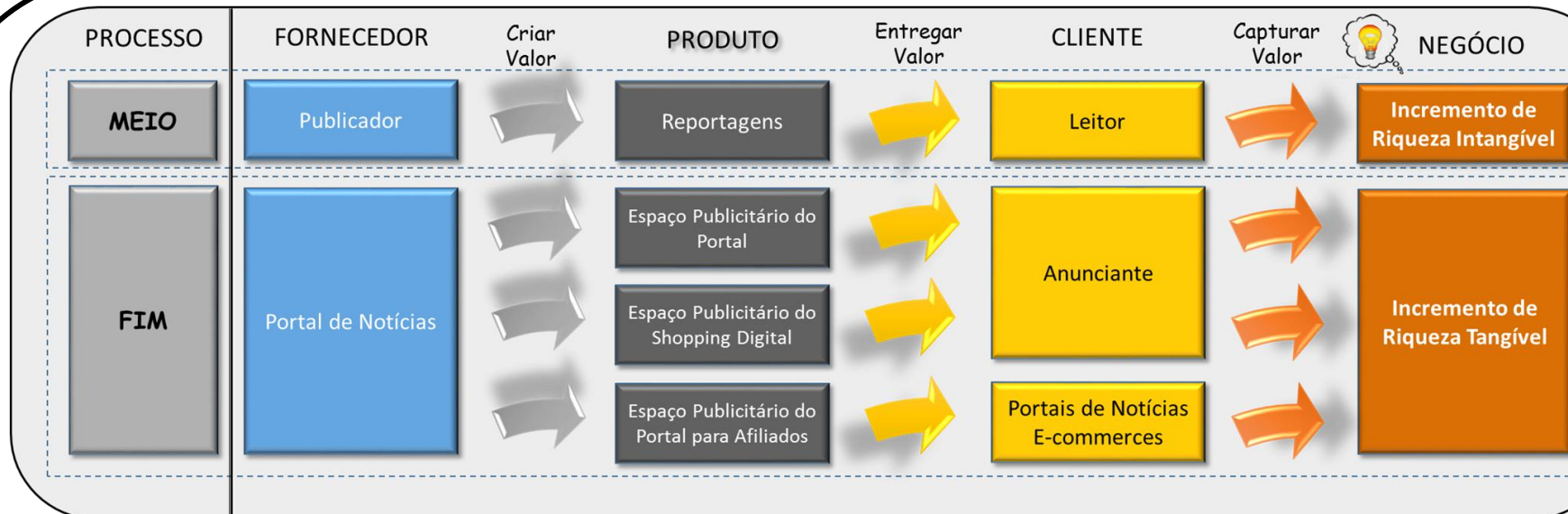
From the perspective of the two processes visualized, process middle and end, it is important to describe the logic of value creation by the supplier, delivery of value to the customer and capture of value by the business for a better understanding.

In the medium process of generation of intangible wealth represented by the multiplication of accesses to the portal, one has the publisher as the agent of creation of value, who realizes the generation of wealth through the elaboration and posting of his reports. The reports will act as attractors of access by readers (clients) who, according to their judgment (enjoy, share and follow) will increase the number of accesses via digital medium, resulting in greater potential for tangible wealth, and consequent appreciation of advertising space.

At the end process of tangible wealth generation represented by the entry of monetary resources, there is the News Portal providing advertising space in three different ways:

- ✓ for advertisers who just want to make their ads on the portal;
- ✓ for advertisers wishing to be part of the Digital Shopping space - having to pay a monthly bond fee (fixed amount), in addition to remunerating the portal with a commission on all sales that they make via portal;
- ✓ and a third type of use of ad space that will occur when the portal decides to join other larger portals to better optimize its ad slots.

Affiliation is a strategy used by many journalistic organizations, especially the beginners, as a way to optimize their spaces not contracted by advertisers, which brings an increase of revenue and, mainly, visibility for the new journalistic enterprise.



Processo	Fornecedor	Criar Valor	Produto	Entregar Valor	Cliente	Capturar Valor	Negócio
MEIO	Publicador	Elaborar e postar	Reportagens	Acessar e ler	Leitor	Curtir , compartilhar e seguir	Incremento de atratividade do Portal referente ao crescimento de acessos (riqueza intangível)
FIM	Portal de Notícias	Disponibilizar	Espaço Publicitário do Portal	Usar e efetuar vendas	Anunciante	Adquirir e Pagar	Ingresso monetário referente a venda de espaços (riqueza tangível)
	Portal de Notícias		Espaço Publicitário do Shopping Digital		Anunciante	Adquirir e Pagar Vender e Pagar	Ingresso monetário referente a venda do espaços e taxas de comissões sobre vendas (riqueza tangível)
	Portal de Notícias		Espaço Publicitário do Portal p/Afiliados		Portais de Notícias e E- commerce	Vender e Pagar	Ingresso monetário referente a taxas de comissões sobre vendas (riqueza tangível)

One of the main points of support for this model is the consideration of increases in tangible and intangible wealth for the purpose of measuring value growth. Such a focus should enable ideas, knowledge, the capacity to process information, and other intangibles, such as human capital, to be identified and quantified as a form of wealth, given that these increases now anticipate, in some way, the future creation of tangible value.

With the second premise, measures will be proposed to measure the performance of all stakeholders in relation to tangible and intangible wealth. Below are some examples of measures to measure the increase in intangible wealth for attribution of performance to reports and recognition of the publisher:

1 - Findability in Search Engines (qualitative) - refers to the positioning of search engines and the various factors that can cause a report to appear on the first, tenth, or hundredth page of results. In this way, it is understood why this measurement is valued, since it will be directly responsible for the optimization of accesses and, consequently, for the visibility of the Portal.

It is common to find specialized applications in this measurement. One of the main applications is the "SEMrush" tool available at <https://www.semrush.com>, which provides a number of attributes of your domain.

An interesting example of investing in intellectual capital would be to offer such courses to publishers of the Portal de Noticias, so that publishers learn how Google's algorithm works, thus seeking the first places of appearance in their system of the search.

2 - Geographic locality of access (qualitative) - the proposal of the business model and management for news portals, presented here, defends a growth strategy starting from a locality focus, close community, to then gaining superior coverage through the Improvement Cycles and reaching new markets such as neighborhoods, city regions, nearby cities, a region of a state, and so on.

Within this context, as the Portal's expansion phase occurs, the geographical origin of the connection will receive a differentiated performance attribute. Thus, in the initial phase of implementation, a connection having as geographical origin China will have a lower value assignment than a connection that has as geographical origin the district of location of the university.

3 - Origin of access in cyberspace (qualitative) - refers to the qualitative origin of navigation. A verification of the reader's source access will be performed before accessing the portal / report. The purpose of this verification is a qualitative evaluation of this access, based on a categorization of the site predecessor to the access to the Portal.

As an example, the Norton categorization table can be used as reference in the model in question, for the

construction of the evaluation of intangible wealth increase, an access coming from a site of the negative category (subjects related to alcohol, crime, drugs, hate, among others) would receive negative qualitative scores, while positive sites (subjects related to advertising, art, government, news, etc.) would receive positive qualitative scores.

4 - Access Abandonment Index (qualitative) - refers to the quantification that the reader left the Portal of News in a certain report. This will negatively punctuate the report/publisher.

5 - Number of Accesses (quantitative) - refers to the quantification of accesses that a given report obtained in a certain period of time. This will positively and directly proportionate the number of hits.

6 - Length of stay (quantitative) - refers to the quantification of the reader's dwell time in a given report, in a given period of time. This will score, positively, and directly proportional the access time.

In order to make due recognition of the News Portal and advertisers, it is important to relate some examples of measures to measure the increase of tangible wealth for attribution of performance to the Portal - advertising space and Portal - digital shopping:

1 - Billing by period - time (quantitative): refers to the billing in monetary units that a certain advertising space obtained in a certain period of time. This measurement will positively score and directly proportionate the billing.

2 - Number of transactions effected in the period - time (quantitative): refers to the number of transactions effected in a given period of time. Thus, it is possible to verify how many transactions the advertising space generated in the billing of a determining period. This measurement will positively and directly proportionate the number of transactions effected.

3 - Quotient between billing and number of transactions effected in the period - time (qualitative): refers to the number of invoicing per transaction effected in a given period. This number will answer the question whether the advertising space generated the billing through many or few transactions. This measurement will score positively and inversely proportional to the index number.

It is considered as better or more positive a construction of billing through many transactions, many customers, because this brings less risk to the continuity of billing.

It is important to emphasize that this was not the objective, nor was it expected to exhaust the possibilities of measurements with the above measures. It is understood that any good logical model development project should have its implementation carried out in

phases. For the effective completeness of measurements, one has to at least go through the development phases of a prototype and test its effectiveness.

Measures to measure the creation of value, both tangible and intangible, associated with news products and advertising space, have become important to the respective acknowledgments that will be given to the agents (publishers, portal as advertising space and digital shopping portal), as a way of providing the convergence movement of the objectives of all the agents involved, according to the third premise.



Fig.6: Reservations to the News Portal agents

Source: Rodrigues (2017)

Initially, bookings will be established for publisher, Portal - advertising space and Portal - digital shopping, as shown in Fig. 06. For these reserves the following calculations and estimates will be used:

- Calculations of estimates of the potentiality of increasing intangible wealth to present value, based on the attractiveness report of the reports, according to the measurement of intangible wealth, previously presented.
- calculations of tangible wealth increase, based on the billing report for the period, segregated by advertising space for general advertisers and digital mall advertisers.

Subsequently, the agents involved in this value creation, publisher and news portal (advertising space and digital mall), should initially receive recognition through levels of performance, illustrated in this research with the categorization of gold, silver and bronze. It has been very common in current business models to use categorizations as a means of customer loyalty and / or bring benefits to participants. Some examples of companies that follow this proposal are: Airbnb, Accor hotel chain, multiplus system and others.

In the case of this environment, performance levels (gold, silver and bronze) will be responsible for the following levels of capture of tangible monetary value:

- Publisher: participation in distributing the publisher reservation;

- Portal - advertising space: reserve for investment in the Portal;
- Portal - digital shopping: participation in the reserve to reduce commission rate on sales passed on to the Portal.

The relative holdings in the respective reserves will be calculated by means of an apportionment mechanism that will maintain direct proportionality to its levels of performance, so far categorized like bronze, silver or gold.

The fourth premise foresees a management control system that, through the use of the reasoning method of the PDCA cycle, will establish the necessary adjustments, both through the PDCA of Maintenance - maintenance of the operation in the short and medium term - and of the PDCA of Improvement - wide spread establishment perpetuating long-term operation, as shown in Fig. 07:

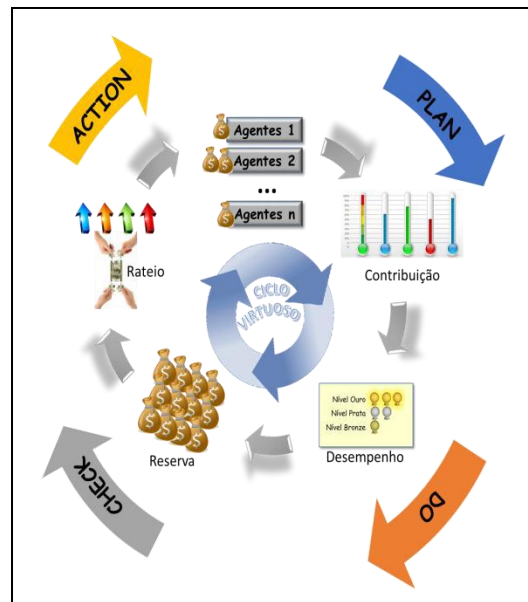


Fig.7: Management control for the VNCE using the PDCA cycle

Source: Adapted from Rodrigues (2017)

The central idea is the controlled evolution of the organization, through a virtuous cycle in which, through the efforts of all the agents involved, governed by the logical intelligence of Goal Congruence, we have the intensification of intangible wealth.

The establishment of the virtuous Cycle, according to the fifth premise, would be as follows: investment in intellectual capital (those intangible benefits that generate value for the company), through an efficient management control system that allows the recognition of agents, will increase intangible wealth. This growth of intangible wealth will increase the attractiveness of the organization (of the Portal de Notícias or VNCE), bringing in the present not only a



greater number of advertisers and clients and growth of scope, but also a greater added value of the services offered, which will materialize in tangible revenue growth, which, fed back in new investments in intellectual capital, would bring the perpetuity of the cycle, which Fig. 08 seeks to elucidate:



Fig.8: Virtuous Enhancement Cycle

Source: Adapted from Rodrigues (2017)

The model proposed here aims to help: segmented regional markets, a community, a neighborhood, a region of the city, a city, a region of a state, a state and so on, and this movement would be called the Improvement Cycles of Scope, as shown in Fig. 09:

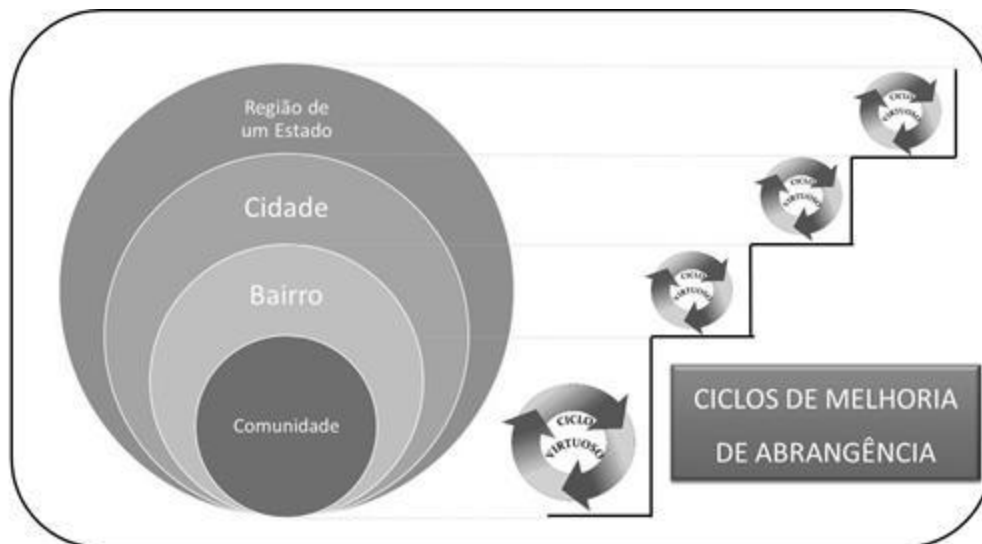


Fig.9: Enhancement Cycle Improvement

Source: Adapted from Rodrigues (2017)

Through the various cyclical movements of PDCA in the management of all stages of the Model (development of environmental activities), new areas of coverage are being achieved; thus establishing the Cycle of Improvement of comprehensiveness, that starts from a focus of locality, near community, to then reach higher reaches, as foreseen in the sixth premise.

The advantage of this initial locality is the optimization of the availability of advertising space with the audience of an appropriate target audience, assertively, at an affordable cost to local merchants, since the digital advertising market via the web and mobiles on the days of today for having dominant brands, for

example in Brazil, we have the Portals UOL, G1, Terra, Yahoo, among others; presents a still very high cost.

Regional markets and their segmentations do not support such large investments and cost optimized benefit, and it is in this niche that the collaborative news virtual environment intends to act.

An interesting example of how greater reach (or visibility) can bring in more revenue is the Metro newspaper, which was launched in 1995, attracting a lot of readers as it was distributed at no cost to train and bus stations throughout Stockholm. According to Osterwalder (2011) this strategy attracted advertisers and quickly it

became profitable, and can now be found in many large cities. (OSTERWALDER and PIGNEUR, 2011).

Costa (2014) in his report "A business model for digital journalism" presents as an alternative to increase revenues the sale of local advertising, made by the company itself, in addition to the offer of value added services, which would be all services that orbit the business and that the company can afford.

The growth strategy to be adopted in the model proposed for the VNCE will be to initiate its activities with the academic community of the partner institutions UENF, UFF and IFF. Being its target audience: publishers (students and teachers of partner institutions), affiliates / advertisers (community of surrounding neighborhoods and commercial establishments of the city of Campos dos Goytacazes with activities of interest to the university public) and reader (students and teachers of partner institutions, community of surrounding neighborhoods and commercial establishments of the city of Campos dos Goytacazes).

A first step of growth, which should happen through university connections and academic use, will be the change of coverage for the North and Northwest region of the State of Rio de Janeiro, where its target audience would be: publishers (students and affiliates / advertisers (communities from all cities in the north and northwest of the state of Rio de Janeiro with activities of interest to the university public) and the reader (students and students from different universities in the north and northwest region of the state of Rio de Janeiro) professors from various universities in the north and northwestern region of the state of Rio de Janeiro, as well as communities from all cities in the north and northwest of the state of Rio de Janeiro).

From this point on, it is understood that the academic nature is no longer assured and the cycles of growth become less predictable, since they can skip steps of State, Country, Country, Mercosur, South American Continent, American Continent, American continent and Europe, passing through Asia and other continents, reaching worldwide reach. This enlargement can be even greater, due to cyberspace, jumping to global reach, because in this digital age everything is possible, with no physical borders for growth.

## VII. FINAL CONSIDERATIONS

In view of the new scenario in which today's journalistic organizations fall into place, new business and management practices are needed that provide real possibilities for the existence and continuity of these organizations, providing convergence and attendance both to the business objectives and the personal objectives of all the agents involved.

In this way, this article aimed to demonstrate a business model and management for a virtual collaborative news environment - VNCE, whose main differential is the recognition of intangible wealth increases in addition to traditional tangible gains.

As a main contribution, the model brought recognition and the possibility of measuring intangible wealth increases in companies in the new economy, where the digital business and the primacy of intangible wealth prevail in the goodwill of these companies.

Based on the selection of management and business concepts, such as controllership, business model, management model, management control system, goal congruence, PDCA cycle, among others, to make it possible to control this new way of generating value in organizations journalism of the "new economy", is that these concepts were harmonically integrated, determining six premises for the model.

In order to meet the new reality of journalistic business in this era of cyberspace, the model presupposes the recognition of the agents involved in the business and proposes measures to measure its contribution as a great intangible value, establishing monetary reserves for these agents, be they reader, publisher, advertiser, or the news portal itself.

Through a management control system, it was possible to measure, evaluate and recognize the participation of each agent involved in the VNCE, in order to obtain the congruence of the objectives of all involved, using the logical intelligence of Goal Congruence and ensuring, in this way, the expansion of the scope and continuity of the operation of the business.

The initial focus of the model is a locality view for the availability of advertising and ancillary services, attending to a specific and qualified target audience, where through the valorization of the agents that increase the attractiveness of the business the revenues will be increased and this will expand its area of comprehensiveness.

Thus, the conceptual proposition of this model comes against the current reality of journalistic organizations, which need to rediscover a profitable way of surviving the challenges represented by the development of new technological platforms.

The limitations of this research are directly related to the intangibility factor and speed in the transformations. Intangible wealth is often difficult to identify and evaluate effectively, but once discovered and exploited, it provides a competitive advantage. And the speed with which the themes related to digital communication change is surprising, for some time they were media convergence, interface, cyberspace, interactivity, etc.; today in full Web 2.0 already entering

the stage of web 3.0, the new keywords become blogosphere, wikis, digital social networks, mobile communication and in the future, closer and closer what awaits us?

According to the above, it is suggested that research be continued in order to deepen the issues raised here, as a way of improving the proposed model.

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# Diagnosis Model as a Support for Family Succession Planning

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**Abstract**— *The present study was aimed to develop a diagnosis model to evaluate the organization before the implementation of a family succession planning. The research was sent to the founder and current manager and successors of a Brazilian timber company, taking into account 07 (seven) major axes: training, decision-making, leadership positions, entry of family members into the company, planning, choice of successor, and family conflicts. The development of the family succession diagnosis model contributes to the literature of the area by presenting a data collection tool to assist managers in the evaluation of the companies, especially allowing them to identify weak points of the organization that need to be solved before the introduction of the succession planning.*  
**Keywords**—*Family business. Succession. Management.*

## I. INTRODUCTION

By definition, family business is when one generation allows for the next generation to take over the leadership of the company. For this to occur with no conflicts, preparation and planning are necessary. Every company is singular, and there are no equal plans [1]. In the case of family businesses, one of the most important characteristics is the interaction between the spheres of a system formed by three subsystems: family, equity and company. The heirs are partners in company and equity, therefore, one cannot neglect the planning of succession and perpetuation of the business [2]. When considering family companies' strengths, it is highlighted: employee loyalty, the reputation of the family name, family succession, quick decisions, family group in terms of market influence, and family generation, which enables the continuation of their name and values. [3].

Succession is not just a transfer of power, since it involves time-consuming processes. It also includes the ongoing solidity of the company and the family. Thus, the level of training, responsibilities, communication of succession, succession planning and most importantly, the successor satisfaction in taking over the business are determining factors for family succession [4]. It is important to identify the roles played in the whole

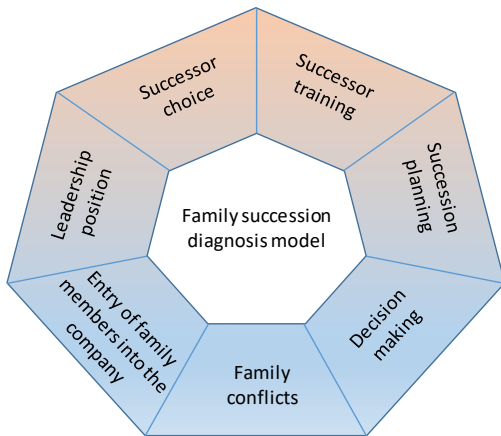
process, the investigation of values, needs and expectations and their impact on the process so that the family business is in the market as long as possible by means of introducing family succession [5]. Among the greatest challenges faced by family businesses in the succession process are the planning for the period, the preparation of a successor able to manage the company in face of challenges, and especially the inclination of the predecessor to transfer the company to another person even if it is a member of the family. Therefore, the succession process takes place only when there is the ability of the predecessor to pass on his knowledge, and the successor to receive it [6].

The diagnosis tool is the first important management analysis for organizations. Despite several advantages, we highlight that no organizational form is perfect, since each of them has strengths and weaknesses. Therefore, compensatory mechanisms have to be introduced. The efficiency of an organization increases when one learns to diagnose one's own strengths and weaknesses [7]. Business diagnosis is paramount and contributes to the companies' knowledge of their internal and external reality; hence, they can better plan their activities and provide the manager with a systemic view of the processes and possible failures of the organization [8]. The most commonly used diagnostic approach in Brazil to effect organizational changes is based on estimates and established solutions (prescription of revenues), providing limits ranging from non-acceptance by the client to the ineffectiveness of the proposed solutions. It stimulates the reactive attitude, emphasizes technical variables and disregards human variables, but it does not consider the reality of the client system, following unified plans that assume that all organizations are identical. [9].

The family succession diagnosis model proposed in this study aims to fill the gaps left by organizational diagnosis models that do not widen the issue of family succession, thus evaluating the organization before carrying out the succession planning.

**II. MATERIALS AND METHODS**

As for the approach, the research was characterized as qualitative, and as for the objectives, exploratory and descriptive. Regarding the procedures of data collection, the research was characterized as bibliographical and case study. The study was limited to analyzing a family-owned company in the timber sector, based in the city of Curitiba, Paraná, Brazil. Field research was carried out by applying a questionnaire composed by 27 questions on a Likert scale sent to the founder/manager, and to the successors of the company. As for the data analysis, the method of Average Ranking (AR) was used.

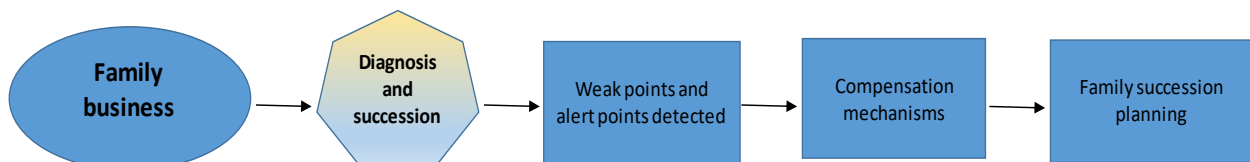


Source: Elaborated by the authors.

Fig.1: Family Succession Diagnosis Model

**III. DISCUSSION**

We present below the results of the seven major axes (Figure 01) analyzed on family succession. The Likert



Source: Elaborated by the authors.

Fig.2: Steps: diagnosis for succession planning

Once the diagnosis is made, it is possible to discover the weaknesses, introduce compensatory mechanisms, and develop a succession planning consistent with the reality of the organization.

As observed in Table 01, the diagnosis seeks to analyze aspects that, in most cases, are unnoticed by the manager. In the first major axis, successor choice, the successor's degree of "freedom" in whether or not to take the leadership of the company in the future is analyzed. The freedom given to the successor, that is, if he really intends to accept the company, is one of the first conditions for a less conflictive and more rational succession planning. The degree of "pressure" on the part of the manager, and

Scale presents items in the form of statements about a category of analysis on which respondents are asked to state their position. As for the analysis of the answers of the questionnaires, the method of Average Ranking (AR) was used to measure the degree of agreement of the respondent subjects. The results with mean < 3 show an evaluation below the reasonable in the research question (weak point). Results with mean > 3 < 4 show a reasonable evaluation with potential for improvement (neutral point). From another perspective, the index with a mean of >3 <4 (depending on the case) in a short period of time may become a weak point. Therefore, the index with mean >3 <4 should be considered as a warning signal. Results with mean > 4 mean a good average and above score (strong point). In order to obtain the values, we initially considered the weighted average  $WA = \text{sum}(\text{frequencies of the answers} \times \text{scales indicated})$  and then we calculated the Average Ranking, expressed by  $AR = WA / \Sigma \text{frequencies of the answers}$ .

According to table 01, each major axis sought to analyze in depth the most relevant aspects, and family businesses is the most relevant when the subject is family succession. A common misconception when the manager thinks about succession is the intention to develop a succession planning with no parameters to carry it out. The thesis that we support in this study is that before developing a succession planning, it is necessary to make a diagnosis that precedes it.

the degree of "influence" of other members of the family, in the expectation that the successor takes the leadership of the company, generates a frequently disastrous intervention in the "successor choice" axis. The "profile" in the choice of successor is a fundamental condition for the manager in his analyzes. However, there are cases in which the successor has the "profile" and, at the same time, has no interest in taking over the organization. Therefore, the great successor choice axis is extremely important in the diagnosis of family succession.

Table.1: Aspects researched in the axes

ASPECTS RESEARCHED IN THE AXES
<b>SUCCESSOR CHOICE</b>
Freedom
Pressure
Profile
Influence
<b>SUCCESSOR TRAINING</b>
General knowledge
Other experiences
Knowledge of the departments
Management training
Incentive
Opportunity
<b>SUCCESSION PLANNING</b>
Execution
Strategies
Knowledge
Disclosure
Transition
Professionalization
<b>DECISION-MAKING</b>
Democratic participation
<b>CONFLICTS</b>
Rivalry
Interference
Family and company separation
Family and company conflicts
Resolution
<b>ENTRY OF FAMILY MEMBERS INTO THE COMPANY</b>
New members
Selection
<b>LEADERSHIP POSITION</b>
Vacancies
Competence
Pressure

Source: Elaborated by the authors.

On the second major axis, successor training, analyzes of "general knowledge" and "knowledge of the departments" are related to the degree of closeness between successor and family business. The sooner the successor is in contact with the company, the greater the chances that they understand the company, adapt to the existing organizational culture, and increase the probability of being accepted by other members (whether they are family members or not). The analysis of "other experiences" reveals the degree of importance given by the manager and successor to a possible successor experience in other companies. Experience in other environments is a great alternative to add knowledge to the future manager. It is possible to identify strengths, weaknesses, opportunities and threats in other companies that can be compared. From these external experiences, strategies can be adopted and mistakes can be avoided, and a range of possibilities is opened to make the successor more prepared and with a greater vision of the market.

The analyses carried out on "Management training", "Incentive" and "Opportunity" are related to the

incentives regarding the formation of successors, whether practical or theoretical (inside and outside the company). In the third major axis, "Succession Planning", the analyses seek to reveal the degree of maturity of the organization with respect to succession. The first step towards good planning is to understand the organization itself by identifying its potentialities and limitations in the context of the relationships between founder, successors, and family members. Understanding of the organization is everyone's liability, whether they are family or not, and it is up to the manager to provide the conditions for such. When we talk about succession planning, some inquiries are needed for the manager of a family business: is there formal planning? The short, medium and long-term strategies are clearly defined? Are family members aware of succession planning? Does the company have an employee prepared to run the company at any time (in an emergency) and/or assist in the transition from succession? In the case of the absence of a successor, has the manager considered the possibility of professionalizing the company? These issues are extremely important and assist in the analysis of the "Succession Planning" axis.

In the fourth major axis, "Decision-making", we study the extent to which "Democratic participation" is present in the company, and its influence on the organization's direction is analyzed. On the fifth major axis, "Conflicts", the analysis seek to reveal the manager's ability to manage the differences and the degree of family interference in the company. Aspects such as rivalry, jealousy and intrigue are present in most family businesses and need to be identified, addressed and minimized. The permanence of these aspects in the medium and long term in some cases lead to the impossibility of elaborating an efficient succession planning.

On the sixth major axis, "Entry of family members into the company", the analysis seek to reveal the degree of family influence in the selection of new employees and whether the manager takes into account the profile of the candidate and not just the relationship, since not accepting a relative in the company can generate occasional inconveniences. However, dismissing a relative when he or she does not meet expectations can lead to permanent conflict and even the inability to dismiss due to strong pressure from other family members.

In the seventh and last lines, "leadership positions", it is analyzed how is made the choice for these positions since relatives have some influence and there are difficulties in demanding results of the family members who have leadership position in the company. Likewise, how complex is the decision to accept or not a relative in the

company since placing a relative in a leadership position requires a lot of caution.

After a brief explanation about the aspects analyzed in each major axis, we show the results achieved in the research. As seen in table 02, there was little divergence in the responses of the manager and successors in the seven axes. This confluence of opinions shows certain clarity among the different generations regarding the process of family succession.

Table.2: Average ranking

Axes	Manager (AR)	Successor (AR)	AR General
Successor choice	3,75	3,5	3,6
Successor training	4,6	4,6	4,6
Succession planning	4	3,6	3,8
Decision-making	4	5	4,5
Family conflicts	2,8	2,4	2,6
Entry of family members into the company	4	4,5	4,2
Leadership position	4,6	4,3	4,4

Source: Elaborated by the authors.

As can be seen in table 03, "Successor choice" (n = 3.6) and "Succession planning" (n = 3.8) are points of alert that require greater attention and analysis of the company. With regard to "Successor Choice" (n = 3.6), although we

Table.3: Average ranking

Classification of axes in descending order	AR = WA / $\Sigma$	Result	Score
Successor training	n= 4,6	> 4	strong
Decision-making	n= 4,5	> 4	strong
Leadership position	n= 4,4	> 4	strong
Entry of family members into the company	n= 4,2	> 4	strong
Succession planning	n= 3,8	> 3 < 4	alert
Successor choice	n= 3,6	> 3 < 4	alert
Family conflicts	n= 2,6	< 3	weak

Source: Elaborated by the authors.

In what regards "Succession planning" (n = 3.8), we detected a concern of both founder and successors about the lack of a qualified employee to take the company in the absence of the manager or to assist in the moment of the transition of power. By worrying about several day-to-day activities, the founder eventually forgets to prepare an employee and/or successor to run the business. As seen in table 03, "Family conflicts" (n = 2.6) are weaknesses and require urgent intervention by the manager. There will always be conflicts within a family business. However, certain factors can increase these conflicts, such as lack of dialogue, disputes between generations, rivalry among siblings, protectionism, jealousy, gossips, among others. Therefore, it is necessary to know how to manage these conflicts so that they do not become unbearable to the point of undermining its maintenance and growth. Lack of communication or communication failure, for example, is a trigger for conflicts, and it is up to the manager to assess the degree of communication within the organization and implement the compensatory mechanisms. Organizations

previously stated that there is certain "confluence of opinions" between different generations, in the "pressure" case, we find that the manager stated that he had never pressured successors to take over the family business. However, the successors considered that there was certain pressure on the part of the manager. There are innumerable reasons for an entrepreneur to open a company, among them we can mention financial independence, freedom to create, do what he likes, control his own future, pride in having developed something, security, flexibility of time, income extra, do not have a boss, work together with the family, provide their own business opportunities for their children, etc.

Whether for one of these reasons or the combination of two or more, the point is that most entrepreneurs tend to unconsciously think of their children taking the company in the future (which is not a problem). The setback is just when they pressure the successors to take over the company. Trying to influence the heirs and to take away their freedom of choice can cause serious problems for the organization by bringing into the company intrigues, doubts and insecurity for everyone.

with a high level of communication tend to solve their conflicts in a faster and more efficient manner. In the case of family businesses, due to the emotional factors involved, communication should be approached as a priority in order to avoid future disagreements and problems.

#### IV. CONCLUSION

The "Diagnosis Model as a Support for Family Succession Planning" proposed here contributes to the topic about succession, but does not finish it. As for the limitations, the model should move forward to analyze other important aspects such as gender, for example. In this way, it is possible to try to reveal the degree of difficulty of the women heirs in disputing the company's leadership with the men heirs and then find out whether or not the founder plays the role of mediator in this situation of possible conflict.



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# Black Holes: a Different Perspective

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**Abstract**—In this paper we propose a full revised version of a simple model, which allows a formal derivation of an infinite set of Schwarzschild-Like solutions (non-rotating and non-charged “black holes”), without resorting to General Relativity. A new meaning is assigned to the usual Schwarzschild-Like solutions (Hilbert, Droste, Brillouin, Schwarzschild), as well as to the very concepts of “black hole” and “event horizon”. We hypothesize a closed Universe, homogeneous and isotropic, characterized by a further spatial dimension. Although the Universe is postulated as belonging to the so-called oscillatory class (in detail, we consider a simple-harmonically oscillating Universe), the metric variation of distances is not thought to be a real phenomenon (otherwise, we would not be able to derive any static solution): on this subject, the cosmological redshift is regarded as being caused by a variation over time of the Planck “constant”. Time is considered as being absolute. The influence of matter/energy on space is analysed by the superposition of three three-dimensional scenarios. A short section is dedicated to the so-called gravitational redshift which, once having imposed the conservation of energy, may be ascribable to a local variability of the Planck “constant”.

**Keywords**—Black Holes, Schwarzschild, Hilbert, Droste, Brillouin, Extra Dimension, Weak Field, Redshift.

## I. INTRODUCTION

We hypothesize a closed Universe, homogeneous and isotropic, belonging to the so-called *Oscillatory Class* [1]. The existence of a further spatial dimension is postulated. Although space, as we are allowed to perceive it, is curved, since it can be approximately identified with a Hyper-Sphere (the radius of which depends on the state of motion) [2], the Universe in its entirety, assimilated to a Four-Dimensional Ball, is to be considered as being flat. All the points are replaced by straight line segments [3] [4]: in other terms, what we perceive as being a point is actually a straight-line segment crossing the centre of the 4-Ball. Consequently, matter is not to be regarded as evenly spread on the (Hyper)Surface of the 4-Ball, but rather as homogeneously filling the 4-Ball in its entirety.

We have elsewhere [4] deduced the following identity:

$$R_m = \frac{2GM_{tot,m}}{c^2} \quad (1)$$

$G$  represents the *Gravitational Constant*,  $c$  the *Speed of Light*,  $R_m$  the mean value of the radius of the 4-ball, and  $M_{tot,m}$  the corresponding mass. According to our model,  $R_m$  and  $M_{tot,m}$  can be conventionally considered as being real values, since the metric variation of the cosmological distances is not thought to be a real phenomenon (in other terms, we hypothesize that the real amount of space between whatever couple of points remains constant with the passing of time) [4] [5]. In this regard, we specify how, in order to legitimize the so-called *Cosmological Redshift*, the *Planck Constant* may vary over time [6] [7].

Replacing, for convenience,  $M_{tot,m}$  with  $M_{tot}$ , and  $R_m$  with  $R_s$  (the *Schwarzschild Radius*), from (1) we have:

$$R_s = \frac{2GM_{tot}}{c^2} \quad (2)$$

The Universe we have hypothesized may be approximately described, with obvious meaning of the notation, by the following inequality:

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 \leq R_s^2 \quad (3)$$

The Universe we are allowed to perceive (static configuration) can be assimilated to the Hyper-Surface defined by the underlying identity:

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 = R_s^2 \quad (4)$$

Let us denote with  $C$  the centre of the 4-ball, with  $O$  and  $P$  two points on the surface, the first of which taken as origin, and with  $O'$  the centre of the so-called *Measured Circumference*, to which  $P$  belongs. Both  $O$  and  $O'$  are considered as belonging to  $x_4$ . The *Angular Distance* between  $O$  and  $P$ , as perceived by an ideal observer placed in  $C$ , is denoted by  $\chi$ .

The arc bordered by  $O$  and  $P$ , denoted by  $R_p$ , represents the so-called *Proper Radius* (the measured distance between the above-mentioned points). We have:

$$R_p(\chi) = R_s \chi \quad (5)$$

The straight-line segment bordered by  $O'$  and  $P$ , denoted by  $R_c$ , represents the so-called *Predicted (or Forecast) Radius* (the ratio between the perimeter of the Measured Circumference and  $2\pi$ ). We have:

$$R_c(\chi) = X(\chi) = R_s \sin \chi \quad (6)$$

From the previous we immediately deduce:

$$\chi = \arcsin\left(\frac{X}{R_s}\right) \quad (7)$$

Consequently, we have:

$$dR_p = R_s d\chi = \frac{dX}{\sqrt{1 - \left(\frac{X}{R_s}\right)^2}} \quad (8)$$

The scenario is qualitative depicted in Figure 1.

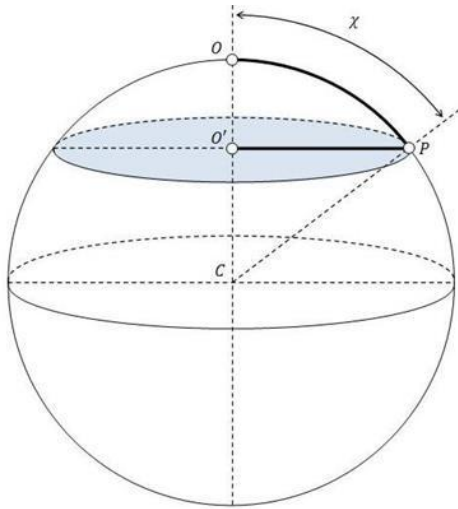


Figure 1. 4-Ball

At this point, for the Hyper-Surface defined in (4), the Friedmann–Robertson–Walker metric [8] can be written:

$$ds^2 = c^2 dt^2 - \frac{dX^2}{1 - \left(\frac{X}{R_s}\right)^2} - X^2(d\theta^2 + \sin^2 \theta d\varphi^2) \quad (9)$$

Let us denote with  $S_2$  the 2-Sphere characterized by a radius of curvature equal to  $R_c$ . In order to simplify the notation, from now onwards we shall denote with the same symbol both the geometrical object and the corresponding surface area or volume. Consequently, we have:

$$S_2(\chi) = X^2 \int_{\varphi=0}^{2\pi} \int_{\theta=0}^{\pi} \sin \theta d\theta d\varphi = X^2 \int_0^{4\pi} d\Omega = 4\pi X^2 \quad (10)$$

$$= 4\pi R_s^2 \sin^2 \chi$$

The above-mentioned surface is simultaneously border of a 3-Ball, denoted by  $V_3$ , and of a Hyper-Spherical Cap, denoted by  $S_3$ .  $V_3$  represents the Predicted (or Forecast) Volume,  $S_3$  the Proper Volume. We have:

$$V_3(\chi) = \int_0^{R_c} S_2(\chi) dR_c = 4\pi \int_0^X X^2 dX = \frac{4}{3}\pi X^3 \quad (11)$$

$$= \frac{4}{3}\pi R_s^3 \sin^3 \chi$$

$$S_3(\chi) = \int_0^{R_p} S_2(\chi) dR_p = 4\pi R_s^3 \int_0^X \sin^2 \chi d\chi \quad (12)$$

$$= 2\pi R_s^3 (\chi - \sin \chi \cos \chi)$$

We can generalize the foregoing as follows:

$$S_3(R, \chi) = 2\pi r^3 (\chi - \sin \chi \cos \chi) \quad R \in [0, R_s] \quad (13)$$

The Hyper-Surface  $S_3$  defined in (12) is associated to a Hyper-Spherical Sector, denoted by  $V_4$ . We have:

$$V_4(\chi) = \int_0^{R_s} S_3(R, \chi) dR = 2\pi (\chi - \sin \chi \cos \chi) \int_0^{R_s} R^3 dR \quad (14)$$

$$= \frac{1}{2}\pi R_s^4 (\chi - \sin \chi \cos \chi)$$

## II. GRAVITY: HOW MASS “BENDS” SPACE

### 1. Gravitational “Singularities”

As previously stated, the (curved) space we are allowed to perceive can be approximately identified with a Hyper-Sphere, the radius of which depends on our state of motion: at rest, this radius equates  $R_s$ . In our simple model the total amount of mass is constant: in other terms, mass can only be redistributed. Let us consider a generic point  $Q$ , belonging to the surface of the 4-Ball, and let us denote with  $\chi_{max}$  the angular distance between this point and the origin  $O$ . In order to create a “gravitational singularity” in correspondence of the origin, we have to ideally concentrate in  $O$ , from the point of view of an observer at rest (who is exclusively allowed to perceive a three-dimensional curved universe), all the mass enclosed in the 2-Sphere defined by (10) (with  $\chi = \chi_{max}$ ). This surface represents the border of the Hyper-Spherical Cap defined in (12) (with  $\chi = \chi_{max}$ ) which, in turn, is associated to the hyper-spherical sector defined by (14) (with  $\chi = \chi_{max}$ ).

According to our theory, in enacting the ideal procedure previously expounded, we actually hypothesize that all the mass of the Hyper-Spherical Sector earlier defined may be concentrated (and evenly spread) along the material segment bordered by  $C$  and  $O$ . The procedure entails a linear mass (energy) density increment, no longer compatible with the previous radial extension: consequently, both the segment and the corresponding space undergo a radial contraction (the segment shortens together with space) and the surrounding spatial lattice, the integrity of which must be in any case preserved, results deformed. We want to determine the new radial extension of the segment (that represents the singularity) and the shape of the deformed spatial lattice.

It is worth specifying how, abiding to the global symmetry elsewhere introduced [2] [4] and herein taken for granted, the procedure previously exploited is symmetric with respect to the centre of the 4-Ball: consequently, we should have actually considered two opposite Hyper-Spherical Sectors, characterized by the same amplitude, and a single material segment, crossing the centre  $C$ , bordered by  $O$  and its antipodal point.

### 2. Three-Dimensional Scenarios

From (3), by setting equal to zero, one at a time,  $x_1$ ,  $x_2$  and  $x_3$ , we obtain the following three-dimensional scenarios:

$$x_{4,1}^2 + x_2^2 + x_3^2 \leq R_s^2 \tag{15}$$

$$x_1^2 + x_{4,2}^2 + x_3^2 \leq R_s^2 \tag{16}$$

$$x_1^2 + x_2^2 + x_{4,3}^2 \leq R_s^2 \tag{17}$$

Evidently, if we take into consideration one among the static scenarios we have just obtained, the procedure previously discussed (the creation of the singularity) is equivalent to concentrating along a segment the mass of a spherical sector.

Let us denote with  $S_{2-1}$ , the Circumference defined by the following relation:

$$S_{2-1}(\chi) = 2\pi X \tag{18}$$

In the three dimensional scenario we have been considering,  $S_{2-1}$  "plays the role" of  $S_2$ , defined in (10).

The circumference defined in (18) is simultaneously border of a Disc, denoted by  $V_{3-1}$ , and of a Sphere, denoted by  $S_{3-1}$ . In the three-dimensional scenario we have been considering, the first "plays the role" of the Predicted (or Forecast) Volume  $V_3$ , defined in (11), while the second "plays the role" of the Proper Volume  $S_3$ , defined in (12). We have:

$$\begin{aligned} V_{3-1}(\chi) &= \int_0^{R_c} S_{2-1}(\chi) dR_c \\ &= 2\pi \int_0^X X dX = \pi X^2 = \pi R_s^2 \sin^2 \chi \end{aligned} \tag{19}$$

$$\begin{aligned} S_{3-1}(\chi) &= \int_0^{R_p} S_{2-1}(\chi) dR_p = 2\pi \int_0^X \sin \chi d\chi \\ &= 2\pi R_s^2 (1 - \cos \chi) \end{aligned} \tag{20}$$

We can generalize the foregoing as follows:

$$S_{3-1}(R, \chi) = 2\pi r^2 (1 - \cos \chi) \quad R \in [0, R_s] \tag{21}$$

Consequently,  $S_{3-1}$  is associated to a Spherical Sector, denoted by  $V_{4-1}$ , characterized by a volume provided by the following relation:

$$\begin{aligned} V_{4-1}(\chi) &= \int_0^{R_s} S_{3-1}(R, \chi) dR = 2\pi (1 - \cos \chi) \int_0^{R_s} R^2 dR \\ &= \frac{2}{3} \pi R_s^3 (1 - \cos \chi) \end{aligned} \tag{22}$$

In the three dimensional scenario we have been considering,  $V_{4-1}$  "plays the role" of  $V_4$ , defined in (14).

As previously highlighted, the new radial extension of the segment (that represents the singularity) is still unknown, as well as the shape of the deformed spatial lattice. Let us carry out some hypotheses.

Let us denote with  $r$  the Radial Coordinate of a generic point of the warped surface. Now, let's suppose that, notwithstanding the deformation of the spatial lattice induced by the mass, if the angular distance between whatever couple of points does not vary, the corresponding

measured distance remains constant. Actually, there is no point in hypothesizing a different behaviour.

From now onwards, we shall resort to the subscript "g" every time we refer to a quantity measured after the creation of the singularity.

We must impose the following:

$$R_{p,g} = \int_0^\chi \sqrt{\left(\frac{dr}{d\chi}\right)^2 + r^2} d\chi = R_s \chi = R_p \tag{23}$$

$$R_s^2 = \left(\frac{dr}{d\chi}\right)^2 + r^2 \tag{24}$$

From the previous we easily obtain the following banal differential equation:

$$\frac{d^2r}{d\chi^2} + r = 0 \tag{25}$$

The boundary conditions can be easily determined by resorting to the well-known shell theorem: in other terms, we have to impose that, for all the points belonging to the circumference defined in (18) once having set  $\chi = \chi_{max}$  (actually, for all the points belonging to the 2-Sphere defined in (10), once having set  $\chi = \chi_{max}$ ), there must be no difference between the initial condition and the final one (matter concentrated in a single point).

Therefore, we have:

$$\frac{dr}{d\chi}(\chi_{max}) = 0 \tag{26}$$

$$r(\chi_{max}) = R_s \tag{27}$$

From (25), taking into account (26) and (27), we obtain:

$$r(\chi) = R_s \cos(\chi_{max} - \chi) \tag{28}$$

From the previous, we can immediately deduce:

$$r_{min} = r(0) = R_s \cos \chi_{max} \tag{29}$$

The scenario is qualitative depicted in Figure 2

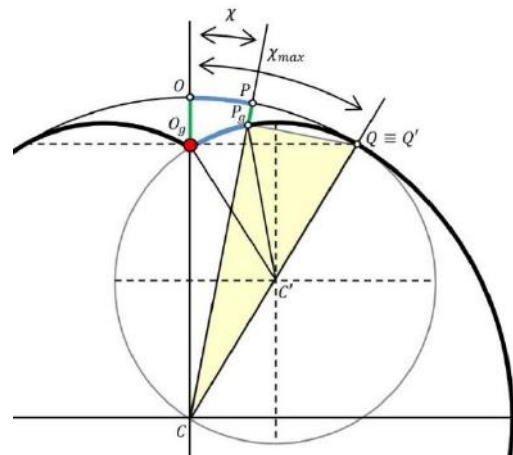


Figure 2. Gravitational Singularity

Figure 2 qualitatively shows how space results in being deformed due to the Gravitational Singularity, perceived as being placed in  $O_g$ . At the beginning, the origin coincides

with  $O$ . If we concentrate in  $O$  (actually along the segment bordered by  $C$  and  $O$ ) the mass of the Spherical Sector (actually a Hyper-Spherical Sector) with an amplitude equal to  $2\chi_{max}$ , space undergoes a contraction. The new origin coincides with  $O_g$ , and the surrounding space is symmetrically warped. The initial radial coordinate of a generic point  $P$  (actually its initial radial extension) is represented by the segment bordered by  $C$  and  $P$ . The corresponding angular distance is denoted by  $\chi$ . The final coordinate (actually the final radial extension), represented by the segment bordered by  $C$  and  $P_g$ , is shorter than the initial one, and its value is provided by (28). The proper radius does not undergo any modification: the arc bordered by  $O$  and  $P$ , in fact, is evidently equal to the one bordered by  $O_g$  and  $P_g$ .

If we denote with  $x$  the Reduced "Flat" Coordinate (the Reduced Forecast Radius), we have:

$$R_{c,g} = x = r \sin \chi = R_s \sin \chi \cos(\chi_{max} - \chi) \quad (30)$$

Moreover, with obvious meaning of the notation, we can immediately write:

$$\delta(\chi) = R_s - r(\chi) = R_s [1 - \cos(\chi_{max} - \chi)] \quad (31)$$

$$\delta_{max} = \delta(0) = R_s (1 - \cos \chi_{max}) \quad (32)$$

If we denote with  $M_{tot}$  the mass of the Ball (that "plays the role" of the 4-Ball with which we identify our Universe), and with  $M_{\chi_{max}}$  the mass contained in the spherical sector with an amplitude equal to  $2\chi_{max}$  (which, as previously remarked, "plays the role" of a Hyper-Spherical Sector), we can write, taking into account (32), the following:

$$\frac{M_{\chi_{max}}}{M_{tot}} = 1 - \cos \chi_{max} = \frac{\delta_{max}}{R_s} \quad (33)$$

$$\delta_{max} = R_s \frac{M_{\chi_{max}}}{M_{tot}} = \frac{2GM_{\chi_{max}}}{c^2} = R_{s,\chi_{max}} \quad (34)$$

In other terms, the procedure entails a reduction of the radial coordinate of  $O$  (actually, the material segment bordered by  $C$  and  $O$  undergoes a contraction) the size of which is equal to the Schwarzschild radius of  $M_{\chi_{max}}$ .

The scenario is qualitatively portrayed in the following figure, where the singularity (as we can perceive it) coincides with the point  $O_g$ .

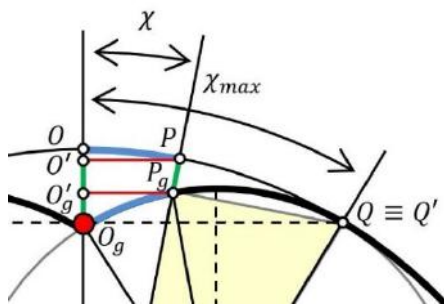


Figure 3. Gravitational Singularity (Particular)

Figure 3 shows once again how the singularity, perceived as being placed in  $O_g$ , does not influence the measured distance (the proper radius). The arc bordered by  $O$  and  $P$ , as previously underlined, is evidently equal to the one bordered by  $O_g$  and  $P_g$ . On the contrary, the "Flat" Coordinate (the Forecast Radius) undergoes a reduction. The segment bordered by  $B$  and  $P$  represents the Forecast Radius ( $X$ ) when matter is evenly spread; the segment bordered by  $B_g$  and  $P_g$  represents the Reduced Forecast Radius ( $x$ ).

### III. QUANTIZATION

If mass homogeneously fills the 4-Ball with which we identify the Universe (static configuration), by virtue of the symmetry [3] [4], the Energy of a Material Segment, provided with a mass  $M$ , can be written as follows:

$$E = Mc^2 \quad (35)$$

The Linear Mass Density [3] [4] is defined as follows:

$$\bar{M} = \frac{M}{R_s} \quad (36)$$

By virtue of the foregoing, the (Linear) Energy Density can be defined as follows:

$$\bar{E} = \frac{E}{R_s} = \frac{Mc^2}{R_s} = \bar{M}c^2 \quad (37)$$

If we denote with  $\Delta R_m$  the (Radial) Quantum of Space [4], the Punctual Mass, denoted by  $m$ , is defined as follows:

$$m = \bar{M}\Delta R_{min} = \frac{M}{R_s}\Delta R_{min} \quad (38)$$

As for the corresponding Energy, by virtue of (37) and (38), we can immediately write:

$$E_m = \bar{E}\Delta R_{min} = \frac{Mc^2}{R_s}\Delta R_{min} = mc^2 \quad (39)$$

Let us denote with  $M_{min}$  the Minimum Linear Mass. The corresponding Energy can be obviously written as follows:

$$E_{min} = M_{min}c^2 \quad (40)$$

As for the Minimum Linear Mass Density we have:

$$\bar{M}_{min} = \frac{M_{min}}{R_s} \quad (41)$$

The Minimum (Linear) Energy Density is clearly provided by the following:

$$\bar{E}_{min} = \frac{E_{min}}{R_s} = \frac{M_{min}c^2}{R_s} = \bar{M}_{min}c^2 \quad (42)$$

The Minimum Punctual Mass, denoted by  $m_{min}$ , is defined as follows:

$$m_{min} = \bar{M}_{min}\Delta R_{min} = \frac{M_{min}}{R_s}\Delta R_{min} \quad (43)$$

Consequently, as for the Energy related to the above-mentioned mass, we have:

$$E_{m,min} = \bar{E}_{min}\Delta R_{min} = \frac{M_{min}c^2}{R_s}\Delta R_{min} = m_{min}c^2 \quad (44)$$

By virtue of (34), we can write the expression for the *Minimum Schwarzschild Radius*:

$$R_{s,min} = \frac{2GM_{min}}{c^2} \tag{45}$$

Now, taking into account the symmetry, the *Maximum Wavelength* for a photon can be written as follows:

$$\lambda_{max} = \pi R_s \tag{46}$$

Denoting with  $h$ , as usual, the Planck Constant, we can determine the *Minimum (Perceived) Energy*:

$$E_{photon,min} = \frac{hc}{\lambda_{max}} \tag{47}$$

From (44) and (47), we can easily obtain the expression for the *Minimum Punctual Mass*:

$$E_{photon,min} = \frac{hc}{\lambda_{max}} = \frac{hc}{\pi R_s} = m_{min}c^2 \tag{48}$$

$$m_{min} = \frac{h}{\pi c R_s} \tag{49}$$

For a (linear) mass to induce a spatial deformation (a radial contraction), the value of the corresponding Schwarzschild Radius must be greater than or equal to the value of the (Radial) Quantum of Space.

Consequently, we have:

$$R_{s,\chi_{max}} \geq \Delta R_{min} \tag{50}$$

If we banally impose that  $M_{min}$  represents the value of linear mass, still unknown, below which no deformation of spatial lattice (no radial contraction) occurs, we can carry out the following (upper-limit) position:

$$R_{s,min} = \Delta R_{min} \tag{51}$$

When mass homogeneously fills the 4-Ball, denoting with  $\mathcal{N}$  an integer (the *Number of Radial Quanta*), we have:

$$R_s = \mathcal{N} \Delta R_{min} \tag{52}$$

Now, from (43), (45) and (51) we have:

$$m_{min} = \frac{M_{min}}{R_s} \Delta R_{min} = \frac{M_{min}}{R_s} R_{s,min} = \frac{2GM_{min}^2}{R_s c^2} \tag{53}$$

From the previous, by virtue of (49), we obtain:

$$\frac{2GM_{min}^2}{R_s c^2} = \frac{h}{\pi c R_s} \tag{54}$$

From the previous, taking into account the definition of *Reduced Planck Constant*, we finally obtain:

$$M_{min}^2 = \left(\frac{h}{2\pi}\right) \frac{c}{G} = \frac{\hbar c}{G} \tag{55}$$

$$M_{min} = \sqrt{\frac{\hbar c}{G}} = M_P \tag{56}$$

The previous represents the Minimum Value for Linear Mass. It is worth underlining how this value formally coincides with the one of the so-called *Planck Mass*, herein denoted with  $M_P$ .

From (56), taking into account (43) and (52), for the *Minimum Punctual Mass* we have:

$$m_{min} = \frac{\Delta R_{min}}{R_s} M_{min} = \frac{1}{\mathcal{N}} M_{min} = \frac{1}{\mathcal{N}} \sqrt{\frac{\hbar c}{G}} \tag{57}$$

Finally, from (45) and (56), we obtain the value of the (Radial) Quantum of Space:

$$R_{s,min} = \frac{2GM_{min}}{c^2} = 2 \sqrt{\frac{\hbar G}{c^3}} = 2\ell_P = \Delta R_{min} \tag{58}$$

At this point, we can also carry out a Time Quantization. Taking into account the previous, denoting with  $t_p$  the so-called *Planck Time*, we define the *Quantum of Time* as follows:

$$\Delta t_{min} = \frac{\Delta R_{min}}{c} = \frac{\Delta r_{min,\pi/2}}{c} = \Delta t_{min,\pi/2} = 2 \sqrt{\frac{\hbar G}{c^5}} = 2t_P \tag{59}$$

We can now start concretely building our simple model of (non-rotating and non-charged) “*Black Hole*”.

#### IV. “BLACK HOLES”

##### 1. Short Introduction

Let us suppose that the total available mass may be concentrated in  $O$ . Abiding by our model, from (27) and (28), by setting  $\chi_{max} = \pi/2$ , we can write the following:

$$r(\chi) = R_s \cos\left(\frac{\pi}{2} - \chi\right) = R_s \sin \chi \tag{60}$$

$$r_{max} = r\left(\frac{\pi}{2}\right) = R_s \tag{61}$$

Evidently, the value of the Radial Coordinate (the *Reduced Radial Extension*) coincides, for any  $\chi$ , with the one of the Predicted Radius provided by (6):

$$R_c = X = r \tag{62}$$

For the *Reduced Predicted Radius*, we have:

$$R_{c,g} = R_c \sin \chi \tag{63}$$

$$R_{c,g} = x = X \sin \chi = R_s \sin^2 \chi \tag{64}$$

The scenario is qualitatively portrayed in *Figure 4*.

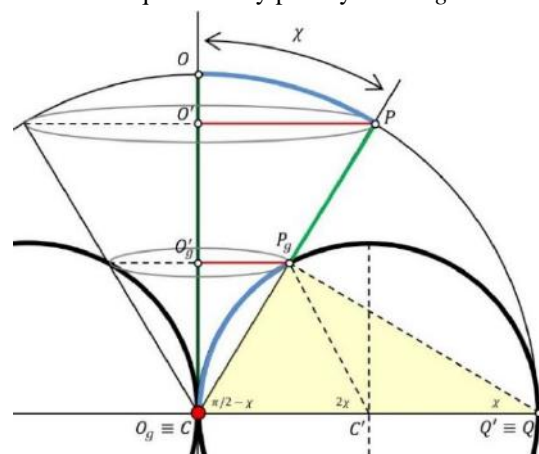


Figure 4. “Black Hole”

As for  $S_2$ ,  $V_3$  and  $S_3$ , the Singularity induces the following modifications:

$$S_{2,g}(\chi) = 4\pi x^2 = 4\pi R_s^2 \sin^4 \chi \quad (65)$$

$$V_{3,g}(\chi) = \int_0^{R_{c,g}} S_{2,g}(\chi) dR_{c,g} = 4\pi \int_0^x x^2 dx = \frac{4}{3}\pi x^3 \quad (66)$$

$$= \frac{4}{3}\pi R_s^3 \sin^6 \chi$$

$$S_{3,g}(\chi) = \int_0^{R_p} S_{2,g}(\chi) dR_p = 4\pi R_s^3 \int_0^\chi \sin^4 \chi d\chi \quad (67)$$

$$= \frac{\pi}{2} R_s^3 (\chi - \sin \chi \cos \chi + 2 \sin^3 \chi \cos \chi)$$

### 2. Variable Space-Quantum

We want to carry out a quantization of the coordinate  $r$ . As shown in (60), this coordinate depends on the angular distance  $\chi$ : the more we approach the ‘‘Singularity’’, the more the value of  $r$  decreases.

However, once again,  $r$  does not shorten within space: it shortens together with space, since space itself undergoes a progressive (radial) contraction in approaching the ‘‘singularity’’.

Consequently, we consider a *Variable (Radial) Space-Quantum*, denoted with  $\Delta r_{\chi, min}$ , the value of which depends on the angular distance  $\chi$ .

If  $\mathcal{N}$  represents the same integer introduced in (52), we impose the following:

$$r = \mathcal{N} \Delta r_{min, \chi} \quad (68)$$

According to the previous, taking into account (52) and (61), we must have:

$$r_{max} = \mathcal{N} \Delta r_{min, \pi/2} = R_s = \mathcal{N} \Delta R_{min} \quad (69)$$

Consequently, by virtue of (58), we can write:

$$\Delta r_{min, \pi/2} = \Delta R_{min} = 2\ell_p \quad (70)$$

From (68) and (69) we immediately obtain:

$$\mathcal{N} = \frac{r}{\Delta r_{min, \chi}} = \frac{R_s}{\Delta R_{min}} = \frac{R_s}{\Delta r_{min, \pi/2}} \quad (71)$$

From the foregoing, taking into account (60), we have:

$$\frac{\Delta r_{min, \chi}}{\Delta r_{min, \pi/2}} = \frac{\Delta R_{min, \chi}}{\Delta R_{min}} = \frac{r}{R_s} = \sin \chi \quad (72)$$

In the light of the previous relation, we can now introduce the following *Non-Dimensional Parameter*, which represents nothing but a simple *Scale Factor*:

$$\eta_{\Delta r_{min}} = \frac{\Delta r_{min, \pi/2}}{\Delta r_{min, \chi}} = \frac{\Delta R_{min}}{\Delta r_{min, \chi}} = \frac{R_s}{r} = \frac{1}{\sin \chi} \quad (73)$$

Now, from (58) and (72), we immediately obtain:

$$\Delta r_{min, \chi} = \sin \chi \Delta R_{min} = 2 \sin \chi \sqrt{\frac{\hbar G}{c^3}} = 2 \sqrt{\frac{\hbar \chi G}{c^3}} = 2\ell_{P, \chi} \quad (74)$$

In other terms, we have been hypothesizing a local variability of the Planck ‘‘Constant’’. From the previous, taking into account (60), we easily deduce the following:

$$\frac{\hbar_\chi}{h} = \left(\frac{r}{R_s}\right)^2 = \sin^2 \chi = \frac{\hbar_\chi}{\hbar_{\pi/2}} \quad (75)$$

The *Variable Quantum of Time* is defined as follows:

$$\Delta t_{min, g}(\chi) = \Delta t_{min, \chi} = \frac{\Delta r_{min, \chi}}{c} = 2 \sqrt{\frac{\hbar_\chi G}{c^5}} = 2t_{P, \chi} \quad (76)$$

By virtue of (59) and (73), from the previous we obtain:

$$\frac{\Delta t_{min, \chi}}{\Delta t_{min, \pi/2}} = \frac{\Delta t_{min, \chi}}{\Delta t_{min}} = \sin \chi = \frac{1}{\eta_{\Delta r_{min}}} \quad (77)$$

### 3. ‘‘Gravitational’’ Mass

In case of singularity, a material segment does not undergo any radial reduction (in other terms, it does not shorten within space): as previously remarked, both the segment and the corresponding space undergo a radial contraction (the segment shortens together with space).

Consequently, if we denote with  $M$  the Mass of a ‘‘Test’’ *Material Segment*, the *(Variable) Linear Mass Density*, in case of gravitational singularity, can be defined as follows:

$$\bar{M} = \frac{M}{r} \quad (78)$$

As for the Mass of a *Test Particle* (the mass we perceive), by virtue of (71) and (78), we can write, with obvious meaning of the notation, the following:

$$m_\chi = \bar{M} \Delta r_{min, \chi} = M \frac{\Delta r_{min, \chi}}{r} = M \frac{\Delta r_{min, \pi/2}}{R_s} = m_{\pi/2} \quad (79)$$

From the previous, by virtue of (38) and (52), we have:

$$m_\chi = m_{\pi/2} = \frac{M}{R_s} \Delta R_{min} = \frac{M}{\mathcal{N}} = m \quad (80)$$

In other terms, thanks to the position in (68) (the meaning of which should now be clearer), the ‘‘Gravitational’’ Mass and the inertial one coincide (as requested by the *Equivalence Principle*) [9].

### 4. Conservation of Energy

As elsewhere deduced, the *Conservation of Energy* for a *Free Material Segment* can be written as follows [3] [4]:

$$E = Mc^2 = M_r v^2 + \left(\frac{r}{R_s}\right)^2 M_r c^2 + (M - M_r) c^2 \quad (81)$$

In our case, by virtue of what has been specified in the previous paragraph, bearing in mind the meaning of  $r$ , we have to banally impose:

$$M = M_r \quad (82)$$

As a consequence, for a *Test Material Segment*, the motion of which is induced by a *(Gravitational) Potential*, from (81) and (82) we immediately obtain:

$$E = Mc^2 = Mv^2 + \left(\frac{r}{R_s}\right)^2 Mc^2 \quad (83)$$

From the previous relation, taking into account (80), we immediately obtain the Conservation of Energy for a (Free-Falling) Test Particle:

$$E_m = \frac{E}{\mathcal{N}} = \frac{M}{\mathcal{N}} c^2 = \frac{M}{\mathcal{N}} v^2 + \left(\frac{r}{R_s}\right)^2 \frac{M}{\mathcal{N}} c^2 \quad (84)$$

$$E_m = mc^2 = mv^2 + \left(\frac{r}{R_s}\right)^2 mc^2 \quad (85)$$

### 5. The (Gravitational) Potential and the Coordinate $R^*$

From (60) and (85) we can easily deduce:

$$v = c \sqrt{1 - \left(\frac{r}{R_s}\right)^2} = c \cos \chi \quad (86)$$

$$\frac{r}{R_s} = \sqrt{1 - \left(\frac{v}{c}\right)^2} = \sin \chi \quad (87)$$

$$\frac{1}{2}mv^2 - \frac{1}{2}mc^2 \left[1 - \left(\frac{r}{R_s}\right)^2\right] = \frac{1}{2}mv^2 - \frac{1}{2}mc^2 \cos^2 \chi = 0 \quad (88)$$

From (2) we immediately obtain:

$$c^2 = \frac{2GM_{tot}}{R_s} \quad (89)$$

Consequently, we have:

$$-\frac{1}{2}c^2 \cos^2 \chi = -\frac{GM_{tot}}{R_s} \cos^2 \chi \quad (90)$$

Let us introduce a New Coordinate [10], denoted by  $R^*$ , defined as follows:

$$R^*(\chi) = \frac{R_s}{\cos^2 \chi} \quad (91)$$

Obviously, from the previous we have:

$$R^*(0) = R_s \quad (92)$$

$$\lim_{\chi \rightarrow \pi/2} R^* = +\infty \quad (93)$$

$$\cos \chi = \sqrt{\frac{R_s}{R^*}} \quad (94)$$

$$\sin \chi = \sqrt{1 - \frac{R_s}{R^*}} \quad (95)$$

From (), taking into account (), we obtain:

$$\frac{1}{2}mv^2 - \frac{GM_{tot}}{R^*}m = 0 \quad (96)$$

Let us define the Pseudo-Newtonian Potential, denoted by  $\phi$ , as follows:

$$-\frac{GM_{tot}}{R^*} = -\frac{1}{2}c^2 \cos^2 \chi = \phi(\chi) \quad (97)$$

Evidently, with obvious meaning of the notation, from the previous we have:

$$R^* = R_s \Rightarrow \phi(\chi) = \phi(0) = \phi_{min} = -\frac{1}{2}c^2 \quad (98)$$

From (), taking into account (), we immediately obtain:

$$\frac{1}{2}mv^2 + \phi m = 0 \quad (99)$$

### 6. Speed of a Free-Falling Particle

From (2), (97) and (99), we have:

$$v = \sqrt{2\phi} = \sqrt{\frac{2GM_{tot}}{R^*}} = c \sqrt{\frac{2GM_{tot}}{c^2 R^*}} = c \sqrt{\frac{R_s}{R^*}} = v_{escape} \quad (100)$$

$$v = c \cos \chi \quad (101)$$

The Speed consists of two Components, denoted by  $v_I$  and  $v_{II}$ . We can evidently write:

$$v = \sqrt{v_I^2 + v_{II}^2} \quad (102)$$

From (100) we can easily deduce:

$$\frac{R_s}{R^*} = \frac{2\phi}{c^2} \quad (103)$$

Consequently,  $v_I$  and  $v_{II}$  assume the following forms:

$$v_I = c \sin \chi \cos \chi = c \sqrt{\left(1 - \frac{R_s}{R^*}\right) \frac{R_s}{R^*}} = c \sqrt{\frac{2\phi}{c^2} - \left(\frac{2\phi}{c^2}\right)^2} \quad (104)$$

$$v_{II} = c \cos^2 \chi = c \frac{R_s}{R^*} = \frac{2\phi}{c} \quad (105)$$

The components of speed are depicted in Figure 5

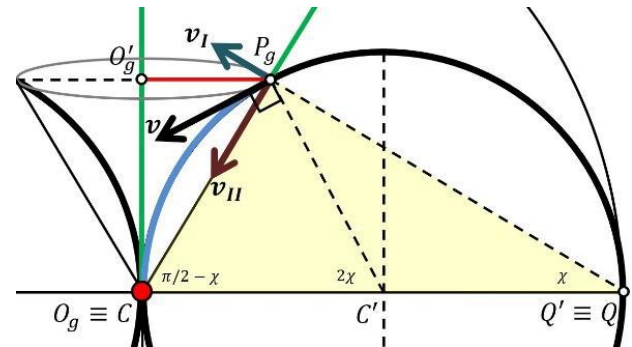


Figure 5. Speed of a Free-Falling Particle

Figure 5 shows how, when a test particle approaches the singularity, the value of  $v_I$  decreases while, on the contrary, the value of  $v_{II}$  increases. It is commonly said that, in approaching the singularity, the Space-Like Geodesics become Time-Like, and vice-versa. In our case, the above-mentioned interpretation is not correct, since the radial coordinate is nothing but the extension of a material segment, that we perceive as being a material point (the Test Particle). The straight-line segment bordered by  $C$  (that evidently coincides with  $O_g$ ) and  $P_g$  represents the radial extension of the particle, the one bordered by  $O_g'$  and  $P_g$  represents the Reduced "Flat Coordinate" (the Radius of the Reduced Circumference).

### 7. Parameterization

We want to find two new coordinates, related to each other, that could "play the role" of  $R_s$  and  $r$ .

Firstly, in the light of (23), we must impose:



$$\int_0^\chi \sqrt{\left(\frac{dR_K^*}{d\chi}\right)^2 + r_K^{*2}} d\chi = R_{p,g}^* = R_p^* \tag{106}$$

$$= \int_0^\chi \sqrt{\left(\frac{dR_K^*}{d\chi}\right)^2 + R_K^{*2}} d\chi$$

Secondly, in the light of (60), we must additionally impose:

$$r_K^* = R_K^* \sin \chi \tag{107}$$

From (106) and (107) we easily obtain the following:

$$\frac{dR_K^*}{R_K^*} = 2 \tan \chi d\chi \tag{108}$$

The general solution of the foregoing, denoting with  $K$  an arbitrary constant, is:

$$R_K^* = \frac{K}{\cos^2 \chi} \tag{109}$$

From the previous we immediately deduce the underlying noteworthy identity:

$$\sin \chi = \sqrt{1 - \frac{K}{R_K^*}} \tag{110}$$

From (109) we have:

$$\frac{dR_K^*}{d\chi} = 2K \frac{\sin \chi}{\cos^3 \chi} \tag{111}$$

From (107) and (109), we have:

$$r_K^* = R_K^* \sin \chi = K \frac{\sin \chi}{\cos^2 \chi} \tag{112}$$

$$\frac{dr_K^*}{d\chi} = K \frac{1 + \sin^2 \chi}{\cos^3 \chi} \tag{113}$$

As for the Predicted Radius, coherently with (62), we have:

$$R_c^* = X_K^* = R_K^* \sin \chi = r_K^* \tag{114}$$

In the light of (63), the relation between the Predicted Radiuses with (additional subscript “g”) and without (no additional subscript) the Singularity must be the following:

$$R_{c,g}^* = R_c^* \sin \chi \tag{115}$$

Therefore, as for the Reduced Predicted Radius we have:

$$R_{c,g}^* = x_K^* = R_c^* \sin \chi = X_K^* \sin \chi = r_K^* \sin \chi = R_K^* \sin^2 \chi \tag{116}$$

From the previous, taking into account (109), we obtain:

$$x_K^* = K \tan^2 \chi = \frac{K}{\cos^2 \chi} - K = R_K^* - K \tag{117}$$

$$\frac{dx_K^*}{d\chi} = \frac{dR_K^*}{d\chi} \tag{118}$$

According to (106), the Proper Radius is not influenced by the singularity. Therefore, from (109) and (111) we obtain:

$$dR_p^* = \sqrt{\left(\frac{dR_K^*}{d\chi}\right)^2 + R_K^{*2}} d\chi = \frac{dR_K^*}{d\chi} \sqrt{1 + \frac{1}{4 \tan^2 \chi}} d\chi \tag{119}$$

$$= \sqrt{1 + \frac{1}{4 \tan^2 \chi}} dR_K^* = dR_{p,g}^*$$

In Figure 6 a useful comparison between old and new (Parameterized) Coordinates, once having set  $K=R_s$ , is qualitatively displayed.

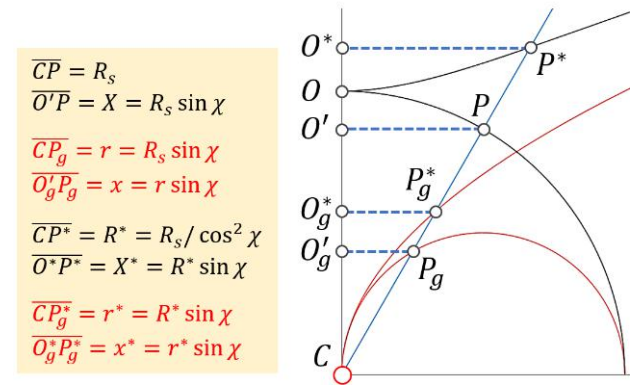


Figure 6. Parameterization ( $K=R_s$ )

### 8. Parameterized Quantization

The parameterization also affects the quantization. Obviously, it is not a real phenomenon.

Coherently with the parameterization we have been resorting to, by virtue of (52) we must now impose:

$$R_K^* = \mathcal{N} \Delta R_{min}^* = \mathcal{N} \Delta r_{min,\pi/2}^* \tag{120}$$

From the previous, taking into account (109), we obtain:

$$\Delta R_{min}^* = \frac{R_K^*}{\mathcal{N}} = \frac{K}{\mathcal{N}} \frac{1}{\cos^2 \chi} \tag{121}$$

If we set  $K=R_s$ , taking into account (52), the foregoing can be written as follows:

$$\Delta R_{min}^* = \frac{R_s}{\mathcal{N}} \frac{1}{\cos^2 \chi} = \frac{\Delta R_{min}}{\cos^2 \chi} \tag{122}$$

Obviously, by virtue of (68), we must also impose:

$$r_K^* = \mathcal{N} \Delta r_{min,\chi}^* \tag{123}$$

From the previous, taking into account (112), we obtain:

$$\Delta r_{min,\chi}^* = \frac{r_K^*}{\mathcal{N}} = \frac{K}{\mathcal{N}} \frac{\sin \chi}{\cos^2 \chi} \tag{124}$$

If we set  $K=R_s$ , taking into account (68), the foregoing can be written as follows:

$$\Delta r_{min}^* = \frac{R_s \sin \chi}{\mathcal{N}} \frac{1}{\cos^2 \chi} = \frac{\Delta r_{min,\chi}}{\cos^2 \chi} \tag{125}$$

Evidently, by virtue of (121) and (124), we can write:

$$\Delta r_{min,\pi/2}^* = \Delta R_{min}^* \tag{126}$$

From (72), (122) and (124), taking into account the foregoing, we have:

$$\frac{\Delta r_{min,\chi}^*}{\Delta r_{min,\pi/2}^*} = \frac{\Delta r_{min,\chi}^*}{\Delta R_{min}^*} = \frac{\Delta r_{min,\chi}}{\Delta R_{min}} = \frac{\Delta r_{min,\chi}}{\Delta r_{min,\pi/2}} = \sin \chi \tag{127}$$

In the light of the previous, resorting to (110), we can now introduce the new following Parameterized Scale Factor:

$$\eta_{\Delta r_{min}}^* = \frac{\Delta R_{min}^*}{\Delta r_{min,\chi}^*} = \frac{\Delta R_{min}}{\Delta r_{min,\chi}} = \frac{1}{\sin \chi} = \frac{1}{\sqrt{1 - \frac{K}{R_K^*}}} \tag{128}$$

The *Parameterized Quantum of Time* is defined as follows:

$$\Delta t_{min,g}^*(\chi) = \Delta t_{min,\chi}^* = \frac{\Delta r_{min,\chi}^*}{c} \tag{129}$$

Taking into account (77), (127) and (128), from the previous we obtain:

$$\begin{aligned} \frac{\Delta t_{min,\chi}^*}{\Delta t_{min,\pi/2}^*} &= \frac{\Delta r_{min,\chi}^*}{\Delta R_{min}^*} = \frac{\Delta t_{min,\chi}}{\Delta t_{min}} = \frac{\Delta t_{min,\chi}}{\Delta t_{min,\pi/2}} = \sin \chi \\ &= \frac{1}{\eta_{\Delta r_{min}}^*} = \sqrt{1 - \frac{K}{R_K^*}} \end{aligned} \tag{130}$$

It is worth highlighting how, from (73), (87) and (128), denoting with  $\gamma$  the so-called *Relativistic Factor*, we have:

$$\eta_{\Delta r_{min}}^* = \eta_{\Delta r_{min}} = \frac{1}{\sin \chi} = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} = \gamma \tag{131}$$

## V. METRICS

### 1. Initial "Flat" Metric (no singularity)

We can immediately write the following general metric:

$$ds^{*2} = c^2 dt^{*2} - dR_p^{*2} - R_c^{*2}(d\theta^2 + \sin^2 \theta d\varphi^2) \tag{132}$$

Bearing in mind the definition of Predicted Radius provided by (114), we have:

$$\lim_{\chi \rightarrow \pi/2} \frac{X_K^*}{R_K^*} = \lim_{\chi \rightarrow \pi/2} \frac{r_K^*}{R_K^*} = \lim_{\chi \rightarrow \pi/2} \sin \chi = 1 \tag{133}$$

Consequently, far from the origin, Predicted Radius and Radial Coordinate are interchangeable. We can write:

$$R_c^* \cong R_K^* \tag{134}$$

Now, we evidently have:

$$\lim_{\chi \rightarrow \pi/2} \sqrt{1 + \frac{1}{4 \tan^2 \chi}} = 1 \tag{135}$$

Far from the origin, therefore, by virtue of (119), Proper Radius and Radial Coordinate are interchangeable:

$$dR_p^* \cong dR_K^* \tag{136}$$

Finally, far from the origin, (132) becomes:

$$ds^{*2} = c^2 dt^{*2} - dR_K^{*2} - R_K^{*2}(d\theta^2 + \sin^2 \theta d\varphi^2) \tag{137}$$

It is fundamental to underline how the approximation in (134) prevents the Predicted Radius from assuming a null value. In detail, by virtue of (109), we have:

$$R_{c,min}^*(\chi) = R_c^*(0) = R_K^*(0) = K \tag{138}$$

### 2. Schwarzschild-Like Metric: Conventional Derivation

As is well known, the General Static, Spherically (and Time) Symmetric Solution can now be written as follows:

$$\begin{aligned} ds^2 &= A(R_K^*)c^2 dt^2 - B(R_K^*)dR_K^{*2} \\ &\quad - C(R_K^*)(d\theta^2 + \sin^2 \theta d\varphi^2) \tag{139} \\ A(R_K^*), B(R_K^*), C(R_K^*) &> 0 \end{aligned}$$

Let us carry out the following position [11]:

$$\sqrt{C(R_K^*)} = R_K^* \tag{140}$$

Thanks to the previous, (139) can be written as follows:

$$\begin{aligned} ds^2 &= A^*(R_K^*)c^2 dt^2 - B^*(R_K^*)dr^2 \\ &\quad - R_K^{*2}(d\theta^2 + \sin^2 \theta d\varphi^2) \tag{141} \\ A^*(R_K^*), B^*(R_K^*) &> 0 \end{aligned}$$

As for the *Metric Tensor*, from (141) we obtain:

$$g_{ij} = \begin{bmatrix} A^*(R_K^*) & 0 & 0 & 0 \\ 0 & -B^*(R_K^*) & 0 & 0 \\ 0 & 0 & -R_K^{*2} & 0 \\ 0 & 0 & 0 & -R_K^{*2} \sin^2 \theta \end{bmatrix} \tag{142}$$

$$g^{ij} = \begin{bmatrix} \frac{1}{A^*(R_K^*)} & 0 & 0 & 0 \\ 0 & -\frac{1}{B^*(R_K^*)} & 0 & 0 \\ 0 & 0 & -\frac{1}{R_K^{*2}} & 0 \\ 0 & 0 & 0 & -\frac{1}{R_K^{*2} \sin^2 \theta} \end{bmatrix} \tag{143}$$

Let's deduce the *Christoffel Symbols*. Generally, we have:

$$\Gamma_{ij}^k = \frac{1}{2} g^{kh} \left( \frac{\partial g_{hi}}{\partial x^j} + \frac{\partial g_{hj}}{\partial x^i} - \frac{\partial g_{ij}}{\partial x^h} \right) \tag{144}$$

The indexes run from 0 to 3. Clearly, 0 stands for  $t$ , 1 for  $r$ , 2 for  $\theta$ , and 3 for  $\varphi$ .

Setting  $k=0$ , from (142), (143) and (144), we obtain:

$$\Gamma_{01}^0 = \Gamma_{10}^0 = \frac{1}{2A^*} \frac{dA^*}{dR_K^*} \tag{145}$$

All the other symbols (if  $k=0$ ) vanish.

Setting  $k=1$ , from (142), (143) and (144), we obtain:

$$\begin{aligned} \Gamma_{00}^1 &= \frac{1}{2B^*} \frac{dB^*}{dR_K^*} \\ \Gamma_{11}^1 &= \frac{1}{2B^*} \frac{dB^*}{dR_K^*}, \Gamma_{12}^1 = -\frac{R_K^*}{B^*}, \Gamma_{13}^1 = -\frac{R_K^*}{B^*} \sin^2 \theta \end{aligned} \tag{146}$$

All the other symbols (if  $k=1$ ) vanish.

Setting  $k=2$ , from (142), (143) and (144), we obtain:

$$\Gamma_{12}^2 = \Gamma_{21}^2 = \frac{1}{R_K^*}, \Gamma_{33}^2 = -\sin \theta \cos \theta \tag{147}$$

All the other symbols (if  $k=2$ ) vanish.

Setting  $k=3$ , from (142), (143) and (144), we obtain:

$$\Gamma_{13}^3 = \Gamma_{31}^3 = \frac{1}{R_K^*}, \Gamma_{23}^3 = \Gamma_{32}^3 = \frac{1}{\tan \theta} \tag{148}$$

All the other symbols (if  $k=3$ ) vanish.

Let's now deduce the components of the *Ricci Tensor*.

Generally, with obvious meaning of the notation, we have:

$$R_{ij} = \frac{\partial \Gamma_{ik}^k}{\partial x^j} - \frac{\partial \Gamma_{ij}^k}{\partial x^k} + \Gamma_{ik}^l \Gamma_{jl}^k - \Gamma_{ij}^l \Gamma_{kl}^k \tag{149}$$

By means of some simple mathematical passages, omitted for brevity, we obtain all the non-vanishing components:

$$\begin{aligned} R_{00} &= -\frac{1}{2B^*} \frac{d^2 A^*}{dR_K^{*2}} + \frac{1}{4B^*} \frac{dA^*}{dR_K^*} \left( \frac{1}{A^*} \frac{dA^*}{dR_K^*} + \frac{1}{B^*} \frac{dB^*}{dR_K^*} \right) \\ &\quad - \frac{1}{R_K^* B^*} \frac{dA^*}{dR_K^*} \end{aligned} \tag{150}$$

$$R_{11} = \frac{1}{2A^*} \frac{d^2 A^*}{dR_K^{*2}} - \frac{1}{4A^*} \frac{dA^*}{dR_K^*} \left( \frac{1}{A^*} \frac{dA^*}{dR_K^*} + \frac{1}{B^*} \frac{dB^*}{dR_K^*} \right) - \frac{1}{R_K^* B^*} \frac{dB^*}{dR_K^*} \quad (151)$$

$$R_{22} = \frac{1}{B^*} + \frac{R_K^*}{2B^*} \left( \frac{1}{A^*} \frac{dA^*}{dR_K^*} - \frac{1}{B^*} \frac{dB^*}{dR_K^*} \right) - 1 \quad (152)$$

$$R_{33} = \sin^2 \theta \left[ \frac{1}{B^*} + \frac{R_K^*}{2B^*} \left( \frac{1}{A^*} \frac{dA^*}{dR_K^*} - \frac{1}{B^*} \frac{dB^*}{dR_K^*} \right) - 1 \right] = \sin^2 \theta R_{22} \quad (153)$$

If we denote with  $R$  the Ricci Scalar and with  $T_{ij}$  the generic component of the Stress-Energy Tensor, the Einstein Field Equations [9] [12] can be written as follows:

$$R_{ij} - \frac{1}{2} R g_{ij} = \frac{8\pi G}{c^4} T_{ij} \quad (154)$$

If we impose that, outside the mass that produces the field, there is the “absolute nothing” (neither matter nor energy), the first member of (154), that represents the so-called Einstein Tensor, must vanish. Consequently, we have:

$$R_{ij} - \frac{1}{2} R g_{ij} = 0 \quad (155)$$

From (155), exploiting the fact that the Einstein Tensor and the Ricci Tensor are trace-reverse of each other, we have:

$$R_{ij} = 0 \quad (156)$$

From (150), (151) and (156), we immediately obtain:

$$-\frac{1}{2A^* B^*} \frac{d^2 A^*}{dR_K^{*2}} + \frac{1}{4A^* B^*} \frac{dA^*}{dR_K^*} \left( \frac{1}{A^*} \frac{dA^*}{dR_K^*} + \frac{1}{B^*} \frac{dB^*}{dR_K^*} \right) - \frac{1}{R_K^* A^* B^*} \frac{dA^*}{dR_K^*} = 0 \quad (157)$$

$$\frac{1}{2A^* B^*} \frac{d^2 A^*}{dR_K^{*2}} - \frac{1}{4A^* B^*} \frac{dA^*}{dR_K^*} \left( \frac{1}{A^*} \frac{dA^*}{dR_K^*} + \frac{1}{B^*} \frac{dB^*}{dR_K^*} \right) - \frac{1}{R_K^* B^{*2}} \frac{dB^*}{dR_K^*} = 0 \quad (158)$$

From (157) and (158), we have:

$$\frac{dB^*}{B^*} = -\frac{dA^*}{A^*} \quad (159)$$

$$B^* = \frac{K_1}{A^*} \quad (160)$$

The value of the constant  $K_1$  can be deduced by imposing that, at infinity, the Flat Metric in (137) must be recovered.

In other terms, we must impose the following condition:

$$\lim_{R_K^* \rightarrow \infty} A^*(R_K^*) = \lim_{r \rightarrow \infty} B^*(R_K^*) = 1 \quad (161)$$

From (160), taking into account (161), we obtain:

$$B^* = \frac{1}{A^*} \quad (162)$$

$$g_{00} g_{11} = -1 \quad (163)$$

From (152) and (156) we have:

$$A^* + \frac{R_K^* A^*}{2} \left[ \frac{1}{A^*} \frac{dA^*}{dR_K^*} - A^* \frac{d}{dR_K^*} \left( \frac{1}{A^*} \right) \right] - 1 = 0 \quad (164)$$

$$A^* + R_K^* \frac{dA^*}{dR_K^*} - 1 = \frac{d}{dR_K^*} (r A^*) - 1 = 0 \quad (165)$$

$$A^* = 1 + \frac{K_2}{R_K^*} \quad (166)$$

Now, if  $\phi$  represents the Gravitational Potential, for an arbitrary metric we have:

$$g_{00} = \left( 1 + \frac{\phi}{c^2} \right)^2 \quad (167)$$

The value of  $K_2$  can be directly deduced by resorting to the so-called Weak Field Approximation:

$$\left( 1 + \frac{\phi}{c^2} \right)^2 \cong 1 + 2 \frac{\phi}{c^2} \quad (168)$$

Far from the source from (97), (110) and (168) we have:

$$A^* = g_{00} \cong 1 + 2 \frac{\phi}{c^2} = 1 - \cos^2 \chi = 1 - \frac{K}{R_K^*} \quad (169)$$

If we set  $K=R_s$ , the foregoing can be written as follows:

$$A^* = 1 - \frac{2GM_{tot}}{c^2 R^*} = 1 - \frac{R_s}{R^*} \quad (170)$$

From (162) and (169), we have:

$$B^* = \frac{1}{1 - \frac{K}{R_K^*}} \quad (171)$$

If we set  $K=R_s$ , the previous can be written as follows:

$$B^* = \frac{1}{1 - \frac{R_s}{R_K^*}} \quad (172)$$

At this point, the Schwarzschild-Like Metric can be immediately written by substituting into (141) the values of  $A^*$  and  $B^*$  deduced, respectively, in (169) and (171).

### 3. Schwarzschild-Like Metric: Alternative Derivation

According to our model, taking into account (106) and (115), from (137) we can deduce, in case of Singularity, the following solution:

$$ds_g^{*2} = c^2 dt^{*2} - dR_K^{*2} - R_K^{*2} \sin^2 \chi (d\theta^2 + \sin^2 \theta d\varphi^2) \quad (173)$$

The previous represents an analytic solution, built without taking into account the modified value of the Space-Quantum. The above-mentioned condition is expressed by means of  $g_{00}$ , the value of which is manifestly unitary: Space and Time Quanta, in fact, are related to each other by means of (129).

Obviously,  $t^*$  represents the proper time (the time measured by an observer ideally placed at infinity, where the singularity has no longer effect).

We can rewrite (173) in the underlying form:

$$ds_g^{*2} \Big|_{g_{00}=1} = c^2 dt^{*2} - dR_{p,g}^{*2} \Big|_{g_{00}=1} - R_{c,g}^{*2} \Big|_{g_{00}=1} (d\theta^2 + \sin^2 \theta d\varphi^2) \quad (174)$$

In other terms, we have carried out the following positions:

$$R_{c,g}^* \Big|_{g_{00}=1} = R_c^* \sin \chi = R_K^* \sin \chi \quad (175)$$

$$dR_{p,g}^* \Big|_{g_{00}=1} = dR_p^* = dR_K^* \quad (176)$$

Now, from (130) we immediately obtain:

$$\Delta t_{min,g}^*(\chi) = \Delta t_{min,\chi}^* = \frac{\Delta t_{min,\pi/2}^*}{\eta_{\Delta r_{min}}^*} = \frac{\Delta t_{min}^*}{\eta_{\Delta r_{min}}^*} \quad (177)$$

$$= \Delta t_{min}^* \sqrt{1 - \frac{K}{R_K^*}}$$

In the light of the previous, we can write:

$$dt_g^* = \frac{dt_{\pi/2}^*}{\eta_{\Delta r_{min}}^*} = \frac{dt^*}{\eta_{\Delta r_{min}}^*} = dt^* \sqrt{1 - \frac{K}{R_K^*}} \quad (178)$$

From (175), taking into account (120) and (127), we have:

$$R_{c,g}^*|_{g_{00}=1} = \mathcal{N} \sin \chi \Delta r_{min,\pi/2} = \mathcal{N} \Delta r_{min,\chi} \quad (179)$$

Exploiting (134) and (175), we can temporarily introduce to following *Non-Dimensional (Normalized) Coordinates*:

$$\bar{R}_c^* = \frac{R_c^*}{\Delta R_{min}^*} = \frac{R_c^*}{\Delta r_{min,\pi/2}^*} = \mathcal{N} \quad (180)$$

$$\bar{R}_{c,g}^*|_{g_{00}=1} = \frac{R_{c,g}^*}{\Delta r_{min,\chi}^*} = \mathcal{N} \quad (181)$$

Evidently, the value of the Predicted Radius, as long as it is expressed in terms of Space-Quanta, can be regarded as being constant. Consequently, from (180) and (181) we can banally write:

$$\bar{R}_c^* = \bar{R}_{c,g}^*|_{g_{00}=1} \quad (182)$$

Now, if we replace  $dt^*$  with  $dt_g^*$ , taking into account (178), we obtain a new value for  $g_{00}$ :

$$g_{00} = 1 - \frac{K}{R_K^*} = \frac{1}{\eta_{\Delta r_{min}}^{*2}} \quad (183)$$

The value of  $g_{00}$  reveals how we measure time (which is still considered as being absolute) and space and nothing else. In other words, we have simply changed the *Units of Measurement* (we have modified the Scale Factor).

By virtue of (183), we can rewrite (173) by changing the Scale Parameter:

$$ds_g^{*2}|_{g_{00}=1/\eta^2} = \left(1 - \frac{K}{R_K^*}\right) c^2 dt^{*2} - dR_{p,g}^{*2}|_{g_{00}=1/\eta^2} - R_{c,g}^{*2}|_{g_{00}=1/\eta^2} (d\theta^2 + \sin^2 \theta d\varphi^2) \quad (184)$$

From (175), (176) and (183), we can write, with obvious meaning of the notation, the following:

$$R_{c,g}^*|_{g_{00}=1/\eta^2} = \eta_{\Delta r_{min}}^* R_{c,g}^*|_{g_{00}=1} = R_K^* = R_{c,g}^* \quad (185)$$

$$dR_p^*|_{g_{00}=1/\eta^2} = \eta_{\Delta r_{min}}^* dR_{p,g}^*|_{g_{00}=1} = \eta_{\Delta r_{min}}^* dR_K^* = \frac{dR_K^*}{\sqrt{1 - \frac{K}{R_K^*}}} = dR_p^* \quad (186)$$

We can finally write the so-called *Droste Solution* [13]:

$$ds_g^{*2}|_{g_{00}=\frac{1}{\eta^2}} = \left(1 - \frac{K}{R_K^*}\right) c^2 dt^{*2} - \frac{dR_K^{*2}}{1 - \frac{K}{R_K^*}} - R_K^{*2} (d\theta^2 + \sin^2 \theta d\varphi^2) = ds_g^{*2} \quad (187)$$

$$R_K^* > K$$

The Singularity is not a point, but a 2-Sphere characterized by a radius equal to  $K$ . However, this strange phenomenon is anything but real, since it is clearly and exclusively caused by the approximation in (134). According to the new scenario, the value of the *Escape Speed* is now provided by (104): it is easy to verify how this value formally coincides with the one that can be derived by resorting to the *Geodesic Equation*.

As for the *New Proper Radius*, we have:

$$R_{p,g}^* = \int \frac{dR_K^*}{\sqrt{1 - \frac{K}{R_K^*}}} = \int \frac{\sqrt{(R_K^* - K) + K}}{\sqrt{R_K^* - K}} d(R_K^* - K) \quad (188)$$

$$= 2 \int \sqrt{(\sqrt{R_K^* - K})^2 + (\sqrt{K})^2} d(\sqrt{R_K^* - K})$$

We have just found an integral of the following kind:

$$\int \sqrt{y^2 + (\sqrt{K})^2} dy = \frac{K}{2} \ln(y + \sqrt{y^2 + K}) + \frac{y}{2} \sqrt{y^2 + K} + C_K \quad (189)$$

Consequently, from (188) and (189) we have:

$$R_{p,g}^* = \int \frac{dR_K^*}{\sqrt{1 - \frac{K}{R_K^*}}} = \ln(\sqrt{R_K^*} + \sqrt{R_K^* - K}) + \sqrt{R_K^*(R_K^* - K)} + C_K \quad (190)$$

As for the constant  $C_k$  we have:

$$R_p^*(K) = 0 \Rightarrow C_K = -K \ln \sqrt{K} \quad (191)$$

Finally, from (190) and (191) we have:

$$R_{p,g}^* = K \ln \left( \frac{\sqrt{R_K^* - K} + \sqrt{R_K^*}}{\sqrt{K}} \right) + \sqrt{R_K^*(R_K^* - K)} \quad (192)$$

The previous, by virtue of (117), can be written as follows:

$$R_{p,g}^* = K \ln \left( \frac{\sqrt{x_K^*} + \sqrt{x_K^* + K}}{\sqrt{K}} \right) + \sqrt{x_K^*(x_K^* + K)} \quad (193)$$

#### 4. Generalization

Taking into account (117), we have:

$$\lim_{\chi \rightarrow \pi/2} \frac{x_K^*}{R_K^*} = \lim_{\chi \rightarrow \pi/2} \frac{R_K^* - K}{R_K^*} = 1 \quad (194)$$

By virtue of the previous, we can write:

$$\lim_{\chi \rightarrow \pi/2} \frac{x_K^{*a}}{R_K^{*a}} = \lim_{\chi \rightarrow \pi/2} \frac{x_K^{*a} + K^a}{R_K^{*a}} = \lim_{\chi \rightarrow \pi/2} \frac{(R_K^* - K)^a + K^a}{R_K^{*a}} = 1 \quad (195)$$

$$a \in \mathcal{R}^+$$

Therefore, far from the source, we obtain:

$$R_K^{*a} \cong (R_K^* - K)^a + K^a \quad (196)$$

$$R_K^* \cong \sqrt{(R_K^* - K)^a + K^a} = \sqrt{x_K^{*a} + K^a} = R_{K,a}^* \quad (197)$$

Evidently, moreover, we have:

$$\chi = 0 \Rightarrow R_{K,a}^* = K \quad (198)$$

$$\frac{dR_{K,a}^*}{d\chi} = (x_K^{*a} + K^a)^{\frac{1-a}{a}} x_K^{*a-1} \frac{dx_K^*}{d\chi} > 0 \tag{199}$$

$$0 < \chi < \frac{\pi}{2}$$

From (195), (198) and (199) we deduce how the *New Parametric Coordinate* defined in (197) and the one defined in (109) are fully interchangeable (since they behave exactly the same way). In other terms, we have:

$$R_{K,a}^* \cong R_K^* \tag{200}$$

Taking into account the foregoing, by setting  $a=1$  in (197), from (187) we obtain:

$$ds_g^{*2} = \left(1 - \frac{K}{x_K^* + K}\right) c^2 dt^{*2} - \frac{dx_K^{*2}}{1 - \frac{K}{x_K^* + K}} - (x_K^* + K)^2 (d\theta^2 + \sin^2 \theta d\varphi^2) \tag{201}$$

$$x_K^* > 0$$

$$ds_g^{*2} = \frac{c^2 dt^{*2}}{1 + \frac{K}{x_K^*}} - \left(1 + \frac{K}{x_K^*}\right) dx_K^{*2} - (x_K^* + K)^2 (d\theta^2 + \sin^2 \theta d\varphi^2) \tag{202}$$

$$x_K^* > 0$$

The previous represents the original form of the so-called *Brillouin Solution* [14].

From (187), by setting  $a=3$  in (197), we have:

$$R_{K,3}^* = \sqrt[3]{x_K^{*3} + K^3} \tag{203}$$

By substituting the previous into (187), we can finally obtain the real *Schwarzschild Form* [15].

### VI. GRAVITATIONAL REDSHIFT

If we impose the Conservation of Energy, we can write, with obvious meaning of the notation, the following:

$$E_{photon,\chi} = h_\chi \nu_\chi = h_{\pi/2} \nu_{\pi/2} = E_{photon,\pi/2} \tag{204}$$

From the previous, by virtue of (75), we obtain:

$$\frac{h_\chi}{h_{\pi/2}} = \frac{\nu_{\pi/2}}{\nu_\chi} = \sin^2 \chi \tag{205}$$

If we impose the *Speed of Light Constancy*, we have:

$$c = \lambda_\chi \nu_\chi = \lambda_{\pi/2} \nu_{\pi/2} \tag{206}$$

The two foregoing relations allows to immediately define a *New Scale Parameter*:

$$\frac{\lambda_{\pi/2}}{\lambda_\chi} = \frac{h_{\pi/2}}{h_\chi} = \frac{1}{\sin^2 \chi} = \eta_\lambda \tag{207}$$

According to the definition of *Gravitational Redshift* [9], usually denoted by  $z$ , from the previous we have:

$$z = \frac{\lambda_{\pi/2} - \lambda_\chi}{\lambda_\chi} = \frac{\lambda_{\pi/2}}{\lambda_\chi} - 1 = \eta_\lambda - 1 \tag{208}$$

From (131) and (207) we have:

$$\lim_{\chi \rightarrow \pi/2} \frac{\eta_{\Delta r_{min}}}{\eta_\lambda} = \lim_{\chi \rightarrow \pi/2} \frac{\eta_{\Delta r_{min}}^*}{\eta_\lambda} = \lim_{\chi \rightarrow \pi/2} \sin \chi \tag{209}$$

$$= \lim_{v \rightarrow 0} \sqrt{1 - \left(\frac{v}{c}\right)^2} = 1$$

Consequently, far from the source, we can write:

$$z \cong \eta_{\Delta r_{min}} - 1 = \frac{1}{\sin \chi} - 1 \tag{210}$$

From the foregoing, taking into account (110), we have:

$$z = \frac{\lambda_\infty - \lambda_{R^*}}{\lambda_{R^*}} = \frac{1}{\sqrt{1 - \frac{K}{R_K^*}}} - 1 \tag{211}$$

If we set  $K=R_s$ , according to (2) and (109), the previous can be written in the following well-known form:

$$z = \frac{1}{\sqrt{1 - \frac{2GM_{tot}}{c^2 R^*}}} - 1 \tag{212}$$

### VII. BRIEF CONCLUSIONS

The coordinate deduced in (109), which appears both in the metrics and at the denominator of the pseudo-Newtonian relation we have obtained for the gravitational potential, does not represent a real distance nor a real radius of curvature. In fact, it is clear how the expression of the above-mentioned coordinate arises from a banal parameterization, by means of which we are able to write the initial ‘‘Flat’’ Metric in (137). From the latter, it is possible to derive an infinite set of Schwarzschild-like Metrics, suitable for non-rotating and non-charged ‘‘Black Holes’’, without resorting to Relativity. According to the simple model herein proposed, the minimum value for the coordinate in (109) equates the Schwarzschild Radius. When this coordinate equates the Schwarzschild radius, both the Proper Radius and the Forecast Radius are equal to zero: in other terms, we are exactly placed in correspondence of the ‘‘Singularity’’.

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# Shelf Life - Managing Building Material in a Warehouse

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**Abstract**— Currently the theme Shelf Life appears as a large tool to increase the quality and control of life time. The present article presents a management model focused on the validity of the material, based on real inventory data, using a computational tool in which it is possible to explore the functionality of the system and improve its performance. The main principal of this Shelf Life system is an auxiliary tool for verifying data search processes and a search for better results, including a computational tool with extensive performance analysis. The method used consisted, first of all, of the process of obtaining real data on the receipt and indebtedness of companies, thus creating a virtual planning and planning environment. The results obtained consisted of a more efficient evaluation of materials management, besides the visualization of cost reductions, with more punctual and weighted results in the supply chain.

**Keywords**— Raw Material Management, Process Automation, Raw Material Storage Methodology.

## I. INTRODUCTION

The need to improve the aging process of a material is not very important for the companies, since there is a constant need, the search for new alternatives that facilitate the management of activities and, consequently, the detection of problems that affect the flow of processes. In many cases, disruption to the internal and external consumer of the organization.

Brazilian legislation consists of all industrialized products, such as food, cosmetics, medicines, household cleaning materials, toiletries, etc., which can be clearly useful in their shelf life. The expiration date is defined as the time period, from the date of shipment, however, which is a quality indicator of an acceptable payment system [1].

Component routing processes are controlled according to the value data being executed for the subordinate components in order to ensure the quality of the product, according to the production, quality, materials and planning sectors.

The maturity of a product starts from its production data and the contribution of some factors such as its production process, hygiene situation and storage, but the largest quantities are the type of packaging used. Choosing the right packaging for each type of product is essential to increase its shelf life, maintaining quality, facilitating identification and facilitating distribution in more distant locations. One of the most sought after solutions today is a vacuum packaging. A vacuum sealer removes all oxygen from the packaging, which is primarily responsible for food spoilage, increasing shelf life [2].

Shelf life means shelf life, time that we must store our materials always within the deadline established by the manufacturer, where it will be automatically monitored in Excel spreadsheet with the manufacturer's information, expiration date, manufacturing date and manufacturing year and week.

Aging can be characterized as a gradual change in the operational characteristics of an electronic component. Generally, this behavior is expected to be more frequent after the lifetime or qualified period reported by the manufacturer. However, some factors can accelerate the aging process even within the qualifying period. There are two types of process that can accelerate the aging of electronic components: external and internal factors (IAEA, 2004), (ERTL et al., 2006). External processes include: ambient temperature; local humidity; sources of ionizing radiation (alpha, beta, gamma and X-rays) and non-ionizing radiation (Radiofrequency, Ultra red); atmospheric chemical condition (presence of gases and solid particles in suspension). The internal factors that can accelerate aging are: heating due to electric or mechanical loads; mechanical stress; oscillations of energy; vibrations [3].

However, after the single supply of a large volume of parts for long periods of time, it is also necessary to ensure the integrity and compliance of these materials. In this sense, the shelf life process is related to the control and monitoring of raw materials with limited life cycles, that is, components whose qualitative and functional

characteristics are conditioned by the respective shelf life [4].

The Materials area where the Shelf Life process is executed was implemented in 2013 by Management seeking to reduce cost by showing how well-executed Shelf Life reduces obsolete costs and increases the turnover of common materials within a warehouse.

The Shelf Life control starts from the input of the material in the receipt, where all the materials are collected through bar code consisting of material code, manufacturing date and quantity, this data is loaded in an excel spreadsheet with macros that are formulas programmed into a single button, the validity of the material is automatically informed by checking for quantity and code divergences.

Temperature is one of the factors that most contribute to the instability of a substance. As a result, the same product can have different shelf life depending on the environmental conditions of the place where it is stored [5].

The material that arrives as SPARE PARTS that are stored, these are changed according to the arrival of the kits, they are controlled in an excel spreadsheet with macros signaling respectively the dates of maturity of the materials, these spreadsheets are accurate every day due to the rotating inventory and internal audits done by quality.

Material planning analyzes according to the maturity date of the raw material using the Shelf Life report sent by the Materials sector, where the quality makes internal audits verifying the validity of the same. Shelf Life is relevant in decreasing obsolete material, unnecessary disposal of material in use.

The logistics chain management is reviewed in [6] and [7].

The present article refers to the Inventory Management having the choice of Shelf Life theme, we will address how to control the life time of the raw material in order to optimize the aging process of the products from the entry of the raw material and manufacturing process.

## LII Contextualization of Materials Management

Current research on Shelf Life shows strong application in a number of areas. [8] reviews the temperature profile in four main home delivery services, addresses the impact of temperature abuse on the remaining life of the materials. Simulates and proposes temperature management options. The material flow management in Thailand is analyzed on the basis of electronic research, which states that 58% of the respondents are managing

material flow information (self-classification), yet companies with material flow management manage waste (hazardous) and raw materials well, addresses the cost relationship and profitability that affect whether companies decide to manage the flow of material.

[10] Existing material flow cost accounting and management perspectives, Material Flow Cost Accounting (MFCA) has been developed around the world as an important tool in environmental management accounting. [11] It deals with an information system for sustainable materials management with material flow accounting and waste input-output analysis. In their work, hierarchical and interactive dashboards allow a convenient overview of material accounts across economy, waste streams, and circulation of secondary resources. In addition, the system can track material flows through associated supply chain activities and production consumption. Integrated with economic models; this system can predict possible overload in the current capacities of the waste management facility and provide decision support for designing strategies to address resource sustainability.

In the work Improving the waste management of electrical and electronic equipment in real scale, using material flow analysis and life cycle evaluation [12]. WEEE management was analyzed in a large scale Italian plant, two recycling scenarios (S0, partial and S1 - improved) were investigated, recycling rates were 40-86% for S0 and 80-99% for S1 for different types of WEEE, major environmental benefits derived from the recycling of metals and other fractions, the main environmental impacts were due to transportation and incineration of polyurethane.

The application of material management has application in distinct areas, using techniques specific to each scenario.

## II. MATERIAL AND METHOD

The Shelf Life project originated in the year 2013, where it was executed in an automated way, using the computational tool (Excel), using macros with programmed formulas in a single button and indicators indicating the validity of each material in months.

### 2.1 Receipt of material

The material is received and scanned 100% in a spreadsheet, reading two labels one containing code, date of manufacture and another containing the quantity.



Model	LE4355970	Qty Items PKL	KIT CONFERENCE		Date / Hour
Invoice	85023732		Responsable		07/07/2017
Qty	10000		RODRIGO/JOAO/PAULO/RAMILTON/FABIO		08:38:00

Status Invoice	NºPt	NºBox	SFIS (ShopFloor)	Qty	Part Number	Year/Wk	Manufacture date	Expire date	Shelf Life
	PLT-01	85023732AA0019	356G0563263424 16101329401MUG181	800	356G0563263424	1610	06.03.2016	06.03.2019	8.07
	PLT14	85023732AA0009	065G080533232K Y16313680503726107	1,000	065G080533232K Y	1631	31.07.2016	31.07.2019	12.97
	PLT14	85023732AA0003	071G 59A121 TA 15323824701730033	4,000	071G 59A121 TA	1532	02.08.2015	01.08.2018	0.83
	PLT01 IM	85023732AA0129	367G215X470PHZ002S17021396401111120	1,920	367G215X470PHZ002S	1702	08.01.2017	07.07.2018	-0.01

Fig.1: Shows the receipt process informing Shelf Life inside the warehouse.

2.2 Addressing material

The material after it is received is addressed via the system and updated in a spreadsheet by entering the data

of the material and arranging in its proper addresses according to the family of material, capacitor, resistor, transistor, IC etc.

S H E L F L I F E									
<span style="color: green;">■</span> >9 months - Out of Risk <span style="color: yellow;">■</span> 6~9 months - Warning <span style="color: red;">■</span> 0~6 months - Critical <span style="color: black;">■</span> <0 months - Expired									
Address	Part Number	Shelf Life (Shop Floor)	Qty.	Scan	Date Code	Manufacture date	Expire Date	Shelf Life	Balance
2R3E010401	367G215X470PHZ002S	367G215X470PHZ002S174713964011A2253	384	1747	19.11.2017	18.05.2019	3.10	365	
2R3E040302	715G6316K02000004I	715G6316K02000004I17283979601170715	840	1728	09.07.2017	05.04.2018	-10.50	840	
2R3E070402	361G0058159LGN005A	361G0058159LGN005A1718366700109F259	1,000	1718	30.04.2017	29.04.2020	14.67	1,000	
2R3E110202	421120315200T14001	421120315200T14001-1738-HH00-A00001	200	1738	17.09.2017	17.09.2019	7.17	200	

Fig.2: Shows the addressing process showing Shelf Life inside the warehouse.

According to the two activities mentioned above, the "Shelf Life" maturity indicators are indicated in black, red, yellow and green, where, respectively, if less than 0 month is due, between 0 and 6 months is risk of maturity, the 9 month forecast for risk of maturity and greater than 9 months is out of maturity risk, this months forecast was analyzed with the data reported by the vendor table, see below the table reporting the restriction in months by color.

Subtitle	
Indicator	Remark
>9 months	Out of Risk
6~9 months	Warning
0~6 months	Critical
<0 months	Expired

Fig.3: Shows the Shelf Life table by color and months of material criticality.

The material conference requires a computer, optical collector and two collaborators, where all the bar codes of the materials containing material code, date of manufacture and quantity will be read, see the figure below, exemplifying the activity.



Fig.4: Shows the conference process.



Fig.5: Shows the addressing process.

The Shelf Life control is checked weekly by a responsible person where it analyzes the materials that needed to be exchanged to keep the stock always out of risk, see the figures below showing the control worksheets:

Subtitle	
Indicator	Remark
>9 months	Out of Risk
6~9 months	Warning
0~6 months	Critical
<0 months	Expired

2.3 Survey of data

The data are collected weekly and fed into the spreadsheet where the most critical items to be exchanged will be analyzed

- Out of Risk
- Warning
- Critical
- Expired

Address	Part Number	Scan Shelf Life	Year/Wk	Manufacture date	Expire Date	Shelf Life	Stock	Life Time	Family	Class Material
2R3E040302	715G6316K02000004	715G6316K02000004117283979601170715	1728	09.07.2017	05.04.2018	0.12	840	9 months	Key Board Imported	A
2R3E070401	715G8009R01000004Y	715G8009R01000004Y17273465501016144	1727	02.07.2017	29.03.2018	0.11	120	9 months	Ir Board Imported	A
2R3E110101	47236308T4A2233G83	47236308T4A2233G8318056604100279705	1805	28.01.2018	28.01.2019	7.05	1,400	1 Year	Board Ktc	A
2R3E110102	47236308T4A2233G83	47236308T4A2233G8318056604100279705	1805	28.01.2018	28.01.2019	10.05	3,600	1 Year	Board Ktc	A

Fig.6: Shows the data collection indicating the criticality of each material.



Fig.7: Shows quantity and monetary value of the material by year of maturity.

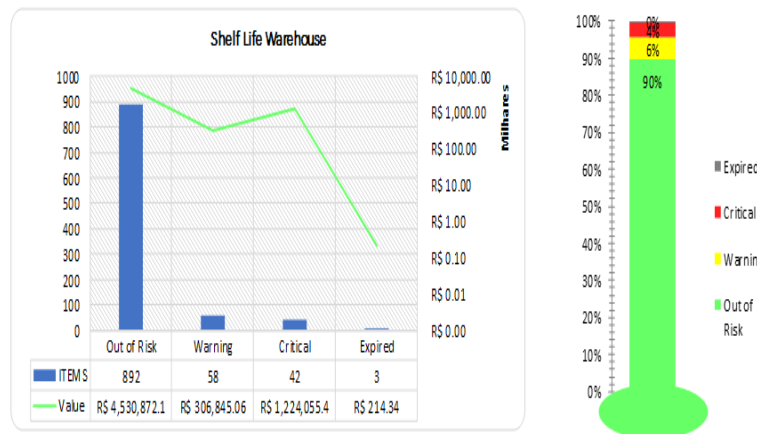


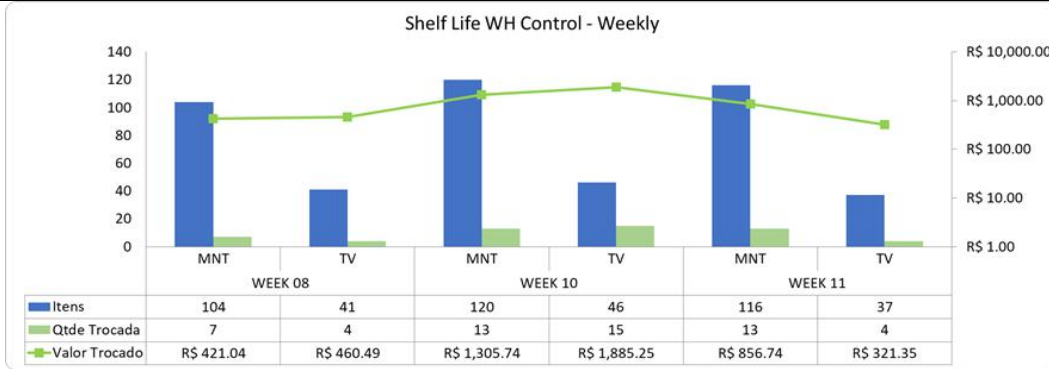
Fig.8: Shows the inventory situation, showing quantity and monetary value of each material and stock criticality in percentage.

The control sheet and indicators cited above demonstrate how much the Shelf Life system is organized, data collection, quantity of material per year of maturity, and the inventory situation showing the amount of material and monetary value and the thermometer next to it shows the percentage of how the stock is evolving.

We obtained great results implemented the process of Shelf Life, where it aims to keep material stock out of risk of maturity and avoid cost with discard of material due inside the inventory, see below two indicators indicating the quantities and monetary value of materials exchanged weekly and monthly.

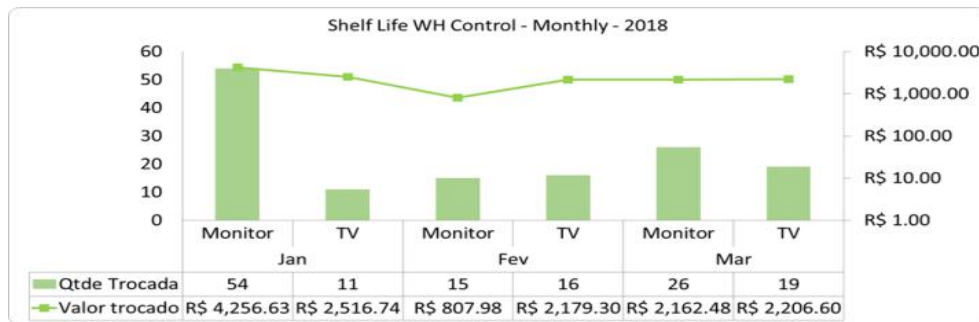
- Weekly report informing the amount and monetary value exchanged.

III. RESULTS



Week	Items	Change Qty	Exchange Value
<b>WEEK 08</b>	<b>145</b>	<b>11</b>	<b>R\$ 881.54</b>
MNT	104	7	R\$ 421.04
TV	41	4	R\$ 460.49
<b>WEEK 10</b>	<b>166</b>	<b>28</b>	<b>R\$ 3,190.99</b>
MNT	120	13	R\$ 1,305.74
TV	46	15	R\$ 1,885.25
<b>WEEK 11</b>	<b>153</b>	<b>17</b>	<b>R\$ 1,178.09</b>
MNT	116	13	R\$ 856.74
TV	37	4	R\$ 321.35
<b>Total Geral</b>	<b>464</b>	<b>56</b>	<b>R\$ 5,250.62</b>

- Monthly report informing the amount and monetary value exchanged.

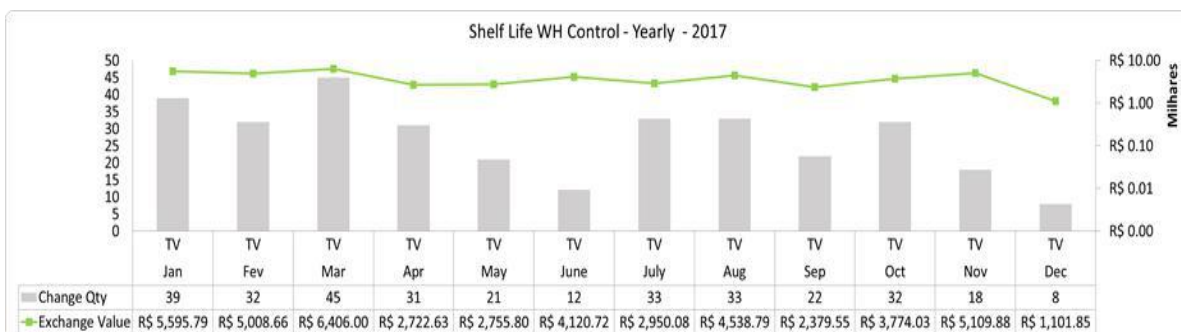


The exchange of older materials for newer materials made the stock always remain with materials within the expiration date, depending on the material input volume, the changeover number, the turnover is very large so we can avoid waste with repair of finished products and reducing the number of defects caused by material overdue, this project Shel Life made us succeed quantitatively and qualitatively, always seeking to reduce unnecessary cost and maintaining the quality of the material.

#### IV. DISCUSSION OF RESULTS

During the year 2017, 963 materials were exchanged, resulting in a savings of R \$ 116,418.27, showing that this Shelf Life project is effective for cost reduction, the inventory was with material that was not risk of maturity and organized, see below this great result:

- Annual results of items that were switched from TV and Monitor.
- TV (Television)



- MNT (Monitor)



This great result gave us great expectations for the year 2018 and we were able to continue with this project as mentioned above in III. Results The first quarter of 2018, which exchanged 141 materials resulting in a saving of R \$ 14,129.73 true data, we saw that this Shelf Life project brought us a work dynamic that generated great results such as economy, qualification and relocation of people.

## V. CONCLUSION

The Shelf life process has been innovative within the warehouse, providing a fast and effective routine in conjunction with Excel so that we have insight into all the materials by date of manufacture that are winning. The turnover of material exchanges results in us always keeping new material in the stock.

With the control worksheets we were able to maintain the accuracy of each material in the inventory referring to its manufacturing date and expiration date, trying to identify several maturity situations facilitating the flow of materials.

The difficulties encountered are due to the internal system (ERP - SAP) that does not allow this dynamic of maturity by the movement inside the stock. This is so that we have manual control in Excel worksheet using advanced formulas and macros, even if well functional, are susceptible to errors.

The implementation of this project resulted in R \$ 116,418.27 in the year 2017 of savings in material disposal, we also added process optimization and better distribution of labor, seeking to add value in the activities in the warehouse, we reduced the emission of Paper, time of conference of the materials and fatigue of the collaborators, because today excel makes the whole conference process.

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# Arduino Applicability Model for the Construction of Flight Controller for Drones

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**Abstract** — The aim of this study was to develop a flight developer for an unmanned aeronautical vehicle (UAV) with copyright technology. The project takes into account several aspects of Mechanical Engineering, as well as knowledge of aircraft dynamics, remote control, sensing and electronics, composing a multidisciplinary work of Electronics, Mechatronics and Aeronautical Engineering. In this project, the UAV is divided into its fundamental components: structure/base, engines, propellers, flight controllers, batteries, sensors and radio, each one being studied and specified for the integration of a full system. Simulation tools and calculation softwares are used to estimate the main features of the final product. We presume that this article serves as a reference for a drone project in general and a guide to the physical production of such a drone, from the initial design with specifications to the selection and integration of components for future work and research projects, becoming a valuable tool of great added value.

**Keywords** — Unmanned Aeronautical Vehicle, Drone, Flight Controller and Arduino.

## I. INTRODUCTION

The use of unmanned aerial vehicles (UAVs) has grown steadily in recent years due to the ease of acquisition and advancement of the technologies involved, such as controllers, transmission systems, sensing and engines [3].

According to the National Civil Aviation Agency (ANAC), the unmanned or remotely controlled air vehicle is a machine capable of sustaining itself in the atmosphere due to air reactions, excluding those ones against the Earth's surface. They are intended for remote operation, differing them from aeromodels that are intended for recreation only and must obey the existing resolutions [1]. The history of the Remotely Piloted Aeronautical Systems (SARP) emerged over a hundred years ago, when technologies were studied and developed for reconnaissance and attack aircraft that could be controlled from the ground [2].

The first documented use of unmanned aerial vehicles (UAVs) took place on August 22, 1849, when the city of Venice was attacked by the Austrian army through balloons containing explosives [8].

Another Record occurred in the midst of the World War II, when the Germans employed flying bombs (UAV), to attack targets at a distance without exposing their pilots. The technology continued to be used in the numerous conflicts that followed. However, in 2003, in the Second Gulf War, which became more known, especially with the dissemination and diffusion through the Internet, when the U.S. army employed technology for the monitoring of enemies, designation of targets and weapons launching and guided projectiles. After this conflict, several countries began to become interested and exploit the technology hardly [8].

The first UAV registered in Brazil was the BQM1BR, manufactured by the extinct CBT (Brazilian Company of Tractors), of jet propulsion. This prototype would serve as an aerial target, making flight in 1983. Another UAV known is the Blue Bird, produced by Embravant. The aircraft had more than 4 meters of wingspan, with autonomy for up to 3 hours of flight. The first two prototypes of the Blue Bird performed several tests in flight, operating by means of radio control [5].

Unmanned aerial vehicles may be classified according to the quantity of engine they use, as can be seen in the table in Figure 1. The main influence of the number of engines is the propulsion force and support of the drone.

Number of Engines	8	6	4	3
Nomenclature	octacopter	hexacopter	quadcopter	tricopter

Fig.1: Classification of the UAVs

In this study, a quadcopter was used Brushless Motors of 935v 860g thrust type. Brushless is a non-toothed DC motor, which has as main features the emission of low noise, durability (absence of wear of the brushes) and the total EMI reduction (Electromagnetic interference).

In the Brazilian Regulation of Special Aviation autonomous UAVs can not fly without an Authorization

Certificate for Experimental Flight (ACEF). In this document are described the three operating classes that separate the unmanned aerial vehicles according to the maximum take off weight, as shown in Figure 2:



Fig.2: Operating classes according to the weight.

Since landing in Brazil in 2013, drones have proven to be an equipment capable of operating in several segments: safety, agriculture, and product delivery. There are more than 34,000 equipments in the country, according to data from National Civil Aviation Agency ( ANAC ), the number refers to the quantity of drones registered according to the sector regulation [5].

Drones are also commonly used for rescues in places of difficult accesses, such as areas of disasters in which occurred floods, fires, collapses, interdicted buildings, among others. The choice of using this technology is due to the fact that devices transmit images and videos in real time , thus contributing to the success of the rescue teams. A drone can capture better angles for photos and footage while keeping the camera stable for longer, thus facilitating video production as well.

These technical valences allow a marked reduction of the financial costs and risks of incidents in filming by TV broadcasters and cinematographic companies, considering the fact that they previously use helicopter for such purposes.

Among other activities, in which its use stands out, we can mention forest mapping, industrial transport, goods deliveries, border inspection and surveillance, monitoring suspicious people, in order to avoid attacks or cases of vandalism. As a highlight in civil use, we can emphasize the use by photographers and videographers at birthday parties, weddings or events in general.

The unmanned aerial vehicles industry has, in recent years, presented a series of technological innovations and optimizations that can be noticed in the evolution of the hardware and software used, increasing the interest of programmers, professionals and investors to use and exploit such technologies.

A Bussiness Insider recently published a new growth forecast for the drone industry, estimating that its market will move around \$ 12 billion until 2021.

This elevation of the projection, according to the report, is due to the popularization of the remotely piloted civilian aircraft and the convergence of the regulatory

environment to a model less restrictive to the use of these artifacts[7].

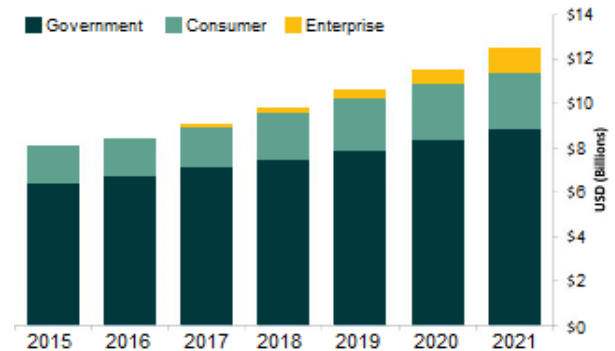


Fig.3: Growth forecast for the Drones sector [7].

It is, therefore, noted that by the year of 2021, governments will continue to be responsible for the largest share of the market, due to the power of military and public security industries concerning the use of remote and autonomously controlled applications. It is also noticed that the civil areas will present a more expressive growth.

Constant improvements in data processing hardware and software solutions, such as autonomous anti-collision systems, aiming to improve systems, reliability and efficiency, are being developed and disseminated on a global scale through students and researchers from different areas, impacting significantly on the market potential of drones and reducing costs from construction and acquisition.

Although the most common is to relate unmmanned aerial vehicles with a very limited number of tasks, such as filming audiovisual parts or military uses, the usefulness of these machines goes far beyond.

The use of drones can represent a value of 127 billion dollars in different industrial segments. Among the sectors that can use the most technology, we highlight infrastructure, agriculture and transport, as can be seen in the graph of Figure 4 [7]:

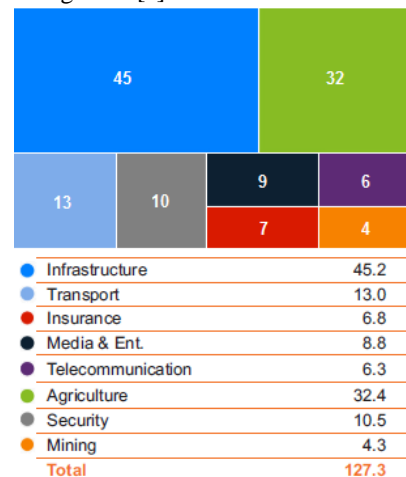


Fig.4: Prediction of investment in Drones by economic sector [7].

In line with the previously elucidated context and in order to disseminate the technical and scientific knowledge about the technology of construction of drones, which is still incipient, this article aims to elucidate the implementation of a model of applicability of Arduino for flight controller construction for drones.

**II. THEORETICAL REFERENCE**

**2.1 LEGISLATION**

On May 02, 2017, it was announced by the National Civil Aviation Agency ( ANAC ) the approval of the regulations for the use of drones. This was a very important step for the market that awaited this decision eagerly. The regulations were posted to public hearing in September 2015 and it is already needed some updates [4].

One such update is concerned with the certification of pilots to operate unmanned aerial vehicles above 400 feet (120 meters). According to the regulations, a driver's license will be required. There is also the need to implement some measures, but this is a natural process. First the National Telecommunications Agency (ANATEL ) regulated the frequency of radios, then the Department of Airspace Control ( DECEA ) released the flight rules for drone to access the airspace and following the National Agency of Civil Aviation ( ANAC ) has signed the regulation of use [4].

The new regulation of ANAC classifies unmanned aerial vehicles in aeromodels, drones used for recreational purposes and remotely piloted aircraft (RPA): used for commercial, corporate or experimental operations [10]. The summary of the regulations can be seen in figure 5:

	RPAS1	RPAS2	RPAS3	AEROMODELS
Aircraft registration?	Yes	Yes	BVLOS: Yes VLOS: Yes	Yes
Approval or authorization	Yes	Yes	Only BOLS or above 400 ft	Not
Age limit for operation?	Yes	Yes	Yes	Not
Medical certificate?	Yes	Yes	Not	Not
License and activation?	Yes	Yes	Operations over 400 ft	Operations over 400 ft

Fig.5: Summary of the ANAC Regulation [10].

For design purposes there are still no specific technical standards on remotely piloted aircraft. At the beginning of 2015 was created the ISSO/TC 20/SC 16, subcommittee of unmanned ISSO aircraft, with the aim of establishing new design standards. In addition to the ISO initiative, there are local proposals from governments and regulatory bodies without, however, a general technical standard.

**2.2 STRUCTURAL COMPONENTES OF AN UAV**

There are 6 main components related to an UAV, which must be cited due to its relevance: engines, structural base, propellers, speed controllers, flight controllers and batteries.

**• Engines**

UAV engines have the function of making the propellers turn and generate momentum, enabling the flight. The classification of the engines can be divided into several ways, but the two main models are the brushes and brushless ones [10].

Brushless DC Motors (BLDC ) are also known as synchronous electric motors powered by inverter through normally low voltage direct current power. Compared to brushless motors, they stand out for greater reliability and durability, lower noise and total reduction of electromagnetic interference. In contrast, its cost is higher, because it requires MOSFET devices, used for the construction of the electronic speed controller and an integrated circuit with more resources.

Simply put, a brushless motor contains a group of electromagnetics ( coils ) that are connected together in specific pairs. The motor controller, commonly known as electronic speed controller or ESC, will be responsible for activating and disabling specific sections of electromagnetics at very specific times to cause the engine rotor to rotate due to the magnetic force. These electromagnetics are connected in three main sections, which is why brushless motors have 3 wires coming out from them.

**III. MATERIALS AND METHODS**

**3.1 MATERIALS**

**3.1.1 PROGRAMMING LANGUAGE**

The programming language used in this study was C.

**3.1.2 DEVELOPMENT ENVIRONMENT**

The Arduino version 1.8.2 was used as an integrated development environment, as can be see in figure 6:

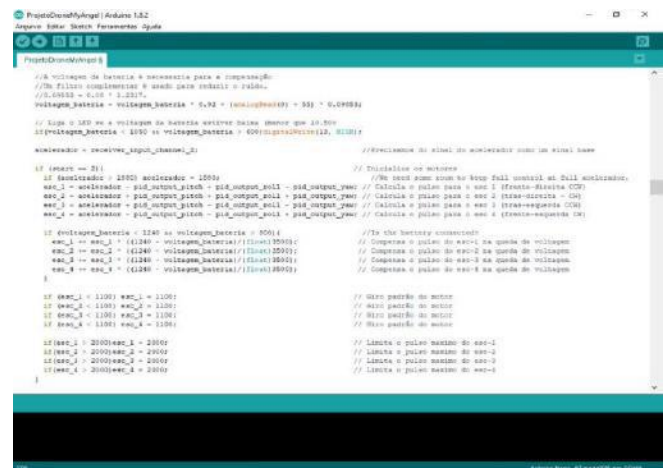


Fig.6: Development environment.

3.1.3 ENGINE

The engine used in this project was Brushless, Emax brand and model Mt2213, as can be seen in figure 7, chosen mainly for offering extremely high efficiency with high load capacity for its small weight of 53g. They are maintenance free and have a very long service life.



Fig.7: Motor brushless

3.1.4 ELETRONIC SPEED CONTROLLER (ESC)

It was used in this project, the ESC of EMAX brand, model BLHeli of 30A Bec 5V/2A and weighing 28g each unit, as can be seen in figure 8. The quality of the equipment coupled with the ease of programming was determinant for the choice of this technology. This component is necessary so that the system can regulate the speed of the motors in order to allow takes-off and vertical landings , as well as the other directional movements, forward and backward, inclinations and manoeuvres. Each engine must have its controller, because it is precisely the combination of different speeds of the motors that allow this variation of movements.



Fig.8: EMAX ESC.

3.1.5 SENSORS AND ACESSORIES

The DJI and model F450 load dividing plate was used, as can be seen in figure 9. A 3-axis accelerometer was used,

with operations: +/-2g, +/-4g, +/-8g, +/-16g and gyro of also 3 axes with operation: +/-250 ,500, 1000 and 2000°/s.



Fig.9: Load Divider Plate.

The microcontroller board used was Arduino UNO R3, basedon the ATmega328 (data sheet), as can be seen in figure 10. It has 14 pin digital input/output, of which 6 can be used as PWM outputs, 6 analogic inputs, a 16MHz oscillator crystal, a USB connection, a power input, an ICSP connection and a reset button. It contains all the components needed to support the microcontroller, simply connects to a computer through the USB port or power supply with a source or with a battery.

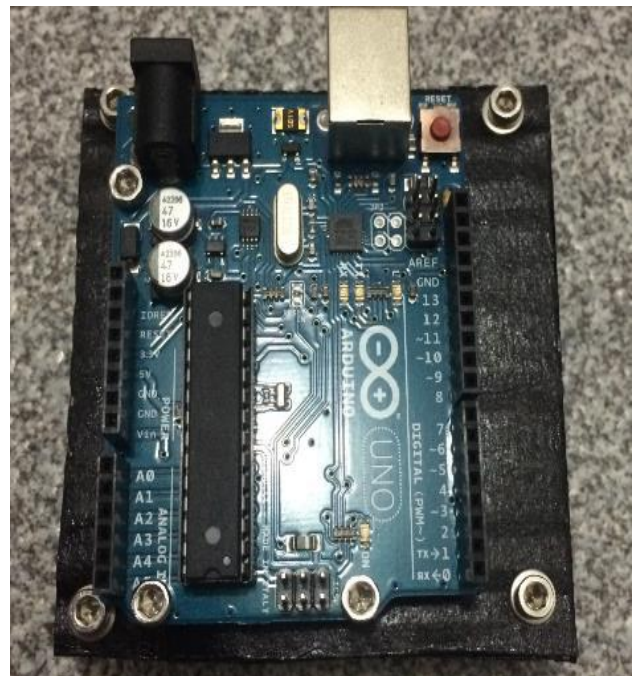


Fig.10: Arduino Uno R3 Microcontroller Board.

The low-voltage alarms have been installed and configured, as shown in figure 11.





Fig.11: Alarm Flags.

We used the radio receiver of the brand Turnigy, model 9X8C-V2, with frequency of 2,4GHz and containing 8 channels, as can be seen in figure 12.



Fig.12: Turnigy Radio Receiver.

The radio transmitter used was the Turnigy brand, model RF9X-V2, with frequency of 2,4GHz , containing 9 channels, as can be seen in figure 13. This component which is generally a radio transmitter with remote control is what allows a (pilot ) operator to send navigation commands to the UAV. A receiver compatible with the radio transmitter must be part of the drone navigation system.



Fig.13: Turnigy Radio Transmitter

Propellers of 10 X 4, 5cm were used, as can be seen in figure 14. The number of propellers must correspond to the number of engines. However, it is necessary to have pairs of propellers designed to rotate clockwise and pairs that turn counterclockwise. This feature is what allows the quadcopter to remain stable in flight.



Fig.14: Propellers

The connection of the motors with the ESCs was performed through 3,5mm bullet type connectors. The integration of BECs with the flight controller was carried out through the 4-pin JST-XH type connectors. The

battery connection with the main circuit was carried out via XT60 connector.

The drone has a radio frequency transmitter of 2,4GHz, using 9 channels being 8 PCM or 9PPM with telemetry. It also has 4 electronic speed controllers (ESC) of BEC 5v/2A ( Battery Eliminator Circuit).

The material used for the central plates, the arms and the brackets for the motors were PA66 + 30GF, possessing high strength. The power distribution frame was installed based on phenolite, with copper tracks, as well as screws and stainless steel base bracket.

To power the entire system is necessary to term a battery. The Lipo 3s 5200mah 11, 1v weighing 415g battery was used. In general , the most used are the lithium polymer, called Lipo ( Lithium Polymer ) batteries. This type stands out for its relative low weight and efficiency, however, require certain care as to the correct use and recharge process, so that they are not damaged or not to become dangerous.

3.1.6 TECHNICAL ESPECIFICATIONS

<b>Codinome:</b>
My Angel
<b>Frame:</b>
- Model: F450 DJI
- Weight: 282g
- Width: 450mm
- Height: 55mm
- Color: 2 Red Arms, 2 White Arms and Black Cent
- Base dividing plate integrated in base
<b>Motor:</b>
- Model: EMAX MT 2213
- Type: Brushless
- Rotação: 935Kv
- Availability: 4
- Amperage: 15,1A
- Motor Buoyancy: 860g
- Drilling: Standard 12N14P
- Weight: 53g
- Diameter (Stator):22mm
- Height (Statror): 13mm
- Spinner: 4x, Red
- Motor shaft: 3mm
- Plugs: Bullet 3,5mm Male

<b>Hélice - Propeller</b>
- Propeller 10x4,5 cm CW
- Propeller 10x4.5 cm CCW

<b>Controlador de velocidade - Speed Controller</b>
- Model: ESC EMAX 30A BLHelo Bec 5V / 2A
- BEC: Yes
- Width: 26mm
- Height: 7mm
- Depth: 52mm
- Weight: 28g
- Amperage ESC: 30 A
- Amperage Burst: 40 A
- Amperage Bec: 02 A
- Voltage Bec: 5V
- Battery Cells: 2s - 4s
- Plugs: Bullet 3,5mm Female
- Firmware: Simonk
- Programmable: Yes
<b>Alimentação - Power Supply</b>
- Bateria LiPo 3s 5200mAh 11,1v
- Weight: 415g

<b>Controladora de voo - Flight controller</b>
- Name: My Angel
- Gyroscope: 3 Axes
- Accelerometer: 3 Axes
- Gyro Operation: +/- 250 500 1000 2000°/s
- Gyro Operation: +/- 2g, +/- 4g, +/- 8g, +/- 16g
- Accelerometer and Gyroscope Dimensions: 20x16
- Arduino UNO v3
- Arduino Weight: 28g

Fig.15: Technical Specifications.

3.2 METHODS

We used the basic and applied research methodology, construction of the entire controller during the project, without a brand or commercial model.

Basic research aims to generate knowledge that is useful for science and technology, without necessarily having a practical application aimed at obtaining profit.

The applied research seeks to generate knowledge for practical application. It is aimed at solving problems that

contain previously defined goals, whether they are medium or long term.

All simulations were performed in the development environment. The equipment and accessories were obtained in aeromodelling and electronics stores. The connection of the motors with the ESCs used bullet type connectors of 3,5mm. The integration of the BECs with the flight controller used the 4-pin JST-XH type connectors. The battery connection with the main circuit used XT60 connector.

The drone has a radio frequency transmitter of 2,4GHz, using 9 channels being 8 PCM or 9PPM with telemetry. It also has 4 electronic speed controllers (ESC) of BEC 5v/2A ( Battery Eliminator Circuit).

The material used for the central plates, the arms and the brackets for the motors were PA66 + 30GF, possessing high strength. The power distribution frame was installed based on phenolite, with copper tracks, as well as screws and stainless steel base bracket.

#### IV. RESULTS AND DISCUSSIONS

##### 4.1 CONSTRUCTION PROJECT

A model of applicability of the Arduino was built for the construction of the flight controller for drones, using its own technology. The aircraft had a total weight of 1081g, as can be seen in the table in figure 16.

Description	Amount	Weight(g)	Total(g)
Frame	1	282	282
Motor	4	53	212
Propeller	4	5	20
ESC	4	28	112
Power supply	1	415	415
Flight controller	1	40	40
Receiver Radio	1		0
<b>Total weight</b>			<b>1081</b>

Fig.16: Drone Weight Description.

The selection of the engines mainly considered the propulsion force, because the aircraft depends solely on their strength to perform maneuvers and maintenance of the flight. However, the necessary propulsion can not be estimated without knowing, for instance, the total weight of the aircraft.

To control the rotation of an engine it is imperative to use a power circuit with several inverters, sensors and a circuit that is capable of controlling the drives.

Figure 17 shows an integration scheme for all components and the connections that must be made to the functioning of the UAV:

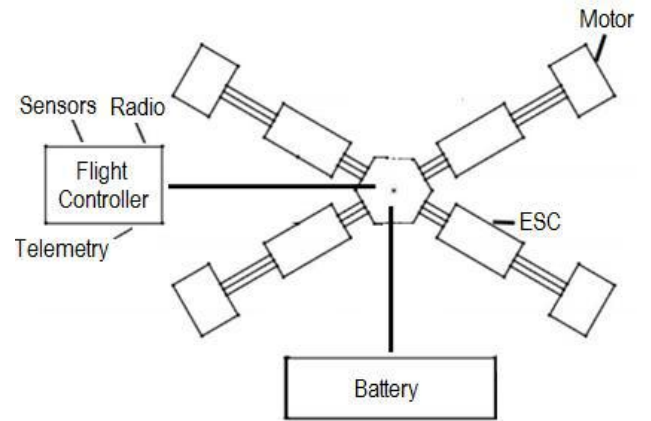


Fig.17: Drone Integration Scheme

For models with 4 engines we use the form of an “X”, as can be seen in figure 18, but the form depends on the flight characteristics we want to give to our UAV. Generally, an “H” format structure allows for faster maneuvers, so they are common in drones targeting high-speed uses.

Typically, the “X” format allows smoother maneuvering and greater stability in tasks that require the drone to hover over a certain point.



Fig.18: Drone built.

##### 4.2 COSTS ASSESSMENT

As a result the general cost table was generated, with the selected components and a price estimate for the consumable materials and connectors.

The final value of the drone is also indicated in the table in figure 19:

Description	Amt	Value Un.	Value Tot.
Frame F450Dji	1	R\$ 129,00	R\$ 129,00
Cargo Dividing Plate	1	R\$ 0,00	R\$ 0,00
EMAX Brush. Motor Xa2212 980Kv 15.1A CW + Spinner Shaft 3mm	2	R\$ 60,00	R\$ 120,00
EMAX Brush. Motor Xa2212 980Kv 15.1A CW + Spinner Shaft 3mm	2	R\$ 60,00	R\$ 120,00
Propeller 10x4,5cm CW	2	R\$ 18,00	R\$ 36,00
Propeller 10x4,5cm CCW	2	R\$ 18,00	R\$ 36,00
Plugs Bullet 3.5mm female to ESC	12	R\$ 0,00	R\$ 0,00
Shock Absorbers	4	R\$ 0,10	R\$ 0,40
ESC (25ah - 30ah) ESC EMAX 30A BLHeli Bec 5V / 2A	4	R\$ 67,00	R\$ 268,00
Flight Controller Board	1	R\$ 84,80	R\$ 84,80
Radio tx-rx kit	1	R\$ 698,00	R\$ 698,00
Battery Pack: Lipo 3s 5200mah 11.1V 80C	1	R\$ 250,00	R\$ 250,00
Charger and Balancer	1	R\$ 280,00	R\$ 280,00
Low Battery Alarm	1	R\$ 17,00	R\$ 17,00
<b>Total</b>			<b>R\$ 2.039,20</b>
			<b>US\$ 520,15</b>

Fig.19: Drone Cost Description

The values entered in the table were the lowest found after quotation in three different vendors. To make a comparison of the costs of a drone of this type, with four engines and containing similar characteristics, a search of commercial models for sale available on internet store sites was conducted. The table below shows a comparison between bussiness models and the drone proposed in this article.

We use price per charge [R\$/kg] , as a comparison parameter, as can be seen in the table in figure 20:

Model	Battery [mAh]	Controller	Price [US\$]	Useful Load [Kg]	US\$/Kg
Proposed	5200	Emax	520,15	3	173,38
Dji F550	5500	Dji Naza	1.745,22	3,8	459,27
Tali H500	5400	Walkera	1.874,90	2,7	1.008,18
Dji S900	16000	A2	6469,43	5,8	1.115,42

Fig.20: Comparison between Freight Costs [R\$/kg].

**V. CONCLUSION**

Throughout the study, we explored the origins and history of unmanned aerial vehicles ( UAV ) and their change of purely military equipment to become a new technology reliable for civilian use, offering very different configurations, which vary greatly in size and performance.

We effectively addressed the implementation and importance of an Arduino applicability model for the construction of the drone flight controller, which has the main function of contributing to the safe and economical operation of the drones.

With the advent and mastery of electronics and control techniques, mechatronics devices supporting pilotage are being studied and implanted in projects with greater vehemence, from electromechanical actuators to advanced robotic systems with potential to carry out

landings and takesoff of commercial aircrafts, whether cargo or passenger transport.

The use of drone has grown exponentially, presenting several possibilities in the field of teaching, research and development. However, in contrast, there are not many relevant theoretical studies regarding drone spectrum. There is an urgent need to create norms and regulations.

The article made evident that the construction and development of this project took into account several parameters, from the programming language to the installation of the high power electric motors.

The drone presented, in tests, with capacity to sustain load up to three kilos, which can be used to load sensors, cameras and other equipment.

Regarding the scope of the project, the product met the needs satisfactorily, achieving its objective of elucidating the implementation of a model of applicability of the Arduino for the construction of the flight controllers for drones, availing parameters, techniques, study methodologies and selection of its components.

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# Extractive Reserves in the State in Rondônia: A Positioning about the Occupation and Expectations / Restrictions Suffered by the Residents

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**Abstract**— *In the state of Rondônia, Extractive Reserves are spread over an area of 1,705,257 hectares, divided into twenty-one state reserves. Currently the reserves are in a situation of abandonment by the government agencies and it is on the basis of these findings that this research was developed to identify the vision that the heads of the families that live in the Extractive Reserves of the State of Rondônia have in relation to the management plans and support from government entities. Thus, the theoretical basis of the concepts of extractive reserves, the national system of conservation units, management plans and sustainable development were used to backup the application of questionnaires and interviews. This research was characterized as a qualitative research, applied and with the use of ethnographic methods. After the study, it was found that the inhabitants of the reserves themselves feel abandoned and thus seek the entry of new residents so that together they can be strengthened and can "enforce" the preservation legislation.*

**Keywords**— *Extractive reserves, Occupation. Forest management.*

## I. INTRODUCTION

Extractive Reserves are areas used by traditional populations and whose survival is based on extractivism with the sustainable use of the natural resources of the conservation unit. The Sustainable Development Reserve is designated by the National Conservation Unit System - SNUC, "as a natural area that shelters traditional populations, whose existence is based on sustainable systems of exploitation of natural resources, developed over generations and adapted to the conditions ecological

conditions that play a fundamental role in the maintenance of biological diversity "(Law No. 9,985 of June 18, 2000).

In the State of Rondônia there are twenty-five Extractive Reserves, with a total coverage of 1,705,257 hectares. In addition to the State Reserves, there are also four Federal Extractive Reserves in the State of Rondônia: Rio Ouro Preto, Lago Cuniã, Barreiro das Antas and Rio Cautário. (GTA, 2008).

The issue of sustainable development began to be formally discussed in the United Nations Conference on the Environment, held in Stockholm in 1972, when the environment was perceived in a global perspective as affecting the quality of life of populations. In this section, this research was motivated by the following question: What is the view that the heads of the families living in the Extractive Reserves of the State of Rondônia in relation to the occupation process, management plans and support from government entities?

In order to develop the study, the overall objective was to verify the perception that the extractivists have in relation to the occupation, conservation and maintenance of Extractive Reserves.

## II. THEORETICAL FRAMEWORK

This topic will address the basic concepts of Extractive Reserves, Conservation Units, Forest Management Plan, Sustainable Development and other aspects that are necessary for the development of the research.

### 2.1 Extractive Reserves

Extractive Reserve is a concept that originated in 1985 at the First National Meeting of Rubber Tappers, which

sought a way to give greater security to the rubber tappers, threatened by the expansion of large pastures, deforestation and land speculation that was happening at the time. As a result of the great similarity with the Indigenous Reserves, since they are also lands of the Federal Government, it was decided to give this nomenclature, since that the beneficiaries are the members of the communities that already resided there (MEMORIAL CHICO MENDES, 2017).

Scientific knowledge is an evolutionary process that goes through improvements over the years until you have a solid position on that subject. The construction of the concept of Extractive Reserves could not have been different, so the Memorial Chico Mendes (2017) divides the study to facilitate understanding in two phases: the first phase (1985 to 2000) was the "period in which the concept of Extractive Reserve was formulated by rubber tappers and incorporated into agrarian reform and environmental policies "; and the second phase (2000s to present) with the "fight for the creation of new areas and the implementation of social and economic programs aimed at improving the living conditions of the residents of these areas."

In this context of creation of the Extractive Reserves, Allegretti (2002) stated that the motivation to assume previous responsibilities even before the creation of the Reserves had as a starting point the concern of the rubber tappers in losing the land or even losing the focus of the initial idea. In the localities where the rubber tappers were not yet organized, Chico Mendes, in an interview given at the time, expressed his concern about the viability of this project, stating that:

There are areas that have been indicated by the government as areas for extractive reserves that do not yet have the participation of the National Council of Rubber Tappers and where the rubber tappers are not yet organized. We fear the future of these areas. We only believe in the areas where, more or less, the rubber tappers are taking over the reins (MENDES, 1989, p. 57-58)

In 1990, the Decree 98.897 was published in January 30, providing a clearer and more objective definition of the concept of Extractive Reserves: "territorial space destined to self-sustaining exploitation and conservation of renewable natural resources by extractive population". Considering that this concept arose from the initiative of the rubber tappers themselves and that most of the environmental conservation plans of Amazonia disregard the existence of the population that inhabits the forests, the Decree was published to distinguish the Extractive Reserve of the Conservation Units and also to preserve the rights, cultural traditions and the organization of the resident population.

Continuing the analysis of the said Decree, it is observed that in addition to the characterization of Extractive Reserves it was also determined that in the act of creation of each one of them, it should contain characteristics such as geographical limits, population to be destined and also the measures to be taken by the Executive Power to allow implementation. Thus, the population that inhabits it will be protected, allowing them to live in harmonious coexistence with the neighbors and the environment, being able to sustainably extract what the system will offer.

In the Decree, the preservation of the environment, the occupation of spaces and the use of natural resources maintained the traditional form and listed the body responsible for supervising the concessions and use, as described in arts. 4th and 5th:

Art. 4º Self-sustaining exploitation and conservation of natural resources shall be governed by a real concession agreement, pursuant to article 7 of Decree-Law no. 271, of February 28, 1967.

1º The real right of use will be granted free of charge.

2º The concession agreement shall include the plan of use approved by IBAMA and contain clauses of rescission when there is any damage to the environment or transfer of the concession *inter vivos*.

Art. 5 Ibama shall supervise the extractive areas and monitor compliance with the conditions stipulated in the contract referred to in the previous article. (BRAZIL, 1990)

After this brief explanation about the historical context during the process of regulating the Reserves, it is necessary to study the Extractive Reserves of the State of Rondônia to continue the study and consolidate the theoretical basis for the application of the research.

### 2.1.1 Extractive Reserves in the State of Rondônia

Based on the information provided by the Grupo de Trabalho Amazônico (2008), in the State of Rondônia there are twenty-five Extractive Reserves, with a total coverage of 1,705,257 hectares, representing 7.15% (seven point fifteen percent) of the State. Being divided according to the table below:

Fig.1: Official data of the State's Extractive Reserves

Nº	Reserve	Decre e	D.O.E	County	Area (ha)
01	Roxinho	7107	8/9/1995	Machadinh o do Oeste	882,2142
02	Mogno	7099	8/9/1995	Machadinh o do Oeste	2.450,1162
03	Angelim	7095	8/9/1995	Machadinh o do Oeste e Cujubim.	8.923,2090
04	Ipê	7101	8/9/1995	Machadinh	815,4633

				o do Oeste	
05	Castanheira	7105	8/9/1995	Machadinh o do Oeste	10.200,000 0
06	Freijó	7097	8/9/1995	Machadinh o do Oeste	600,3607
07	Massarandub a	7103	8/9/1995	Machadinh o do Oeste	5.566,2166
08	Maracatiara	7096	8/9/1995	Machadinh o do Oeste	9.503,1284
09	Seringueira	7108	8/9/1995	Machadinh o do Oeste	537,4691
10	Carrote	7109	8/9/1995	Machadinh o do Oeste	802,5166
11	Piquiá	7098	8/9/1995	Machadinh o do Oeste	1.448,9203
12	Itaúba	7100	8/9/1995	Machadinh o do Oeste	1.758,0759
13	Jatobá	7102	8/9/1995	Machadinh o do Oeste	1.135,1793
14	Sucupira	7104	8/9/1995	Machadinh o do Oeste	3.188,0291
15	Aquariquara	7106	8/9/1995	Vale do Anari/ Machadinh o do Oeste	18.100,000 0
16	Rio Preto Jacundá	7336	19/1/1996	Machadinh o do Oeste e Cujubim	95.300,000 0
17	Rio Cautário	7.028	08/08/95	Costa Marques e Guajará- Mirim	146.400,00
18	Pedras Negras	6.954	14/07/95	São Francisco do Guaporé e Alta Floresta do Oeste.	124.408,97 56
19	Curralinho	6.952	14/07/95	Costa Marques	1.757,6564
20	Rio Pacaás Novos	6.953	19/07/95	Guajará – Mirim	342.903,50 29
21	Rio Jaci – Paraná	7.335	17/01/96	Porto Velho, Nova Mamoré e Buritis.	191.324,31 18

Source: Costa, 2012.

In addition to the State Reserves, there are also four Federal Extractive Reserves in the State of

Rondônia: Rio Ouro Preto, Lago Cuniã, Barreiro das Antas and Rio Cautário. (GTA, 2008).

Although there are a significant number of Reserves in the state, there are still places, such as the Rio Candeias, that failed to formalize this zoning despite the clear interest of local residents. As mentioned in the previous topic, Chico Mendes' concern was tied exactly to what happened in this region, as the rubber tappers were not strengthened and ended up losing their strength and being driven out by invaders (“grileiros”), loggers and squatters.

## 2.2 National System of Conservation Units

The National System of Nature Conservation Units (SNUC) was created by Law 9,985 of July 18, 2000 (the year the second phase of the concept of Extractive Reserves begins), with the objective of establishing criteria and norms for the creation and management of conservation units.

Along with the creation of the law, several concepts were instituted, among them the units of conservation that are "territorial spaces and their environmental resources, including jurisdictional waters, with relevant natural characteristics, legally established by the Government, with conservation objectives and limits defined, under a special administrative regime, to which adequate guarantees of protection are applied "(BRASIL, 2000).

There are several objectives foreseen in the law that are linked to the SNUC, which may be emphasized to contribute to the maintenance of biological diversity and resources, to protect endangered species throughout the national territory; to promote sustainable development, preserving and restoring ecosystem diversity; to protect natural landscapes and relevant geological, geomorphological, speleological, archaeological, paleontological and cultural characteristics; to recover or restore degraded ecosystems; to protect the natural resources necessary for the subsistence of traditional populations, to respect and value their knowledge and culture and promote them socially and economically and others.

In order to be able to respect the positioning of the SNUC, it was necessary to determine some guidelines to govern its activities, as described in art. 5 of Law 9,985, of July 18, 2000:

I - Ensure that significant and ecologically viable samples of the different populations, habitats and ecosystems of the national territory and jurisdictional waters are represented in the conservation units , safeguarding the existing biological heritage;

II - Ensure the necessary mechanisms and procedures for the involvement of society in the establishment and revision of the national policy of protected areas;



III - ensure the effective participation of local populations in the creation, implementation and management of conservation units ;

IV - Seek the support and cooperation of non-governmental organizations, private organizations and individuals for the development of studies, scientific research, environmental education practices, leisure activities and ecological tourism, monitoring, maintenance and other management activities of conservation units ;

V - Encourage local populations and private organizations to establish and manage conservation units within the national system;

VI - Assure, in possible cases, the economic sustainability of the protected areas;

VII - allow the use of conservation units for in situ conservation of populations of wild genetic variants of domesticated animals and plants and wild genetic resources;

VIII - ensure that the process of creation and management of conservation units is carried out in an integrated manner with the administration policies

From the surrounding lands and waters, considering local social and economic conditions and needs;

IX - Consider the conditions and needs of local populations in the development and adaptation of methods and techniques for the sustainable use of natural resources;

X - Guarantee to the traditional populations whose livelihood depends on the use of natural resources within the units of alternative livelihoods or fair compensation for lost resources;

XI - ensure adequate allocation of the necessary financial resources so that, once established, conservation units can be managed effectively and meet their objectives;

XII - seek to confer conservation units, where possible and respected the conveniences of administration, administrative and financial autonomy; and

XIII - seek to protect large areas by means of an integrated set of conservation units of different categories , close or contiguous, and their respective buffer zones and ecological corridors, integrating the different activities of nature preservation, sustainable use of natural resources and restoration and recovery of ecosystems. (BRASIL, 2000).

It is noteworthy that both SNUC's objective and the guidelines converge towards sustainable development, but it does not fail to consider the existing culture of the residents who lived there.

### 2.3 Sustainable development

The concepts of sustainability started in 1972 at the United Nations Conference in Stockholm and thereafter it was defined that sustainable development is a process of

change in which resource exploitation, investment and development should be linked to the needs of generations: current and future. Thus, the concept of sustainable development has broken the frontiers and has reached a high point at the United Nations Conference on Environment and Development (Rio-92) in which "[...] sustainable development was recognized as a new universal paradigm, although the concept is not clear "(BECKER, 1994).

Also in Rio-92, there was the production of Agenda 21 with the objective of disseminating the concepts of sustainable development throughout the world to protect the right of human beings to live and produce always in harmony with nature without leaving aside the concern with an economy compatible with the development and environmental needs of present and future generations (COSTA, 2012).

Over the years and with the growing concern for sustainable development, the United Nations Conference in 2012 had this aspect as its theme and was it called Rio + 20. When reading the objectives and results of the conference, it is observed that the objective was to establish a plan for humanity to pursue its development processes, yet with quality of life and managing scarce natural resources. However, most of the negotiations were not successful, leaving the adoption of the established measures for the year 2015. The document "The Future We Want" established guidelines for social, economic and environmental well-being, but it does not establish what concrete results should be achieved. (O FUTURO QUE QUEREMOS, 2012).

Sustainable development in the view of authors such as Sachs (1994; 2002; 2004), Guimarães (1997) and Bellen (2005) apud Siena et al. (2008) consider several dimensions and criteria: social, cultural, ecological, environmental, territorial, economic, national and international sustainability.

Social sustainability aims to reduce social inequalities through the implementation of quality of life for the entire population, the production of goods primarily to meet social needs, equal access to social services and fair distribution of income.

Economic sustainability aims to increase production and social wealth through the implementation of efficient management that seeks to reduce regional differences, guarantees food security, autonomy in scientific and technological research, absorption of environmental and other costs.

Environmental sustainability aims to improve the quality of the environment by respecting the capabilities of the ecosystem and nature to absorb the impacts and recover from the aggressions provoked by the development of humanity. Political sustainability has the objective of providing the full incorporation of

individuals into the development process through the construction of citizenship.

Ecological sustainability aims at preserving the potential of natural capital in the production of resources, producing with respect and prudence to ecological cycles of ecosystems, reducing energy intensity and increasing energy conservation, and reducing waste rates.

Territorial sustainability aims at improving the urban and rural environment and overcoming disparities, avoiding excess agglomerations. Measures such as respect for nature's support capacity, comparison between economic growth, rates of productivity increase and population growth, age composition and other demographic variables, spatial deconcentration and other methods.

### 2.3.1 Forest Management Plans

The management plan is an important instrument for the management of conservation units, as it establishes criteria and implementation strategies. This should be elaborated no more than five years after the creation of the Conservation Unit, since it will establish the zoning of the reserve and the rules of use of the area and rational and sustainable use of natural resources. The management plan should be prepared by the managing body of the Unit and approved by the deliberative councils in the case of extractive reserves or validated by the advisory councils in the case of other Conservation Units (IMAZON, 2011).

The management plan should be composed of objective and specific lines of action, so as to enable the evaluation and continuous improvement of management. To achieve these objectives efficiently and effectively, all management plans must consider an ecosystem approach, enable social participation and must be continuous and adaptive (SEMA, 2009). It is important to have strategies that consider: the public budget, since the hiring of the base team and the fiscalization and control actions are functions of the Union, the State or the Municipality; environmental compensation, as provided for in Law 9,985 / 2000 (SNUC), and concessions in public forests , since according to Law 11.284 / 2006 there should be an onerous concession of the exploitation of services and forest resources in Sustainable Use Conservation Units.

Law 12.651, of May 25, 2012, governs the protection of native vegetation, reduced the size of forest reserves, riparian forests and environmental advances that have been fought and conquered over decades, and foresees the management plan for native forests: to explore native forests within Legal Reserves, the owner must approve a Sustainable Forest Management Plan.

Sustainable forest management has the following technical and scientific bases: detailed characterization of the physical and biological resources; it must determine the existing stock; specify the intensity

of exploitation compatible with the forest's environmental support capacity; clarify the cut cycle compatible with the time of restoration of the volume of product extracted from the forest; determine the natural regeneration time of the forest; to adopt adequate silvicultural and operational systems; monitor the development of the remaining forest; and to adopt mitigating measures of environmental and social impacts (BRAZIL, 2012).

With forest management, it is possible to use the forest products, timber and non-timber, maintaining its structure and its ecological functions.

## III. METHODOLOGY

This research is qualified as applied, since it has the immediate purpose of identifying the restrictions that the population that inhabits the Extractive Reserves of the State of Rondônia is facing in the ecological / environmental and economic context in relation to the guidelines of the SNUC. And it also generates as a product the view that the extractivists have on migration, management plan and process of occupation of the extractive reserves.

According to Vianna (2013) descriptive research is a type of research describing the characteristics of a particular population or phenomenon, establishing relationships between variables and involves the use of standard techniques of data collection: questionnaire and systematic observation. Taking this into consideration, this is a descriptive research, as it records and describes the facts that were observed without interfering in them. For the study, a semi-structured questionnaire, interviews and on-site observation of the population characteristics were used.

This research also qualifies as a qualitative approach, since according to André (1995) "they consist of detailed descriptions of situations with the objective of understanding individuals in their own terms" and has the natural environment as its direct source of data and the researcher as its main instrument. And in relation to procedures, it qualifies as ethnographic, since the main focus of interest of ethnographers is the description of culture (practices, habits, beliefs, values, languages and meanings) of a social group. Therefore, this type of research is considered appropriate to the present study.

For the execution of the research, a survey of all the families residing within the Extractive Reserves of the State of Rondônia was carried out, followed by the application of a semi-structured questionnaire to all heads of families and interviews. With the answers, the data were stratified and transformed into two tables to be demonstrated in the next topic.

## IV. ANALYSIS AND DISCUSSION OF RESULTS

During the process of applying a questionnaire and conducting the interview with the heads of families residing in the extractive reserves, it was recorded that the Rio Cautário and Pacaás Novos Extractive Reserves have as their main characteristic the internal migration. In the reserve of Machadinho do Oeste, the external migration is highlighted, mainly from other reserves and neighboring municipalities. Probably this pattern is due to the search for the maintenance of the cultural characteristics of these peoples, besides the improvement of the conditions of life.

Forest management, as it has been adopted in the reserves in Rondônia, is far from being an alternative for both the Reserves and the resident population, as they remain hostage to companies that promise to finance and execute the plans. The government's own organs are dependent on the companies, because they can not execute without their participation.

In the view of the extractivists, the forest management programs (FMP) have gained prominence among the residents, as it is pointed out as an alternative income, since they receive a promise to buy their products from the companies that are carrying out the management. The extractive reserves that have FMP in execution are: Aquariquara, Maracatiara, Rio Preto Jacundá, Massaranduba, Rio Cautário, Sucupira, Castanheira, Angelim, Itaúba e Piquiá.

The great majority of the extractivists interviewed have a good view of the management plan and affirms that it facilitates life within the reserve, as it ends up bringing improvements to the occupants. Others have stated that the plan as well as being a viable alternative for preservation is also a solution to the other problems of extractive reserves.

When questioned about the occupation of Extractive Reserves, the great concern that the interviewees showed was related to the areas that are uninhabited, because their great desire is for other people to occupy the reserves to fight the illegal exploitation of wood and the practice of invasion. Fig. 2 - shows the opinion of the interviewees, divided by reserve, in relation to the occupation or not of the Reserves.

Fig. 2: Table of the interviewees in regard to occupation

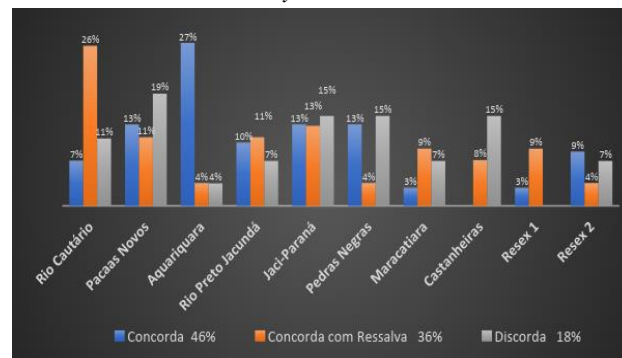
Reserves	Agree	Agree with reservations	Disagree
Reserve A	2	5	0
Reserve B	6	2	2
Aquariquara	18	2	1
Castanheiras	0	4	4
Jaci-Paraná	9	7	4
Maracatiara	2	5	2

Pacaas Novos	9	6	5
Pedras Negras	9	2	4
Rio Preto Jacundá	7	6	2
Rio Cautário	5	14	3
<b>Total</b>	<b>67</b>	<b>53</b>	<b>27</b>

Source: Elaborated by the authors, 2017.

It is observed that of the 147 (one hundred and forty seven) interviewed, 67 (sixty seven) agree with the total occupation of Extractive Reserves, 27 (twenty seven) disagree and 53 (fifty three) agree with reservations, that is, agree provided that the occupants are rubber tappers, that they obey the norms or they are "good people".

Graph 1 – Percentage of opinion regarding occupation by reserve



Source: Elaborated by the authors, 2017.

The graph shows that 46% (forty-six percent) of the extractivists agree that the reserves can be occupied, 36% (thirty-six percent) agree that they must be occupied, but with some reservations such as being rubber tappers, the requirement to obey the norms or even to be known persons or relatives of some who already lived. Finally, 18% disagreed with the occupation. In Aquariquara and Rio Cautário reserves, the greatest desire for occupation is present. As for Pacaás Novos, Jaci-Paraná, Pedra Negras and Castanheiras, there was greater resistance to occupation, as the interviewees showed that they did not agree with this practice.

Another relevant aspect observed in the interviews is the desire to make improvements in social, environmental and economic conditions within the Reserves, as well as issues related to health, education, energy and new income alternatives. Extractivists also struggle for the permanence of traditional practices requesting improvements and support, but demonstrate the interest in continuing in the reserve with a better quality of life.

An analysis was also made of the expectations and constraints that emerged on the organizational / institutional / guidelines (SNUC) perspectives,

considering the situations of how it should occur and how it occurs in the extractive reserves of the State of Rondônia, shown in fig. 03.

Fig.3: Expectations and restrictions in the extractive reserves - SNUC guidelines

Situation	Guideline 1	Guideline 2	Guideline 3
<b>Expectations</b>	<b>How it should be</b>	To seek support and cooperation from non-governmental organizations, private organizations and individuals for the development of scientific research, environmental education practices, monitoring, maintenance and other management activities of Conservation Units.	To seek to confer to the conservation units, in the possible cases and respected the conveniences of the administration, administrative and financial autonomy.
	<b>How it is</b>	The institution has timidly sought to partner with local social organizations.	Inclusion of two State Extractive Reserves to the HARPA Program.
<b>Restrictions</b>	<b>Agent's view</b>	Delay in legal procedures.	Increase the number of Extractive Reserves in the Program.

<b>How it is</b>	There is a lack of dynamism in bureaucratic processes.	There is a lack of dynamism in bureaucratic processes.	There is a lack of dynamism in bureaucratic processes.
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Source: Elaborated by the authors, 2017.

The same comparison occurred for the ecological / environmental perspective, considering the situations of how it should occur and how it occurs in the Resex of the State of Rondônia, shown in fig. 04.

Fig.4: Expectations and restrictions in extractive reserves - Ecological and environmental perspective

<b>Expectations</b>	<b>How it should be</b>	To seek to protect large areas by means of an integrated set of conservation units of different categories, near or contiguous, and their respective buffer zones and ecological corridors, integrating the different activities of nature preservation, sustainable use of natural resources and restoration and recovery ecosystems.
	<b>How it is</b>	Creation of the Southern Mosaic with conservation units of the states of Rondônia, Mato Grosso and Amazonas in order to hinder deforestation.
<b>Restrictions</b>	<b>Agent's view</b>	Delay in legal procedures.
	<b>How it is</b>	There is a lack of dynamism in bureaucratic processes.

Source: Elaborated by the authors, 2017.

For the economic perspective, it was carried out a comparison of expectations and restrictions of the situations of how it should occur and as it occurs in the reserves of the State of Rondônia, shown in fig. 05.

Fig.5: Expectations and restrictions in the extractive reserves - Economic perspective

<b>Expectations</b>	<b>How it should be</b>	To consider the conditions and needs of local populations in the development and adaptation of methods	To guarantee to the traditional populations whose subsistence depends on the use of the natural resources existing inside the units of alternative means of subsistence or the right indemnity
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		and techniques for the sustainable use of natural resources.	for the resources lost.
	<b>How it is</b>	The realization of Socioeconomic Diagnosis, aiming to have an overview of the extractive reserve.	Elaboration of Public Policies focused on the permanence and quality of life of these populations.
<b>Restrictions</b>	<b>Agent's view</b>	Delay in legal procedures.	Delay in legal procedures.
	<b>How it is</b>	There is a lack of dynamism in bureaucratic processes	There is a lack of dynamism in bureaucratic processes

Source: Elaborated by the authors, 2017.

## V. Final Considerations

By analyzing in a general way all the aspects covered and based on the information collected during the research, it can be inferred that the legislation is in perfect condition to meet the needs of extractive reserves. However, the greatest need is of an effective follow-up by government agencies on how the implementation of extractivism is being carried out within the preservation areas, since as an explanation one must meet the limits established for a change in the current abandonment scenario that the vast majority of them are submitted.

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# Student's attention: The use of Brain Waves Sensors in Interactive Videos

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**Abstract**— This article describes the use of brain wave sensors to investigate attention to the use of interactive videos. Attention is a psychological and neurophysiological phenomenon. With the use of electroencephalogram tools, it is possible to map this attention through brain waves. This study has found the status of attention to the use of tasks proposed to it. No study the student performed the two activities suggested to him. The results indicate that attention status is essential for learning effectiveness.

**Keywords**— **Keywords: attention, learning, brainwaves**

## I. INTRODUCTION

It is well known that attention and concentration are required skills for good learning. In fact, attention has been subject of study for a long time. The first studies of attention are from the nineteenth century. There is evidence in the literature demonstrating the close relationship between attention and learning. [10], states that “if there is no attention, there is no memory”. And if there is no memory, there is no learning.

Due to the importance of attention and concentration in learning effectiveness, the aim of this study is to map attention status using brain waves sensors, using different teaching and learning technologies.

The education system suffers from a lack of resources and understanding, which undermines teachers' ability to mentor students with learning disabilities or simply does not learn well from conventional methods. Some classes have already been done in the EEG readings, although the students are somehow focused on English class. In addition, EEG-enabled educational games are characterized as being of great intensity and assisting students to get discarded in a training of their brains to concentrate better. The technologies for the application of

neuro education already exist, however, a little more to acquire, what already exists is that of a software of programming for applications that already has been developing in a very great rate of programming. As the developments are being developed with applications for measuring brain waves, the process as a whole is more promising. Teachers can retell more often for mobile and portable applications for student follow-up (NeuroSky, 2019).

## II. TECHNOLOGIES

### A. NeuroSky;

NeuroSky is a portable EEG brainwave sensor used to detect electrical activity in the brain. Studies published in the literature regarding brain waves detection, recording and interpretation began in the late nineteenth century,[2], with the discovery and exploration of electrical patterns in mammalian brains. From this point on, the technology has evolved allowing its application in a wide range of situations such as in the detection of neurological disorders and games controlled entirely by the mind. Figure 1 illustrates the headset.



Fig. 1: Headset Neurosky

**B. Effective Learner**

Effective Learner app has a simple and intuitive interface. The app uses NeuroSky sensor to detect the student learning effectiveness. The app informs the students, in real time, their effectiveness through color charts during the execution of a task. Reports are recorded for learning effectiveness data analysis. Figure 2 illustrates the effective learner.



Fig. 2: Affection data

**C. Videos used in the study**

Educational and interactive content was created using H5P as a complement to traditional teaching. The content was developed to address the student's ability to require short- and long-term memories with predefined stimuli and their neural behavior. Data analysis identifies how brain understands this type of technology in relation to the traditional ones, in order to recognize the most effective teaching and learning tool. Figure 3 and figure 4 illustrates the framework H5P.

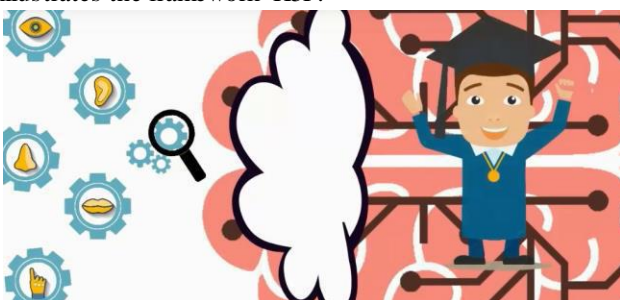


Fig. 3: Video on H5P



Fig. 4: Framework H5P (H5P.org)

**III. DATA COLLECTION**

This paper shows the most significant data found in the survey, which was based on the information collected by 7 individuals. The volunteers were submitted to two different tasks: (1) a 3-minute duration reading, available at Moodle Platform; (2) a 3-minute interactive video, with the same content shown at activity 1. Data were obtained in extra-class hours at a Federal Teaching Institution, with undergraduate students, using the Blind Review technique.

**A. Data analysis**

The results were obtained based on two different scenarios: (1) a reading at Moodle Platform; (2) watching a video. In both situations, students used NeuroSky in order to detect brain waves and evaluate attention status/level.

Effective Learner app provides, as a final result of attention, the sum of the percentages in the highest levels of attention, that is, the sum of the percentages referring to blue, dark green and light green colors.

It can be observed that 34.7% of students were not effective, 21.5% were intermediate and 16.7% were effective.

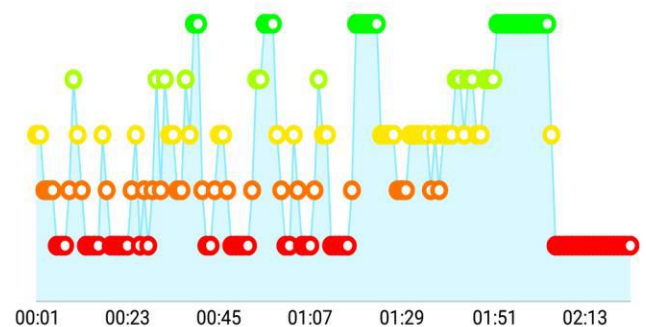


Fig. 5: Attention status during the reading session at Moodle Platform

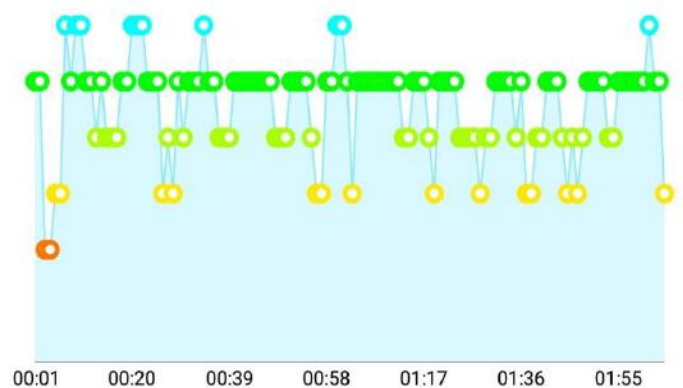


Fig.6: Attention status during the video session

It is clearly demonstrated, in Figures 5 and 6, that the attention density is higher in Figure 6 when compared to Figure 5.

As can be observed in Figure 6, the students had higher levels of attention density during video exposure. However, it is important to point out that this higher density observed during video exposure could be due to distracting elements. Oscillation and confusion can be observed during the first minutes of the video, in which the student is still imagining what is happening, trying to find the theory that fits the content. Such oscillations involve the possible resumption of thinking and the organization of new ideas for response stimuli, as well as the re-reading of each alternative. According to Ausubel's theory, there are signs of representational and conceptual Significant Learning, because the student is able to think the phenomenon and assign meanings to them, [1].



Fig.7: Attention status during the video session

#### IV. CONSIDERATIONS

The aim of this study is to map attention status using brain waves sensors, using different teaching and learning technologies. Our results demonstrate that interactive activities develop students' higher attention in the learning process than traditional activities.

The relationship between the studied concepts brings the existence of subsumers and the evolution to occur the fuller attention. In addition, teachers' use of mobile devices in order to have real-time feedback corroborates for effectiveness in teaching.

At the same time that the student is assimilating the content in an attentional or non-attentional situation, the teacher can verify this stimulus in real time, changing its practice, while the class is still happening. Finally, we conclude that the use of interactive video with the mapping of brain activity are important tools to assist teachers during the teaching process. Further research is required to advance studies with the use of ocular tracking during video viewing and reading with students. To propose visual narratives to detect stimuli during the process in a traditional classroom and classes with the use of technologies.

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# Development of a Sound Simulator for inclusive Learning: The use of a Prototype in Teaching

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**Abstract**— *The demand for practical experiments in the disciplines of Veterinary Medicine is paramount for training of future veterinary doctors. In practical classes in veterinary clinics, teachers uses electronic animal prototypes to simulate care and train real-life skills, reducing the use of live animals in class. Our simulator makes it possible for people with disabilities to have tactile and sonorous access to animals, either for educational purposes in higher education or contact with animals that are difficult to access. The project aims to improve the Animal Sound Simulator (SAVEDOG) and develop a single control center application for preparing theoretical-practical classes of Veterinary Clinic. Vygotsky's socio-historical theory is used as basis for developing a methodology for developing the higher psychological functions in students with visual impairment.*

**Keywords**-*Assistive Technology, Educational Robotics, Veterinary Education*

## I. INTRODUCTION

The number of Brazilians with some type of visual impairment, congenital or acquired, is approximately 16 million [7] and the insertion of this population in formal education through assistive technologies is mandatory by law on the Education Guidelines and Bases Law (Law No. 9.394 / 96) and Resolution 02 of the National Council of Education [3].

The Technical Assistance Committee (Administrative Rule 142 of November 16, 2006) defines this area as interdisciplinary because it encompasses strategies, methodologies, resources, practices, products and services to promote the participation of disabled persons with disabilities or reduced mobility, aiming at greater

autonomy, independence, quality of life and social inclusion. In general, instrumental mediation processes can also: favor, compensate and enhance abilities or functions compromised by visual, auditory, motor or communication deficiency [2].

The common sense about visual impairment cognitively incapacitating the subject is rejected by Vygotsky [11], by admitting a reorganization of the forces of the organism and personality under the action of higher psychological functions, through the voluntary articulation of knowledge. The visual impairment uses the auditory, olfactory, tactile and kinesthetic senses to develop individual processes of coding and creating mental images. This leads to understanding, interpreting and apprehending according to the plurality of experiences, the efficiency of the instructional material, and the way in which subject-object interaction is stimulated.

Blindness, therefore, is not characterized as an obstacle to development, but it reorganizes it sensorially in relation to the construction and structuring of knowledge. Visual information is acquired by other means, matching the learning capacity with that of the seer. If seers define an object through visualization, the blind articulate the higher psychological functions by relating already appropriate elements to others they wish to understand. Such functions correspond to thought, memory and concentration, with possible ramifications of logical conceptual thinking and imagination, mediated and visual memory (in the blind acquired), voluntary attention and concentration [1].

The common aspects between objects or phenomena are identified and generalized so that they can be mentally represented and participate in the construction of concepts. Thus, through language, the capacity for

abstraction meets with conceptualization via the elaboration of complex mental activities. Then, the visual impairment articulates information from touch and hearing to mentally represent images of objects or signs. The symbolic contents replace the objects or phenomena, enabling the elaboration of a mental vision of the empirical world. By understanding conceptualization as a voluntary process of abstraction in relation to concrete situations and the objects contained within it, language provides the possibility of expressing the concepts arising from the connections between higher psychological functions [9].

The learning of certain contents by people with visual impairment requires specific mediations and differentiated resources capable of helping to overcome any difficulties that may arise during the subject-object interaction. To that end, the development and application of assistive strategies related to the unaffected senses are expected, creating challenges that stimulate, among other capacities, voluntary attention and logical reasoning [12]. In this sense, this work aims to present the development of a robotic device, through which the subject with some visual impairment can enhance their emerging psychological functions, and improving their process of knowledge construction in classes of the discipline of Veterinary Clinic on the following cognitive abilities: perception, attention, memory and problem solving.

**II. LEARNING MEASURED BY ANIMAL SOUND SIMULATOR**

In the area of Veterinary Medicine it is common the use of living beings for chemical tests, practice of surgical techniques or proof of theories. While this may qualify for undergraduate training, it raises sensitive issues both in the field of ethics and to the safety of students and animals. In this scenario, the use of an electronic simulator, replacing the living animal, is a good complementary tool in teaching practice. Educational activities with a simulator can facilitate the safe and continuous development of skills needed to detect abnormalities, reducing diagnostic error and avoiding trauma to the patients. Therefore, clinical practice through teaching tool that simulate real behavior can really improve learning, by allowing systematic repetition and facilitates corrections of failures in the anamnesis [5].



Fig.1: SAVEDOG with educational audio simulator.

Source: The Author

In the learning context, the use of the SAVEDOG simulator is in accordance with Vygotsky's theory because it constitutes a triad formed by the subject of learning, the object of knowledge and the mediating element (colleague or teacher or cultural artifacts). As in the clinical examination, the students must assess the heart rate and breathing sounds to make a diagnosis consistent with the knowledge acquired in the classroom [6], the process of dealing with the use of material instruments and audio signs promotes the improvement of the higher psychological functions as: reflection, abstraction, invention, creation, imagination, designing and operating symbols of signs and therefore being linked to both the concept of internalized action and the zone of proximal development - ZPD [13].

The main idea here is to construct a learning space for the visually impaired subject, considering the modes of action on the object of knowledge through the interaction of the electronic animal sound simulator and the teacher. This is an experimental approach, where the qualitative aspects of the phenomena of acquiring knowledge preponderate over the quantitative, contributing to increase both the capacity for observation and phenomenological description, in the conceptual construction on the subject.

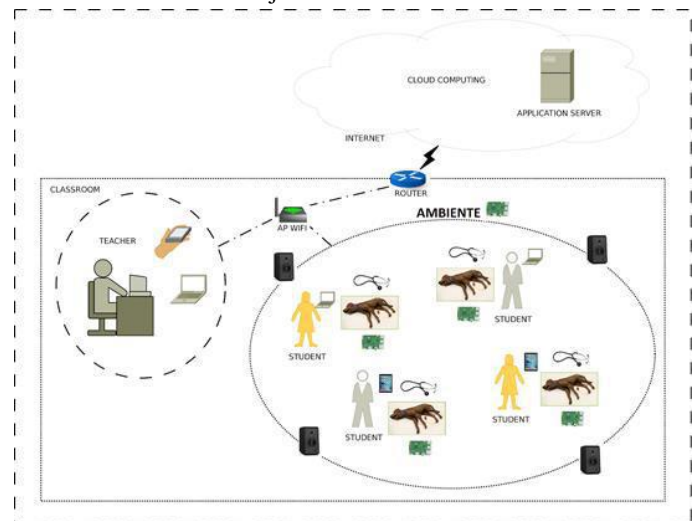


Fig. 2: Conceptual map of the learning environment.

Source: The Author

In this sense, the main task on teaching can be considered as ways to producing meanings, as a process that underlies the connection between the world and the subject, learning concepts related to symptoms of clinical diseases that affect the respiratory and cardiovascular systems of domestic animals. Thus, we hope to collaborate in an environment in which learning can be conceived as a process of appropriation of cultural elements that result in the reproduction of historically formed human properties, capacities and modes of behavior [14].

In the class, teachers use an electronic device capable of emitting various sounds related to the state of health of a dog, but limited to a single sound emitted by several audio outputs at a time. The configuration of the sound to be emitted is determined by the teacher through a cable connected to the puppet, allowing to programs some situations in a supervised scenario.

Thus, the developed electronic system performs the independent configuration of audios in each animal simulator, in which each device contemplates an animal or environment and its quantity is determined by the number of IP (network address) available in the local network of the institution, being able to obtain 100 devices without difficulties.

According to Cedro [4], to produce meaning and considering the dynamic interactions between the subjects, it will be necessary to have the following characteristics:

- Performing by the subject, as protagonist;
- Involve in a problem situation;
- Enable searching for a solution;
- Allow the development of knowledge through analysis and synthesis;
- Allow the creation of a mode of action;

In this way, will follow the following procedures:

- Inform the objectives of the experiment and how it will be carried out;
- Establish a narrative that can contribute to the motivation and the active participation of the students in the proposed activity;
- Map student's main concepts and ideas on the subject to be worked on;
- Submit a script written in Braille, so that students can work on the skills related to this language, reading the proposed questions and responding verbally, as the experiment will be recorded in audio and video;
- Perform the anamnesis procedures proposed in the script, verbally registering the description of the phenomena addressed and how the proposed problem was solved;

The technique for data collection will be participative observation, where the researcher establishes a dialogue with the subject, seeking to intermediate the relation with [www.ijaers.com](http://www.ijaers.com)

the object of knowledge. The activity will be recorded in video and audio for later analysis of the subject's speeches, where they will be searched for elements able to indicate the presence of the higher psychological functions as [4]:

- Be performed by the subject as Protagonist;
- Criticism: such as the possibility of the subject to question, contradict and debate;
- The discovery: as the possibility of the subject to experiment, model, symbolize generalize;
- Social practice: emphasized by social relevance and applicability of knowledge to the community;

### III. TECHNOLOGY DEVELOPED

The project goal is developing a universal platform for remote audio playback, in which, each device can play at least 04 different audios in their outputs. The control panel is able to individually control each device individually, with the possibility of updating sounds. The core was developed in Windows platform using the Visual Studio development tool in C# language. The tool makes it possible to select the audios in each of the outputs in the different devices found in the network.

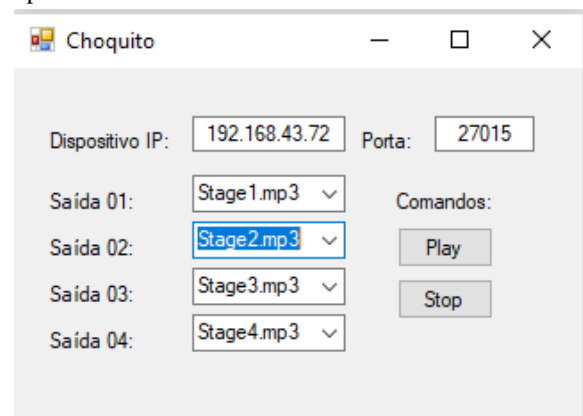


Fig. 3: Sending audio to a respective device in the network called choquito (Educational Frog). Source: The Author

In order to select the chosen device, its respective IP address is required in the local network, to which the program will send the sounds to be executed in the outputs predetermined by the user. The hardware was designed using the Arduino Uno board (fig. 4), an audio module and a wifi module, both independent. During development a prototype functional protoboard was created.

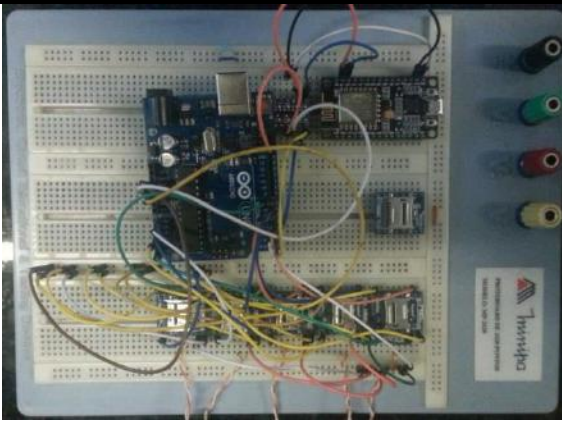


Fig. 4: Preliminary functionality test. Source: The Author

After this first prototype, the circuit was modeled on blueprint for board circuit factoring, followed by mounting all electronic components on the board (fig. 6)

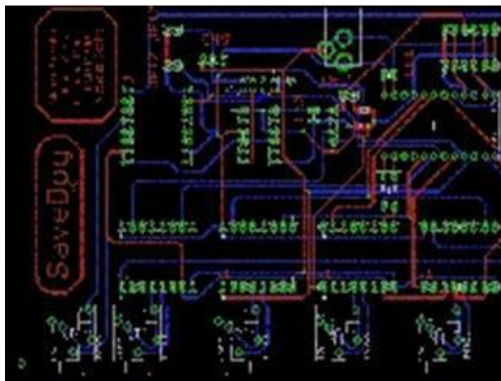


Fig. 5: Circuit modeling. Source: The Author

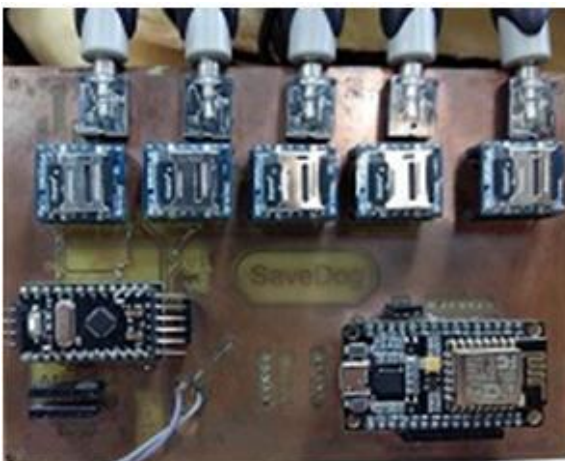


Fig. 6: Test of the developed circuit. Source: The Author

The platform used was RaspBerry Pi3 (fig. 7), Plug and Play audio modules with the Linux operating system Ubuntu MATE IoT embedded.



Fig.7: Design of the second version of the audio system:  
The Author

In this sense, we installed the operating system and 04 USB audio modules. In the operating system was developed the module of data reception by network (cable or wireless), with several other devices connected, but properly identified by a unique IP number. Designed in Python language, the system obtains instructions from a central in the local network receiving, through network message, the addressed IP, the audio name and the numbering of the respective port to be reproduced. From this information it is checked whether the message is for a defined IP and, if so, executes the command in Linux Shell for the requested audio playback.

#### IV. RESULTS AND DISCUSSION

From the perspective of cognitive development based on the socio-historical relationship of the subject with the object of knowledge, this project was in line with Passerino's approach [8], regarding technology's action in the dimensions of knowledge, reasoning and culture. The purpose is to intermedate the relevant information in the field of Veterinary Clinic, stimulating visually impaired students to understand scientific phenomena, and preparing them for testing hypotheses in order to re-elaborate beliefs, towards of developing negotiation attitudes in a technologically interaction practices. The Vygotsky's theory of learning has guided the elaboration of all didactic-pedagogical strategies, where SAVEDOG has successfully performed the main role as a tool for implementing these strategies.

The opportunity to perform simulations in real evaluation conditions, from audios previously extracted from animals with diagnosed diseases, effectively improve the learning of visually impaired students. The results achieved by SAVEDOG educational toolfills the requirements of reliability and complexity for the desired pedagogical model, since that electronic animal prototype offers a level of complexity appropriate to the student's degree of experience, as well as to value the principles of ethics and well-being of students and animals.

This teaching environment can also contribute to the immediate comparison between veterinary diagnostic experiments, enhancing the construction of scientific

knowledge by students. In addition to enabling by programming, the reconstruction of new scenarios for the application of several other simulations of veterinary environments without the need of physical displacement of students and teachers.

Among the results achieved are:

- Development of a methodology for use of assistive technology in the construction of veterinary diagnostic knowledge for students with visual impairment;
- Improvement use realistic simulators, like SAVEDOG, as a learning tool in the discipline of Veterinary Clinic;
- Reduction of the cost of acquiring and maintaining equipment for animal sound simulation;
- Possibility of creating a multidisciplinary room for the simulation of difficult access environments.

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# IT Service Management: Analysis and Proposition of the ITIL Model in a Brazilian Federal University

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**Abstract**— *Service management is critical to balancing the relationship between institutional resources and management processes, improving IT value and promoting strategic alignment between top management and the responsible department. This paper focuses on analysing the aspects of IT Service Management at a Federal University, aiming to present its theoretical conception and the practical aspects involved in IT Governance. The methodology used consisted of the application of maturity models capable of determining how well the University knows and applies the practical aspects of the ITIL library. During the research it was possible to observe a low level of maturity and the lack of adherence to the governance standards, where some aspects showed an urgent need for intervention to improve the institutional conditions. Finally, with institutional maturity and knowledge of the current service management process, it was possible to present an intervention proposal that sought to optimize the relationship between the IT workforce and the responsible department in the University. This adequacy sought to enhance the technical staff, while promoting improvements in resource management and providing user-oriented and aligned IT management principles in the ITIL library.*

**Keywords**— *IT Service Management, Institutional Maturity, ITIL Library, Customer Service Process.*

## I. INTRODUCTION

In recent years, Technological Innovation and advances in Information Technology (IT) have impacted the way social, economic and cultural relations take place. Businesses and governments have realized the advantages that this area provides to the organizational environment and have invested in improving and evolving their participation in the business environment. As IT has a multifaceted approach, involving different foci of actuation, several challenges arise regarding its planning and control, encouraging organizations to invest more and

more in the adoption of governance practices, seeking in Corporate Governance a flow of actions to direct and to control IT (FERNANDES; ABREU, 2014; MAGALHÃES; PINHEIRO, 2007).

In this context, IT has taken on a role that for a long time has remained beyond its competence. In many organizations, it has always been seen as an operational area with no strategic importance and represents a low return investment when compared to other areas. In contrast to this reality, the current scenario shows a strong participation in the strategic context, having a prominent role in the planning, measurement and institutional alignment (FERNANDES; ABREU, 2014; WEILL; ROSS, 2004).

As IT is a relatively new area and made up of a series of interconnected agents, it becomes a tool that requires control and planning. In this sense, organizations have applied strategies previously defined for Corporate Governance, thus achieving the so-called IT Governance. IT Governance seeks alignment with organizational objectives, supporting the strategic planning of the organization, always seeking to deliver value to its users. One of IT Governance line of action is Service Management. A good example is the ITIL framework, which has focus and specifications directly related to management. ITIL defines a series of good practices aimed at planning IT resources in order to enable better management (FERNANDES; ABREU, 2014; MAGALHÃES; PINHEIRO, 2007).

The Federal University of Grande Dourados (UFGD) is a public institution focused on higher education. In order to carry out its activities, UFGD uses a set of IT tools and resources, some of them being arranged in its Plan of Institutional Development (UFGD, 2013). In this sense, the objective of this study is to explore the institutional characteristics of the UFGD, seeking to point out possibilities for improvements capable of improving the current condition of IT service management.

In order to do this, the existing definitions in the ITIL library were used in the current context of the institution, allowing a comparison between the best practices defined by the model and the current condition of the UFGD's IT service management.

Finally, the institutional maturity in relation to the ITIL library is presented, as well as proposals for improvement for each of the analyzed aspects. Alongside this, an improved model is showed, based on institutional conditions.

## II. THEORETICAL FOUNDATION

### 2.1 ITIL Model

The ITIL Model supports the view that organizations are increasingly dependent on IT to achieve their organizational goals. The IT services need to be reliable and of high quality, this requires a good level of management so that availability and reliability are guaranteed (COUGO, 2013; MAGALHÃES; PINHEIRO, 2007).

In this sense, IT Service Management becomes a structure of policies, processes and functions that aim to meet the objectives of the organization by offering and supporting information technology services. ITIL was created to systematically and cohesively disseminate proven practices in IT management, and its approach is based on service quality and the development of effective and efficient processes (MAGALHÃES; PINHEIRO, 2007; WEILL; ROSS, 2004).

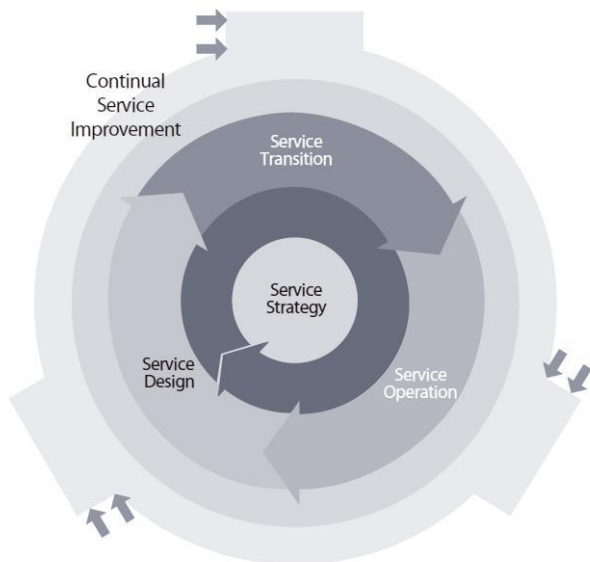


Fig.1: ITIL Model Lifecycle (Cannon, 2011 e Cestari, 2011)

Each of the processes defined in ITIL refers to an area of IT, some of them being: The development of a service, the infrastructure management, the offer and the support to services, among others. With a service-focused approach, ITIL can describe the best IT service

management practices independently of the organization's structure, which is reflected in standards of good practice rather than a rigid definition of processes (FREITAS, 2010; NIETO et al., 2012).

As can be seen in Fig 1, the model has five distinct phases, with Service Strategy as the core, Service Design, Service Transition and Service Operation as stages orbiting the core, supported by the Continuous Service Improvement, with each phase, having its specific objectives:

- **Service Strategy:** Helps transform Service Management into Assets to meet the organization's strategic objectives. It is at this stage that strategic decisions are made about the services that will be developed (CANNON, 2011).
- **Service Design:** Guiding the design of IT services to ensure quality and customer satisfaction and the cost / benefit ratio in the provision of services (HUNNEBECK, 2011).
- **Service Transition:** It serves to guide the development of resources for the implementation or modification of new services in the Service Operation, ensuring that the objectives defined by the Service Strategy and planned in the Service Design are being effectively carried out to control and minimize the risks of failures or service disruptions (RANCE, 2011);
- **Service Operation:** It seeks to guide how to achieve efficacy and efficiency in the delivery and support of the services, to guarantee the value expected by the client and the fulfillment of the strategic objectives of the organization (CANNON; WHEELDON, 2011);
- **Continuous Service Improvement:** Identify results and guide service improvement by joining efforts with Strategy, Design, Transition, and Service customers to create or maintain the value of services (LONG, 2012).

In this sense, the IT Services Operation is highlighted, which concentrates the activities of an IT team at an operational level. Many of the actions defined in this process are present in the institutions IT departments, but without structure or planning. Based on this assumption, it is sought to identify the level of institutional maturity of the UFGD based on the ITIL and PMF (Process Maturity Framework) models.

## III. MATURITY MODELS

They are responsible for describing the evolution of a given entity over time, can be an organization, process or an organizational function. In general, maturity models are based on people, organizations, functional areas, and processes that evolve towards a more mature direction,

traversing several stages (KLIMKO, 2001; VITORIANO; SOUZA, 2015).

By collecting data and analyzing results, it is possible to make improvement recommendations and action plans to reach higher levels of maturity. In the words of Klimko (2001), the advantage of maturity models lies in their simplicity, which facilitates understanding and communication.

There are several maturity models for different application types ranging from simpler to more sophisticated. In relation to IT Service Management, more specifically to ITIL, Pereira e Silva (2010) point to the PMF model as being the most suitable for calculating maturity.

3.1 Maturity levels

The PMF adopts five levels of maturity to qualify the state of the processes: Initial, Repetitive, Defined, Managed and Optimized. Hunnebeck (2011) classifies each of these according to Fig. 2 and Table 1:

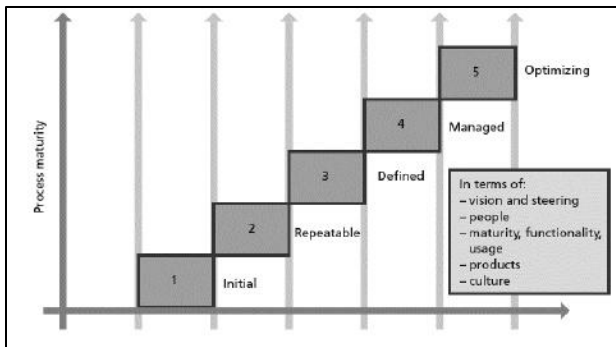


Fig. 2: Process Maturity Framework (Hunnebeck, 2011)

Table.1: Maturity Levels of ITIL v3 Processes and Functions

Level	Description
<b>Level 1 (Initial):</b>	The process is recognized, but there are few activities within its scope. Alongside this, there are no resource allocation or budget for the it.
<b>Level 2 (Repetitive):</b>	The process is recognized, but it does not arouse due interest within the organization. As a consequence, it receives few resources and the related activities do not have coordination, being carried out in an irregular way, without direction and with low effectiveness.
<b>Level 3 (Defined):</b>	The process is recognized and documented, but there is no formalization as to its acceptance and recognition within the organization. However, in this case, the process already has a person responsible, has goals and formalized, having allocated

	resources seeking efficiency and effectiveness. Reports are prepared on the activities carried out, allowing for future analysis.
<b>Level 4 (Managed):</b>	The process is completely recognized and accepted throughout IT, with a focus on service delivery. Goals are aligned with those of the organization. It is fully mapped, managed and proactive in nature, having its interfaces established and documented.
<b>Level 5 (Optimized):</b>	The process is fully recognized, having goals and objectives aligned with those of IT and business, being part of daily activities, and actions are performed for continuous improvement as part of the process.

Source: Adapted from Hunnebeck (2011)

III.1 PMF Dimensions

To perform the maturity level classification, the PMF model uses the levels discussed in the previous section along with some aspects that govern the processes. These, in the work of Hunnebeck (2011) e Silva (2012) are called the Dimensions. The great advantage in the use of dimensions is the possibility of systematically evaluating the categories that directly influence the quality of the executed processes. The dimensions used in the PMF model and their characteristics are presented in Table 2:

Table.2: Dimensions Process Maturity Framework

Dimension	Description
<b>Vision and Guidance</b>	They have a relationship with the objectives that the organization determines, being directly linked to the available budget and the setting of goals.
<b>Processes</b>	It is how the organization structures itself to achieve its goals. In this dimension, isolated or segmented actions are analyzed in well-defined processes.
<b>People</b>	It concerns the interaction between the professionals involved in the execution of the activities. Analyze whether there is integration or isolation between team members. These characteristics determine the levels of collaboration and sharing of information
<b>Technology</b>	It deals with the presence of an architecture capable of providing the integration between people and processes.



<b>Culture</b>	It synthesizes the set of ideas, values, beliefs, practices and expectations shared among the organization's employees.
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**Source: Adapted from Hunnebeck (2011)**

The level of process maturity is directly related to the maturity of the respective dimensions, that is, maturity is decomposed into five strands, encompassing a systemic view of what actually influences process quality. In addition, this segmentation provides a detailed view of the components that interfere in maturity, allowing managers to act in a timely manner in each dimension, establishing priorities of the way of acting, thus facilitating the strategy to increase maturity (LLOYD; RUDD, 2008; SILVA, 2012)

**IV. METHODOLOGY**

In order to carry out the survey of the institutional maturity of the UFGD, questionnaires were applied that involved two different approaches. Focusing on the search for maturity recognition, the direct people responsible for the IT activity at the institution were interviewed, as shown in **Table 3**. For this purpose, the PMF model was used as a semi-structured questionnaire (CRESWELL, 2010; VITORIANO; SOUZA, 2015).

*Table.3: IT Departments at UFGD*

Department	Occupation area
DAU	Responsible for managing support, monitoring, control and quality of IT activities
DDS	Responsible for the planning, development, maintenance and implementation of institutional systems
DGPTI	Responsible for the management, planning and maintenance of IT processes and hiring
DSSTI	Responsible for network infrastructure, datacenter and IT security equipment

**Source: (UFGD, 2016)**

In order to calculate the maturity of each dimension of the PMF model, as described previously, the mathematical model adopted is a simple arithmetic mean, described through **Equation (2)**, inspired by the work of Morgado e Carvalho (2015):

$$M_A A_1 = \frac{\sum_{j=1}^4 A_{1j}}{4} \quad (2)$$

Where,

$M_A A_1$ : Arithmetic mean of the scores obtained for the first question.

$A_{1j}$ : First question, where  $j = 1, 2, 3, 4$  each of the respondents.

*Dim*: Vision and Guidance Dimension.

$M_A A_i$ : Arithmetic mean of the questions about Vision and Guidance, where  $i = 1, 2, 3, 4 e 5$ .

In this way, to calculate the maturity of the ITIL Model processes, a weighted average is used between the maturity of each of the dimensions, defined by the previous model, and the weight defined for each one of them. A mathematical model, inspired by the work of Morgado e Carvalho (2015) and that exemplifies how the calculation is performed is described by **Equation (5)**.

$$MatProc = \frac{P_1 \left( \frac{\sum_{i=1}^5 M_A A_i}{5} \right) + P_2 \left( \frac{\sum_{i=1}^5 M_A B_i}{5} \right) + P_3 \left( \frac{\sum_{i=1}^5 M_A C_i}{5} \right) + P_4 \left( \frac{\sum_{i=1}^5 M_A D_i}{5} \right) + P_5 \left( \frac{\sum_{i=1}^5 M_A E_i}{5} \right)}{P_1 + P_2 + P_3 + P_4 + P_5} \quad (3)$$

Being  $P_1 = 2$  for Vision and Guidance dimension,  $P_2 = 3$  for Process dimension,  $P_3 = 2$  for People dimension,  $P_4 = 2$  for Technology dimension and  $P_5 = 1$  for Culture dimension, we have:

$$MatProc = \frac{2 \left( \frac{\sum_{i=1}^5 M_A A_i}{5} \right) + 3 \left( \frac{\sum_{i=1}^5 M_A B_i}{5} \right) + 2 \left( \frac{\sum_{i=1}^5 M_A C_i}{5} \right) + 2 \left( \frac{\sum_{i=1}^5 M_A D_i}{5} \right) + 1 \left( \frac{\sum_{i=1}^5 M_A E_i}{5} \right)}{2 + 3 + 2 + 2 + 1} \quad (4)$$

Where,

$$MatProc = \frac{2 \left( \frac{\sum_{i=1}^5 M_A A_i}{5} \right) + 3 \left( \frac{\sum_{i=1}^5 M_A B_i}{5} \right) + 2 \left( \frac{\sum_{i=1}^5 M_A C_i}{5} \right) + 2 \left( \frac{\sum_{i=1}^5 M_A D_i}{5} \right) + \left( \frac{\sum_{i=1}^5 M_A E_i}{5} \right)}{10} \quad MatProc:$$

Process maturity.

$M_A A_i$ : Arithmetic mean of the questions about Vision and Guidance, where  $i = 1, 2, 3, 4$  and 5.

$M_A B_i$ : Arithmetic mean of the questions about Process, where  $i = 1, 2, 3, 4$  and 5.

$M_A C_i$ : Arithmetic mean of the questions about People, where  $i = 1, 2, 3, 4$  and 5.

$M_A D_i$ : Arithmetic mean of the questions about Technology, where  $i = 1, 2, 3, 4$  and 5.

$M_A E_i$ : Arithmetic mean of questions about Culture, where  $i = 1, 2, 3, 4$  and 5.

**4.1 Maturity Levels**

When finalizing the calculations using the PMF model and the guidelines established in the previous sections, the result obtained will vary from 0 (zero) to 5 (five), according to the scores assigned by the selected respondents.

To classify the level of maturity of the organization analyzed, Silva (2012) makes a correlation between the scores obtained and the five levels of maturity of the PMF model. This correlation is made using the score obtained in the

maturity calculation using two decimal places, which identifies the level of maturity. Score variation and correlation with maturity level are available in **Table 4**.

Table.4: Process Level of Maturity

Score	Level
Less than or equal to 1,9	1 Initial
Greater than or equal to 2 and less than or equal to 2,9	2 Repetitive
Greater than or equal to 3 and less than or equal to 3,9	3 Defined
Greater than or equal to 4 and less than or equal to 4,9	4 Managed
Equal to 5	5 Optimized

Source: Adapted from Silva (2012)

V. RESULTS AND DISCUSSIONS

The maturity survey was carried out according to the theoretical framework, using the evaluation method defined by the PMF model. For the context of UFGD, the functions set out in the IT Service Operation process analyzed were Service Center, Technical Management, Operations Management and Application Management.

5.1 Service Desk

In the case of the UFGD Service Desk, Table 5 summarizes the maturity for each of the Dimensions analyzed and their classification in relation to the PMF model.

Table.5: Maturity of the Dimensions of the Service Center UFGD

Dimension	Maturity	Classification
Vision and Guidance	1,10	Initial
Processes	0,60	Initial
People	1,20	Initial
Technology	1,35	Initial
Culture	0,95	Initial

Fonte: Dados da Pesquisa

The result obtained, when compared to the maturity levels shown in **Table 4**, reveals a deficit condition, classifying the UFGD Service Center dimensions as Initial, since none of the grades obtained was greater than 1.9. In **Graph 1** the maturity of each one of the analyzed dimensions is arranged.

Graph1: Service Desk Maturity



Source: Research Data

With the results it is possible to obtain institutional maturity over the analyzed function as a whole. In this case, the collected data go through the calculation described in the methodological procedures through **Equation (5)**, being:

$$MatProc = \frac{2.(1,1) + 3.(0,6) + 2.(1,2) + 2.(1,35) + (0,95)}{10} \tag{6}$$

$$MatProc = 1,00 \tag{7}$$

As indicated by the maturity of the Service Center Function, the UFGD needs to make greater efforts in the planning and execution of the activities. It is necessary to define processes and improve the allocation of resources, be they financial or human. **Table 6** presents the diagnosis of Maturity for the UFGD Service Center Function.

Table.6: UFGD Service Desk Maturity

Maturity	Maturity Assessment
1,00	Level 1 - Initial
	The process is recognized, but there are few activities within its scope. Alongside this, there are no allocation of resources or budget for the same

Source: Research Data

Together with the understanding of the maturity of the Service Center, the research gives subsidies to point out the causes that lead to the score obtained in the analyzed dimensions. **Table 7** summarizes those that most impact on the result obtained.

Table.7: Causes for UFGD Service Center Maturity

Dimension	Causa
Vision and Guidance	<ul style="list-style-type: none"> <li>➤ Lack of planning under the IT capabilities of the Service Desk</li> <li>➤ There is no service level agreement to the support</li> </ul>

	execution
Processes	<ul style="list-style-type: none"> <li>➤ The existing process is not formally established, documented and modeled on BPMB</li> <li>➤ The process does not have a standards manual</li> </ul>
People	<ul style="list-style-type: none"> <li>➤ The number of servers is insufficient</li> <li>➤ The staff were not trained for the work they perform</li> </ul>
Technology	<ul style="list-style-type: none"> <li>➤ The tools that make up the process do not have integration</li> <li>➤ The management reports are not generated automatically</li> </ul>
Culture	<ul style="list-style-type: none"> <li>➤ There is no communication channel for the staff to collaborate in the process</li> <li>➤ The process does not have the proper publicity</li> </ul>

**Source: Research Data**

Following the survey of the causes that influence the institutional maturity of the Service Center, it is possible to point out some opportunities for improvement, such as:

- Perform the analysis and modeling of the work process of the UFGD Service Desk, formalizing the process established and publicizing it
- Establish a communication plan capable of properly integrating the staff involved in the Service Desk.
- Identify the IT workforce available at the UFGD.
- Establish a manager, able to control and monitor the process by aligning its execution to institutional goals.
- Train the IT workforce for the integrated execution of the activities of this Role.

Having pointed out the failure of the structure of points representing the Service Desk and presented some suggestions for improvement, it is up to the UFGD Corporate Governance, with the IT department to establish an action plan aiming at mitigating the identified flaws.

**5.1 Technical Management**

The Technical Management focuses planning activities and study of institutional needs, being able to organize the best arrangement between the possibilities that this infrastructure can offer and the institutional demand. In general, this ITIL Model Function serves to coordinate the allocation of resources, being able to provide subsidies that justify the acquisition of IT infrastructure, Software or increasing the workforce in the organization.

**Table.8:** summarizes the calculation of the grades obtained for this function from the ITIL model.

*Table.8: Maturity of UFGD Technical Management Dimensions*

Dimension	Maturity	Classification
Visão e Orientação	1,10	Initial
Processos	0,65	Initial
Pessoas	1,25	Initial
Tecnologia	0,80	Initial
Cultura	1,35	Initial

**Fonte: Dados da Pesquisa**

Based on the parameter defined in **Table 4**, the maturity reached in this case is classified as Initial. This reflects a reality where there is a lack of planning and integration between the IT department and UFGD Corporate Governance. In **Graph 2** shows the maturity of each one of the analyzed dimensions.

*Graph 2: Technical Management Maturity*



**Source: Research Data**

The scores obtained in the dimensions of the Technical Management provided information on the institutional maturity analyzed as a whole. In this case, as happened with the Service Center, the collected data goes through the processing described in **Equation (5)**. In a simplified approach, the calculation is demonstrated by:

$$\text{MatProc} = \frac{2.(1,1) + 3.(0,65) + 2.(1,25) + 2.(0,8) + 1.(1,35)}{10} \tag{8}$$

$$\text{MatProc} = 0,51 \tag{9}$$

As indicated by the maturity of the Technical Management Function, the UFGD must carry out the planning for execution of the activities of this function. **Table 9** consolidates the diagnosis of the UFGD Technical Management.

Table.9: Technical Management Maturity

Maturity	Maturity Assessment
0,51	Level 1 - Initial
	The process is recognized, but there are few activities within its scope. Alongside this, there are no allocation of resources or budget for the same

**Source: Research Data**

As in the Service Center, the research provides information capable of pointing out the factors that most influence the maturity obtained. **Table 10** summarizes what most impacts on the result obtained.

Table.10: Causes for UFGD Technical Management Maturity

Dimension	Cause
Vision and Guidance	➤ There is no planning for staff training
	➤ There is no scope for the knowledge needed for the IT staff to perform
	➤ IT scope are not known
Processes	➤ The process is not modeled or formally established
	➤ The process does not have a standards manual
People	➤ Roles and responsibilities are not defined
	➤ There is no communication flow nor is a responsible person defined
	➤ The number of workforce is insufficient
	➤ The servers are untrained or do not know the role
Technology	➤ The tools that make up the process do not have integration
	➤ The management reports are not generated automatically
Culture	➤ There is no communication channel for the staff to collaborate in the process
	➤ The process does not have the proper publicity

**Source: Research Data**

When conducting the survey for causes that influence the maturity on the Technical Management, based on the good practices of the ITIL model it is possible to point out some opportunities for improvement:

- Modeling of UFGD Technical Management, including the IT workforce and the study of assets available within a unified process, giving publicity to it.

- Establish a communication plan capable of properly integrating all the people involved in IT activities and encourage them to take part in the department decision-making.

- Identify the IT workforce available in the UFGD and integrate them into the defined process.

As in the Service Center, the article presents the main flaws of the Technical Management of the UFGD and presents some suggestions for improvement, it is up to the UFGD Corporate Governance, together with the IT department, to establish an action plan capable of seeking to eliminate the flaws pointed out.

V.1 Operation Management

Operations Management is responsible for the treatment of actions that require low level of planning with simple project preparation and with little or no financial allocation. These activities are mainly planned on a daily basis and have high capacity for automation.

When considering the conditions of UFGD, it can be observed again a low performance for this function. The mean of the analyzed dimensions was below 1.9, which presents the institution again with Initial maturity level compared to the parameters defined by the evaluation model set forth in **Table 4**. In **Graph 3** the maturity of each of the dimensions analyzed.

**Table 11** summarizes the institutional maturity for the Operations Management function.

Table.11: Maturity of UFGD Operation Management Dimensions

Dimension	Maturity
Vision and Guidance	1,35
Processes	0,20
People	1,25
Technology	0,50
Culture	1,05

**Source: Research Data**

Graph3: Maturity of Operation Management



**Source: Research Data**

In order to understand in detail the results obtained, we performed the calculations for maturity of the Operations Management Function as described in Equation (5). In a simplified approach, the calculation is performed by

$$(10)$$

$$\text{MatProc} = \frac{2.(1,35) + 3.(0,20) + 2.(1,25) + 2.(0,5) + 1.(1,05)}{10}$$

$$(11)$$

$$\text{MatProc} = 0,435$$

As the maturity of the Operations Management Function indicates, the UFGD must carry out planning for execution of the activities. It is required to define a process and plan the allocation of resources. **Table 12** consolidates the diagnosis of the UFGD Technical Management.

Table.12: Maturity of UFGD Operation Management

Maturity	Maturity Assessment
0,435	Level 1 - Initial
	The process is recognized, but there are few activities within its scope. Alongside this, there are no allocation of resources or budget for the same

**Source: Research Data**

As in the Central Service and Technical Management Functions, it was possible to obtain information capable of pointing out the factors that most influenced the maturity obtained for Operations Management. **Table 13** summarizes those that most impact the outcome.

Table.13: Maturity of UFGD Operation Management

Dimensão	Causa
Vision and Guidance	➤ There is no planning for staff training
	➤ There is no scope for the knowledge needed for the IT staff to perform
	➤ IT scope are not known
Processes	➤ The process is not modeled or formally established
	➤ The process does not have a standards manual
People	➤ Roles and responsibilities are not defined
	➤ The number of workforce is insufficient
	➤ The servers are untrained or do not know the role
Technology	➤ The tools that make up the process do not have integration
	➤ The management reports are not generated automatically

Culture	<ul style="list-style-type: none"> <li>➤ There is no communication channel for the staff to collaborate in the process</li> <li>➤ The process does not have the proper publicity</li> </ul>
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**Source: Research Data**

As in the Service Center and Technical Management, after conducting a survey of the causes that influence the maturity of Operations Management, using the good practices of the ITIL model, it is possible to point out some opportunities for improvement.

- Modeling of the work process of the Operations Management in the UFGD, giving publicity and formalizing the means of communication to carry out its activities.
- Establish a communication plan capable of properly integrating all the people involved in IT activities and encourage them to take part in the department decision-making.
- Establish a manager with ability to control and monitor the process, aligning it with the institutional goals.
- Training and qualification of the IT staff oriented towards their activities.

The results show the need to understand and apply the good practices of ITIL. It is necessary to formulate a process with well defined rules and roles.

**5.2 Application Management**

Application Management is the role responsible for planning and implementing the applications that support the organization's business processes. In general terms, it should be part of IT service planning, so that they are able to keep the business processes under operational conditions.

As a result, poor institutional performance is evident. For this function, the UFGD did not reach the minimum score to leave the Initial level of maturity, when it has its performance compared to the definition given in **Table 4**.

**Table 14** summarizes the institutional maturity for each of the analyzed dimensions of the Application Operations.

Table.14: UFGD Application Management Dimensions

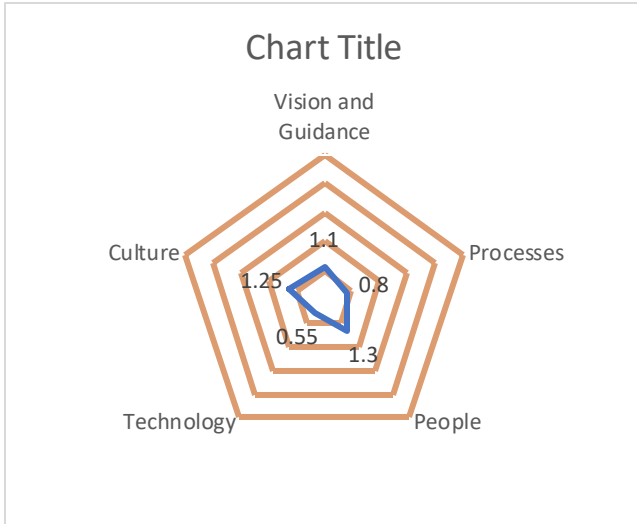
Dimension	Maturity	Classification
Vision and Guidance	1,10	Initial
Processes	0,80	Initial
People	1,30	Initial
Technology	0,55	Initial
Culture	1,25	Initial

**Source: Research Data**

In order to elucidate the level of institutional maturity on the parameters defined in the ITIL and PMF models for Application Management, the maturity of each of the dimensions analyzed is shown in Figure 4.

This condition reflects a reality of the factors exposed that corroborate the need to invest in actions to shape the functions to the strategic alignment, raising resources and seeking a greater participation of the IT area in institutional decisions.

Graph4: Application Management Maturity



**Source: Resource Data**

In order to understand the results obtained, the calculations were performed to obtain the maturity of the Application Management Function as described in Equation (5). In a simplified approach, the calculation is performed by:

$$\text{MatProc} = \frac{2.(1,1) + 3.(0,8) + 2.(1,3) + 2.(0,55) + 1.(1,25)}{10} \tag{12}$$

$$\text{MatProc} = 0,95 \tag{13}$$

The UFGD needs to carry out the planning for execution of the activities. It is necessary to define the process and plan the allocation of resources, whether financial or human. Table 15 consolidates the diagnosis of the UFGD Technical Management.

Table.15: UFGD Application Management

Maturidade	Avaliação da Maturidade
0,95	Level 1 - Initial
	The process is recognized, but there are few activities within its scope. Alongside this, there are no allocation of resources or budget for the same

**Source: Research Data**

As with the Service Center, Technical Management and Operations Management Functions, the survey provided information that proposed factors that most influenced the maturity achieved for Application Management.

Table 16 summarizes what the biggest impact on the results had obtained.

Table.16: Maturity of the UFGD Application Management

Dimension	Cause
Vision and Guidance	<ul style="list-style-type: none"> <li>➤ Leadership lack of understanding about the importance of Application Management.</li> <li>➤ Lack of resource planning under the responsibility of Application Management</li> <li>➤ Lack of agreement on the service level to answer the requests made</li> </ul>
Processes	<ul style="list-style-type: none"> <li>➤ Lack of modeling, such as the operating rules.</li> <li>➤ No publication to users</li> </ul>
People	<ul style="list-style-type: none"> <li>➤ The number of workforce is insufficient</li> <li>➤ The servers are untrained or do not know the role</li> </ul>
Technology	<ul style="list-style-type: none"> <li>➤ Lack of process automation tools</li> <li>➤ The tools that make up the process do not have integration</li> <li>➤ The management reports are not generated automatically</li> </ul>
Culture	<ul style="list-style-type: none"> <li>➤ There is no communication channel for the staff to collaborate in the process</li> <li>➤ Users do not know the Application Management</li> </ul>

**Source: Research Data**

As in the Service Desk, Technical Management, and Operations Management, after conducting a survey of the causes that influence the maturity of the Application Management, using the good practices of the ITIL model, it is possible to point out some opportunities for improvement.

- Modeling Applications Management work process in UFGD, publicizing and formalizing the media for carrying out its activities.
- Establish a communication plan capable of properly integrating all the people involved in IT activities and encourage them to take part in the creation of policies to be applied in Application Management
- Establish a manager with ability to control and monitor the process, aligning it with the institutional goals.
- Train both the IT workforce for the execution of activities and users to understand the activities of this Role and the possibilities it offers.

The result obtained demonstrates the need to understand and apply the good practices of ITIL to the context of

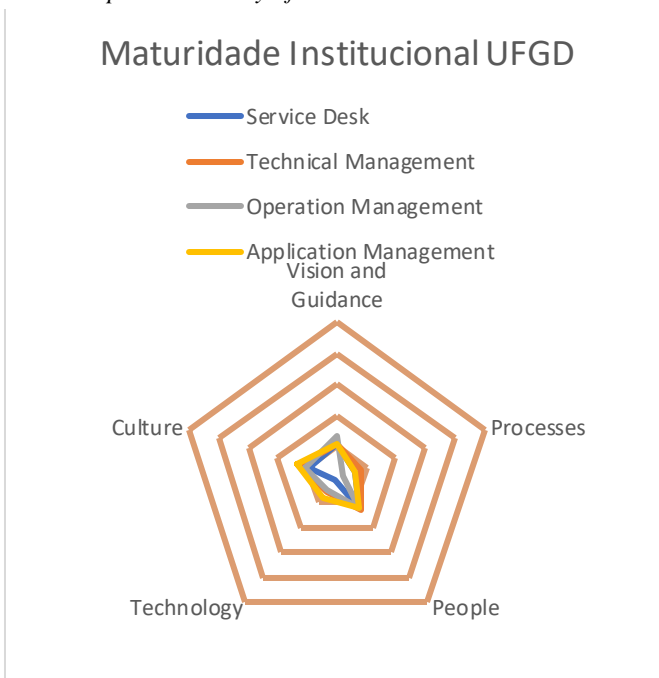
Application Management. It is possible to observe some actions in this sense, however work is still needed to create a process with well-defined rules and attributions.

**VI. ITIL MATURITY IN UFGD**

So far the research has demonstrated the maturity levels of each of the functions separately. As described in the theoretical framework, these four functions built a set of services available to users.

Initially, the low level of institutional maturity could be observed. All functions had averages of below 1.9, and their maturity level was defined as Initial. As shown in **Graph 5** and in previous topics, the UFGD demonstrates recognizing and applying the principles of the functions analyzed, but in a very superficial and misaligned way. The initiatives implemented are insufficient and uncoordinated, reflecting a lack of knowledge and application of own governance concepts, which are not part of a strategy or alignment according to the parameters defined in the ITIL library.

*Graph.5: Maturity of ITIL Functions in UFGD*



**Source: Research Data**

Much of what is operating in the UFGD comes from a model where the IT department has an exclusively operational focus, where IT actions are not part of the strategic planning of the organization. Given this condition, the interviewees pointed out as the main causes for the current level of maturity of the UFGD the factors set out in Table 17:

*Table.17: Causas para baixa Maturidade Institucional*

Function	Main Causes of Low Maturity
Service Desk	<ul style="list-style-type: none"> <li>➤ Reduced staff;</li> <li>➤ Inefficiency of human and material resources;</li> <li>➤ Limited view of the role of IT by the Administration</li> <li>➤ Lack of integration between the different IT teams</li> <li>➤ Lack of IT Planning</li> </ul>
Application Management	<ul style="list-style-type: none"> <li>➤ Lack of Linkage between the goals of the organization and the objectives of the Role</li> <li>➤ Absence of an administrative vision, aimed at continuous improvement</li> <li>➤ Low perception about the importance of automation for the management of services</li> </ul>
Operations Management	<ul style="list-style-type: none"> <li>➤ Reduced Staffing</li> <li>➤ Deficiency of internal communication</li> <li>➤ Absence of an administrative vision, aimed at continuous improvement</li> <li>➤ Lack of integration between the different IT teams</li> </ul>
Technical Management	<ul style="list-style-type: none"> <li>➤ Reduced Staffing</li> <li>➤ Absence of an administrative vision, aimed at continuous improvement</li> <li>➤ Lack of integration between the different IT teams</li> <li>➤ Lack of IT Planning</li> </ul>

**Source: Research Data**

By consolidating the results obtained in the previous sections through the PMF model, it was possible to obtain a systemic view of the condition of the Functions of the ITIL Model in UFGD. The use of the model was able to extract, through its dimensions, the necessary improvements to raise the level of maturity of the ITIL Functions in UFGD, and it is possible to point out the following actions as initial steps to increase the institutional indicators.

- Elaboration of a plan of actions to increase maturity in each of the Functions analyzed.
- Defining a responsible manager for each of the functions, and prior training is required to coordinate the alignment process with the principles of the ITIL model.
- Modeling the processes for each function seeking to integrate the functions that are related.

- Establish a communication plan between functions and processes within the IT department.
- Train the IT involved servers about the ITIL library
- Periodic valuation and investment in sectors that demonstrate lower maturity.

The organization of the ITIL functions seeks to align the technical teams, providing greater control and ensuring that IT is able to provide the necessary support for business processes, making the most of available IT resources and minimizing the costs involved

### 6.1 Resources and Capabilities

Understanding the importance of adopting good practices presented in the theoretical framework, the research seeks now to diagnose the current condition of the technical staff available at the UFGD, seeking to identify opportunities for improvement considering the resources and capacities currently available.

#### 6.1.1 Academic formation

With regard to academic training, as the profile defined by the research takes into account the performance in IT, it is expected a greater number of graduates in courses such as Computer Science, Information Systems or courses aligned to this area.

This scenario is confirmed in the UFGD, in the analyzed frame 30.8% are graduated in Computer Science, another 20.5% are trained in Systems Analysis and 15.4% in Information Systems. At the same time, it is possible to observe the occurrence of graduates in other areas that have no relation with IT. It was possible to find 1 Administrator, 2 graduates in Mathematics and 1 Pharmacy. In general, the academic profile of the staff meets the requirements of its area of operation, giving subsidies for the work being done.

#### 6.1.2 Public tender and designation

As the research delimited its focus of action to the IT staff of UFGD, we sought to understand how the selection process of these was given. About 35.9% reported having tendered for Information Technology Analyst, this being a job position for higher education level with profile and attributions dedicated to IT with IT designation specified in the UFGD IT department.

Another part of the group, 25.6% reported having been hired as a Computer Laboratory Technician. Another 15.4% reported occupying the position of Information Technology Technician. In addition, it was possible to find other positions in IT activities, among them: Laboratory Technician of Mathematics 5.2%, Laboratory Technician Didactic Multimedia 2.6%, Technician of Laboratory of Geotechnology 2.6%, Assistant in Administration 2, 6% and Manager 2.6%.

#### 6.1.3 Performance

Regarding the performance, it is observed that the section that concentrates the largest number of technicians is the

IT department, with 48.9% of those interviewed said to work in this unit. As well a smaller number, about 38.6% work in an academic unit, and another 7.8% declared to work an administrative unit.

#### 6.1.4 Training

When asked about the level of training, interviewees showed a disturbing picture. About 33.3% of the respondents stated that they had never received any training courses in the area of IT. Another 30.8% performed between 1 and 2 courses at the most, which would be too little considering the number of participants and the time in which they work in the UFGD. These two slices represent more than half of the technical staff who received little or no training for the activities they perform

To complete the data, about 5.1% reported having received between 2 and 3 courses and 30.8% received 3 or more. Although one-third of respondents report having received a significant level of training, this privileged share does not reduce the negative impact of the majority of UFGD's IT workforce having a low level of training.

#### 6.1.5 Knowledge about IT Governance

Regarding knowledge about good practices in governance framework such as ITIL, 51.3% of respondents stated that they knew it superficially, but were not able to respond if any of the suggested practices were implemented. Another 33.3% stated that they knew absolutely nothing about governance frameworks.

To complete the picture, 10.3% stated to know a little about the frameworks, seeking to follow the recommendations they know. However, without formally instituted processes, the actions carried out are restricted to the scope of the work place. Along with these, another 5.1% declared to know the governance frameworks and works for their promotion within the institution.

#### 6.1.6 Work Process

About 38.5% of the respondents stated that they had a defined workflow, where the activities were reported to the IT department and later assigned to them. As for the others, about 35.9% stated that they did not participate in any workflow, receiving the requests in various ways and meeting the demands according to the possibility. This condition portrays a reality in which there is no type of management, it is impossible to calculate the waste of the work force, as well as the negative view that the users have regarding the performance of the technicians.

For 20.5% the workflow was defined by the server itself, without the intervention of the IT department or other staff in the area, which shows a precarious performance, without any technical support.

#### 6.1.7 Control Tools

Regarding control technologies to identify, classify or respond to requests, 56.4% answered using the tool provided by the IT department, OTRS (Open Ticket



Request System), even with some level of difficulty. Moreover, a total of 15.4% stated to make a satisfactory control of their activities with their own tools (e-mail and spreadsheets), however for 10.3% these tools have not met their needs. This condition reinforces the need to change the current process so that the tool used can contemplate the management of the activities of the staff, giving them the means to control their activities by improving the service provided.

**VII. OVERVIEW OF THE WORKFORCE**

According to the data presented in the previous sections, the UFGD has a technical staff capable of promoting the improvement in IT services without the need for large financial investments. According to the above, the institution does not adhere to ITIL library standards, while at the same time revealing an environment where actions do not form a well-defined pattern or process.

**Fig. 4** represents the current flow that the requests follow. Clients do not have a defined communication channel. Instead of they may ask a unit technician to service without the intervention or knowledge of the IT department. Only in cases where the technician needs support or permission to perform the service, the IT department interacts with the request.

In general terms, what is observed is that the institution has the necessary conditions to implement a good management of IT services. As the research shows, the staff has adequate training and is present in adequate numbers. What the institution lacks is awareness of IT Service Management, a condition that was evident when analyzing the institutional maturity of the ITIL library. In this way, the work points to the model presented in **Fig. 5** as a suggestion to change the current process so that it is able to adhere, even if in a primary form, to good ITIL practices, taking advantage of the available structure and resources.

Considering the experience brought by the ITIL library and the observation of the process established in the UFGD, it is clear that the Client is the agent responsible for initiating the request, being the only one able to attest its compliance.

As recommended in the ITIL library, a request can be made from a variety of means of communication, being available in these phases, the currently available call system (OTRS), the sending of an e-mail message or a telephone call. With these resources, the client is able to inform the need for a service, reporting the problem and the current need. The Client's performance model in the presented proposal is exemplified in **Fig 3**.

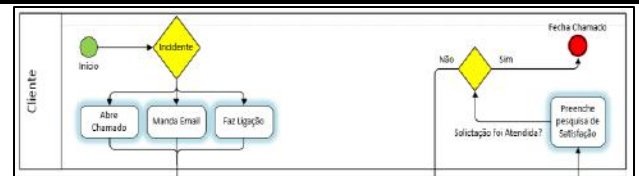


Fig.3: Customer Service at the Service Desk (The Author)

With the possibility of opening an order, the customer also interacts in the closing process, responding to a satisfaction survey and informing the level of quality of the service received. The level of satisfaction should serve as a parameter to evaluate service delivery, and it is possible to reinsert the call in the service process if the user deems it necessary.

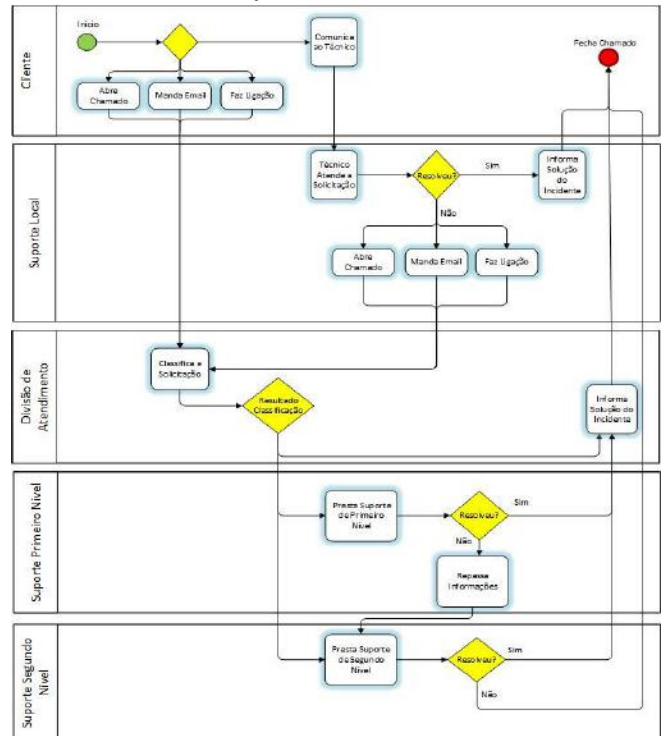


Fig.4: Current IT Service Process of UFGD (O Author)

The constant assessment of the quality of calls serves as feedback on the work of the Service Desk team, serving to evaluate the process instituted and possible improvements that can be applied.

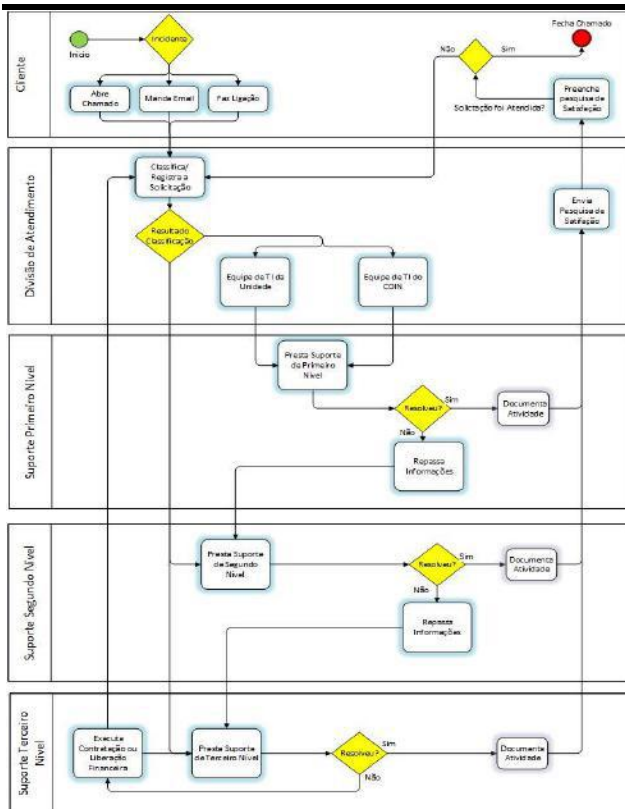


Fig. 5: Proposed Service Process of the Service Center of the UFGD (O Author).

### 7.1.1 Customer Service Division – DAV

As part of the organization chart of the IT department and having among its duties the receipt, scheduling and fulfillment of requests, the DAV is responsible for classifying the demands received. It is able to identify the specifics of each call and assign to the team better trained. As the teams are distributed according to their focus of action, DAV concentrates a portion of the workforce responsible for performing first-level calls. In the process presented, this responsibility is shared with the technicians designated in other units, and this division is responsible for the classification and scheduling of the team responsible for the service, whether internal to the IT department or the unit responsible for the demand received. The layout of the Division and its functions are shown in Fig. 6.

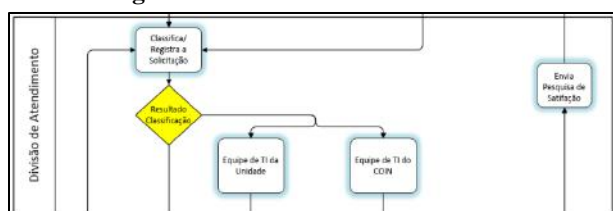


Fig. 6: Customer Service Division (O Author)

In this context of the process, it performs the classification of the demands and the follow-up of the phases of attendance of the call. When it is in the final

process, it must pass through the division so that it is sent to the survey of user satisfaction.

### 7.1.2 First Level Support

First level support generally refers to simpler requests that require less technical knowledge or that are already part of the knowledge acquired by the team during the attendance of similar requests that occurred at other times.

First-level calls, although characterized by its low complexity, usually occurs in large numbers and at high frequency. This condition requires that the responsible team has a good number of servers and is able to meet the demands distributed by the organization. As the UFGD has a structure composed of several blocks, the service team at this level must be able to traverse the entire structure, being distributed in a way to optimize its scope of action. The arrangement of the activities of the First Level Support is shown in Fig. 7.

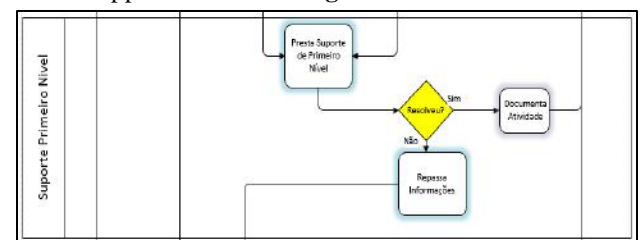


Fig. 7: First Level Support (O Author)

As a suggestion, the crowded team in the Customer Service Division and First Level Support can organize service islands where trained teams would be responsible for requests that were geographically closer. This arrangement assists in the distribution of demands and the agility of answer. The organization model, together with the standard defined by the service process, must be able to establish first level support without major difficulties throughout the institution.

Remembering that this proposal considers the resources available in the institution, the good practices defined in ITIL and improvement of the current process, however there may be factors that are not included in this context and that should be discussed if the proposal is implemented.

### 7.1.3 Second Level Support

Second-level Support is responsible for solving problems that have no known solution, in addition to carrying out activities that require a higher level of administrative rights.

The process currently instituted for this level of support, but does not provide any documentation guidelines. Another important factor is the relationship with the first level support, which must be improved by seeking to prioritize the execution of managerial functions and reducing their performance in problems whose solution is already known.

Because the changes suggested in the current Service Desk process involve significant changes, it is possible that second-level support is affected. The changes must prioritize the action in problem solving and favor the performance of the first level teams, giving them the necessary subsidies to carry out their activities. The arrangement of the activities of the Second Level Support is shown in Fig. 8.

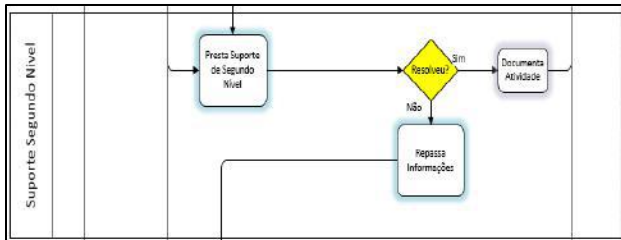


Fig. 8: Second Level Support (O Author)

#### 7.1.4 ThirdLevelSupport

Third-level support is not predicted for in the current process. In the proposal presented it comes into existence, being responsible for receiving all the demands that have already passed the first and second level of support.

Usually requests that reach this level are those that require some sort of financial investment or acquisition, so that beyond the operational scope of the Service Desk performance. The third level is responsible for resolving non-technical issues that prevent the progress of solving the demand received. In general, its participation in the process is quite simple, having its attributions arranged in Fig. 9.

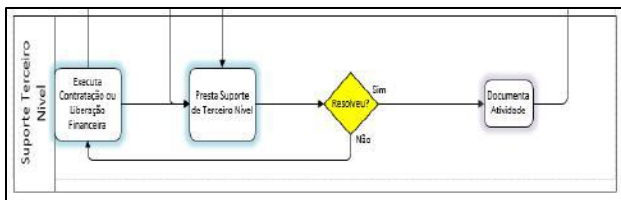


Fig. 9: Third Level Support (O Author)

## VIII. CONCLUSIONS

This work aimed to analyze the application of IT Service Management focused on the ITIL library at the Federal University of Grande Dourados. The two main IT governance frameworks and their relationship with each other and Corporate Governance were presented and analyzed.

Understanding the theoretical aspect of the integration between IT and Governance, it was tried to present the importance of the management of IT services and the possible impacts that the lack of this initiative causes to the organization, together with this it was tried to understand how it is possible to classify the maturity of an institution in this respect. In order to do this, the evaluation methods were considered institutional maturity

with reference to the ITIL library and its PMF evaluation framework.

Thus, in view of the low levels of maturity identified during the research, a proposal is proposed that alters the existing process in the IT Service Operation of UFGD. This proposal considers the available resources and good practices of the ITIL model that are applicable in the current institutional context. The model emphasizes the importance of the participation of the IT workforce of the academic and administrative units of the UFGD, emphasizing the integration of these servers to the process proposed in this work.

Alongside this, the factors that may influence the success of the proposal are explicit, emphasizing the need for the participation of the senior management in the change process, the collaboration of the employees that act in IT in the formulation of the work process and improvement of the methods to the alignment of the proposal presented with the institutional principles, since they must influence the path taken by IT as a whole.

In addition, the work presented the level of institutional maturity, exposing a condition in which the UFGD urgently needs to invest in training of its work force, in order to begin the adoption of good practices that the ITIL model defines. The UFGD has sufficient human and technological resources to initiate the alignment of the work process in order to increase its maturity level and promote the constant search for improvement of the process.

By the maturity analysis, it was possible to identify the factors that have a negative impact on each of the analyzed functions. Given this information, it is important that the UFGD is sensitive to defining practical actions that are capable of improving the conditions of the IT environment pointed out in the research.

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# Analysis of Socioeconomic and Environmental Vulnerability: A Case Study in the Quilombola Community “Sucurijuquara” in the Metropolitan Region of the Paraense Amazon

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**Abstract** – The purpose of this article is to present the results of a Regressive Analysis on Socio-Environmental, Economic and Cultural "SEA" aspects of the remaining quilombo community of Sucurijuquara in the Mosqueiro District, Belém / Pa. For this study, qualitative and quantitative approaches were used, based on the application of semi-structured interviews, photographic records, software application (SEA) for the survey and analysis of data collected from study sites. The results point to the problem of establishing the processes of organization and empowerment in the social, economic, environmental, cultural and land aspects that are fundamental for the quilombola community. It is concluded that the land regularization is paramount, since they would grant rights with the possession of title of land, improvements in education, basic sanitation, health and housing in these spaces away from the central regions of the Metropolitan Region of the Paraense Amazon.

**Keywords** — Public Policies, Resistance, Identity, Culture

## I. INTRODUCTION

When the construction of the quilombola identity is discussed, it is essential not to associate with the territory, in which the construction of the territory will produce the ethnic identity and the identity produces the territory as a reciprocal action of the subjects. Territorialization is due to the relation of the subject to nature that tends to move along time and space. This relation is registered by the memory, individual and collective, fruit and condition of knowledge and knowledge (MALCHER, 2006). Over time, the communities come, through strategic forms, organizing themselves so that they remain in the territory,

being necessary the official titration from the federal constitution of 1988 that sought to guarantee the rights of reminiscence to Afro-descendants. After the end of black slavery in the Brazilian territory the quilombos began to organize themselves, but what was marked was the "protest to the inhuman and degrading conditions to which the slaves were subjected" (Malcher, 2006, p.5). Being a form of ethnic resistance, to demonstrate black slave labor and exploitation, in this sense, most quilombos were formed by slaves who rebelled or fled tired of the situation of mistreatment.

In the Brazilian Amazon, the arrival of the black people occurred through a strategy of the Portuguese crown for the exploitation of the resources of the earth, through slave labor. As a way of enriching the reign, slaves were used as a bargaining chip and the way blacks were annexed in the Amazon were not different from the various regions of Brazil. This exploration is reported by contemporary studies, showing the contribution of the black people in the history of Brazil (ALBUQUERQUE; FRAGA FILHO, 2006). In this way, the bonds of solidarity and the collective use of the land formed the basis of a fraternal society free from the most cruel forms of prejudice and disrespect for its humanity (MUNANGA; GOMES 2006). In Pará, the struggles of quilombola communities were of great importance for social movements, which infers the conquest by the title of land on the federal scale and in the state, did not occur through the development of the quilombos, but was conquered through urban black movements. This union achieved good results, according to the State Planning Department of the State of Pará (SEPlan) of 2018, today Pará is the Brazilian state that

most titled areas in favor of the remaining quilombos in all Brazil.

In this sense, this article proposes to carry out an economic and social analysis, with comparative information (previously, current and prospecting) on the quilombola community of "Sucurijuquara" Metropolitan Region of the Amazon Paraense, to the point of contributing to future actions implemented by public administrations in different spheres (municipal, state and federal).

## II. METHODOLOGY

Researches were carried out based on bibliographies referring to the history of formation of quilombos in Brazil and in the territory of Pará, based on the importance of ethnography in space, in scientific articles, works on the theme involving this context. In a quantitative way, analyzing the data referring to the socio-spatial condition of the remaining quilombo in a comparative way, added to the database available. In a qualitative way, semi-structured interviews were conducted with different groups of the quilombola community of "Sucurijuquara", in order to confirm data and identify possible changes. Thus, the qualitative and quantitative analysis are integrated in the interpretation of the results made from SEA Analysis software, as the main element of the study, based on scores with the respective meanings: (1) Very low; (2.) Low; (3.) Medium; (4.) High; (5.) Very high. The objective criteria for assigning scores related to the different parameters, this step of the method consists of an exercise subject to some degree of subjectivity. In the very contrasting evaluations could be revealed of the insufficiency in the information collection or the conceptual incomprehension by some of the evaluators, in this case the theoretical framework was used on each topic discussed.

The scores attributed to each of the parameters summarize objective information about the characteristics of those who manage Natural Resources (RN) and Environment (MA) analyzed, their Socioeconomic situation (SE) and the current process for Empowerment Analysis (AE) and Public Policy (PB). The advantage of this representation of the systemic qualities in synthetic valuations is to simplify the communication of a complex and interdependent set of variables, thus facilitating the comparative evaluation regarding time and space and in the process of changes, that is, in different phases of its development or with other perceptions of those who mainly use the NB in a given territory. In contrast, aggregate indicators, represented by means of synthetic scores composed by the processing of sets of variables, do not convey substantive information about the complexity of the socioeconomic phenomena involved. For this reason, it was essential to assign the scores accompanied by synthetic records (negative and positive points) on the objective criteria that refer to the judgments made.

The description of the criteria was an explicit reference to the information systematized in the field, and functioned as logical justifications of the defined scores. Only with these records, it is possible to create a Reference Information Base (IR) for the comparative evaluation or for the systematic monitoring of the NB and MA, SE, AE and AP. The dialogue for the analysis of the newborns and others in the same territory provided a continuous collective calibration of the criteria used in the assignment of scores to the different parameters evaluated. Being a participatory process, this exercise favored the exchange of perceptions, enriching the collective knowledge about the diversity of those who manage the newborns and others and who are present in the territory, particularly with regard to their logics of socioeconomic reproduction. Based on content, such as analysis of interviews with selected groups, combined with information from the database to investigate possible changes in the five year period between 2012 and 2017, in the management and delivery of social and environmental services in the community.

## III. RESULTS AND DISCUSSION

### 3.1. Ethnography in the quilombola Community of Sucurijuquara

In the quilombola community of "Sucurijuquara" the persistence by titling of their lands and the recognition is not very different from other communities by Brazil. The struggle of the remnants began in 2008, and since then its representatives have been participating in several lectures, movements and conferences in Belém / PA with themes about the quilombo, all to understand and argue based on documents to be sent to Brasilia so that in fact, the recognition of the community being of quilombola origin. All under the support of the members of the coordination of the associations of the remaining communities of quilombos in Pará (MALUNGU).

About the historicity and origin of the name "Sucurijuquara", this name comes from an event of date not identified. The president of the community residents' association, Roberta points out that "[...] according to reports by the community matriarch, the name comes from the junction between 'Sucuri' which refers to the species of snake commonly found in the Amazon region, 'Ju' a hole and 'Quara' to the Indian [...]" (Field interview on February 28, 2018). And she still reports that "a group of hunters went to the 'forest of the burned' to hunt and saw a lost Indian who communicated with strange sounds, there was also a large hole with a snake, and the hunters did not know how to kill it, and that they had to go through them, they then made a 'contract' with the Indian, that in case he could kill the snake and clear the way, they would then direct him to his place of origin, and it was done." on February 28, 2018). However, it can be said that with the

accelerated process of urbanization and population growth, over the years the territory belonging to the remaining quilombo community has been occupied by outsiders, which has brought some internal problems to the village, such as the illegal sale of land, violence, and the unbridled exploitation of natural resources.

### 3.2. Regressive Analysis Subsidiary for the Future Vision of the Quilombola Community of "Sucurijuquara"

Based on interviews with representatives of community residents, we can compare elements based on specific criteria established in the community, and were of great relevance for the quantification of the data in graphs, as we will see below (Figure 1).

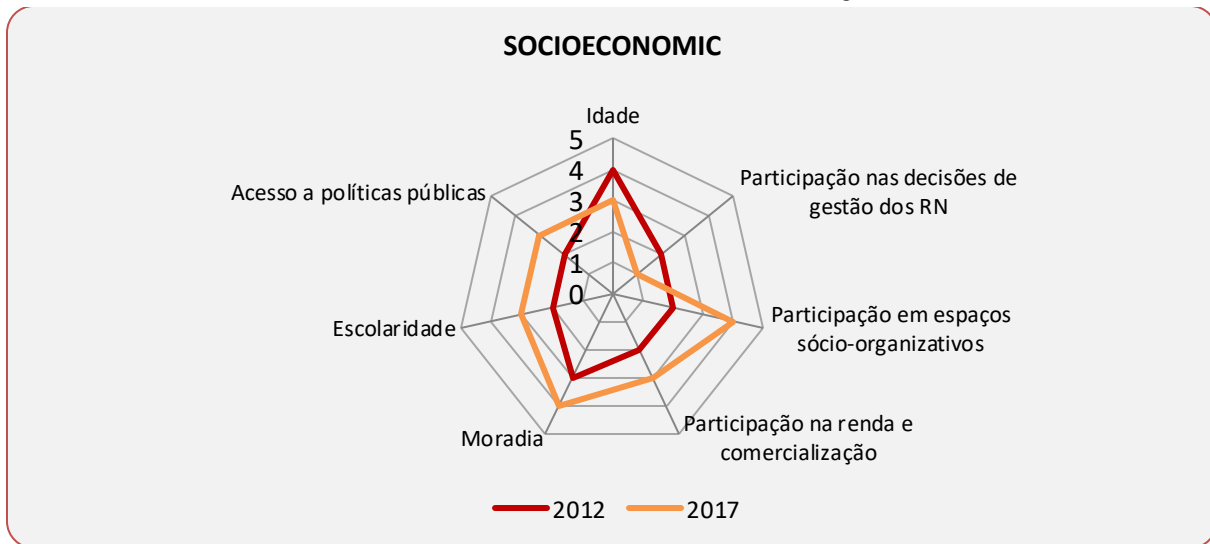


Fig.1: Socioeconomic Aspect

The chart above allows for a systemic comparison in the community between 2012 and 2017, based on scores ranging from 0 to 5 for the age group, being lower from 2012 to 2017, as well as other perspectives and analyzes to be analyzed Next.

Based on the analysis of figure 1, in the quilombola community of "Sucurijuquara" agricultural practices are traditional and of "low technological level", being developed in small areas and with rudimentary technique. Federal Government programs such as the "Bolsa Família" and retirement supplement family income in the community. Family farming is an important source of income for quilombolas in this community, as well as cultural and recreational practices on festive occasions that help the economy by selling handicrafts produced by themselves, fishing and extracting açai (*Euterpe oleracea*), as shown in figure 1, the strong growth between the years 2012 and 2017. A considerable part of the population of this community also operates outside the rural production unit, working as a maid, construction, carpentry, electrician, in the post medical and community school

among other occupations, who collaborate in the movement of income.

The recommendations for this analysis consist in the expansion of partnership with organs and institutions for the destination of the production of this community. In addition to increasing the incentive to create training courses for residents of the quilombo, as they perform functions within the community without the technical training to pursue such a profession.

Since 2003, under the "Lula" government, rural housing is now seen as a social policy, and the right to housing is now accessed by farmworkers, and is now made up of the Ministries of Agrarian Development (MDA) and Ministry of Agriculture (MC) of the first Rural Housing Program in Brazil, this program consists of two modalities, one for the settlers of Agrarian Reform and the other for Family Agriculture (STEFFENON, MOSER, 2010).

In the Quilombola community there are still problems, such as illegal sales of quilombo properties (Figure 2), but belonging to the Union, an illegal practice that merits greater oversight of public power.



Fig.2: Illegal sale of land in the community

In this sense, the importance of access to housing, through initiatives of the public power, is extremely relevant to the community, because as the quilombola population grows, there will be a need for a greater number of residences for the residents.

Analyzing the increase in the use of social-organizational spaces by the community, there is an emphasis on the benefits of this practice that not only in the field of leisure and culture, but also, in a way, strengthened the local economy, already that during the events there is an intense flow of people in the community, which drives trade.

However, despite the increase in leisure activities and culture, it is necessary to make some recommendations, such as the importance of seeking partnerships, whether public or private, for the strengthening of events, for better dissemination, infrastructure etc. It is also necessary to increase the number of events (currently only four) occurring in Quilombo.

Within the federal government's integrated actions program, the infrastructure and quality of life project aims to create and expand the primary services to the community, that is, basic sanitation, however, the focus for the implementation of these systems is through sustainable alternatives. But for them to be contemplated, quilombola communities must be duly certified before the responsible bodies. All to ensure the quality of life and development of communities. However, despite the slight improvement of the "Sucurijuquara" quilombo between 2012 and 2017 (FIGURE 1), there is a need to intensify these services in the community, so that the demands are met, especially in the areas of health and social assistance.

According to the residents, there is currently only one school (E.M.E.F Angelus Nascimento) that has existed for

at least 45 years, and only meets the demands of elementary level I and II. The level of schooling in relation to the elderly is low, since most of them do not know how to read and write, while the young people, most of them go to the fundamental level, because there is a comfort for most of them, as Roberta points out. ] at the time of school holidays many of them go to the várzea to harvest açaí and target this practice for commercial purposes."

As a recommendation, through projects, the president of the association seeks to bring a better quality of teaching to children and young people, she says that it would be interesting if there was the "Young Pro" (Education Program for young people of the state of Pará) in the community. There is the program that gives access to state public universities through the Special Selective Process for Quilombolas. In addition, it targets other projects such as "The Knowing of the Earth" still to be implemented, a project created by her seeking to preserve the culture, knowledge and customs that the community has, so that it is not left behind, and continues being passed from generation to generation, generation, and also the project that will help the later students to finish their studies, in primary and secondary education, in two years each, so that everyone will seek a better quality of life.

Also on recommendations to improve the quality of education, is to create more schools, especially middle schools that are still present in the community, in order to meet the demands, because there is a certain lack of interest on the part of young people in continuing the studies and often settle with the life they lead.

The visit and the observations made from the graphs enabled us to analyze in practice how the dynamics of a remnant community of quilombos take place and, in addition, enabled us to do a regressive analysis on the main social, environmental and economic changes (FIG. 2). We realize that there have been changes that have led to the improvement of the quality of life of the community, however, there is still a lot to be done, such as land titling, quality transportation service, creation of more schools and health posts.



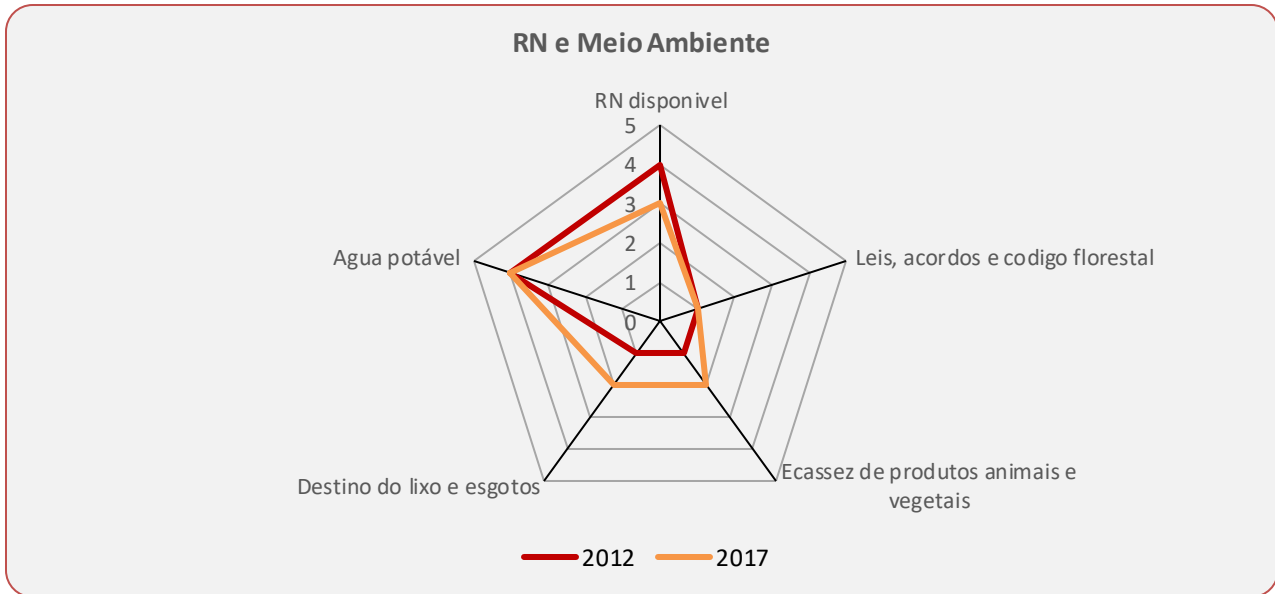


Fig.3: Natural Resources and the Environment

Based on the comparative data of figure 2, we can detect another problem caused by the progress made in quilombola areas, by the advance of agriculture and agriculture, and one of the factors that contribute to the decrease of the resources of the communities. A large area for the deforestation of a production of monoculture or cattle production that, consequently, with the forest of the forest, a loss of fauna and flora to help the subsistence of the communities with a hunting and extractivism.

Fishing has been going through the same problems as hunting, this mainly affects the quilombola communities that are located the riverbanks. The problem is very recurrent because of the contamination of the rivers that are "poisoned" mainly because of the mineral exploration that contaminates the waters of the rivers and makes them unfit for consumption as well as for the reproduction of the aquatic fauna. (BARBOSA and MARIM, 2011).

We noticed in interviews with the community that they are not aware of what is APP (Permanent Protection Area) and other programs focused on the environmental protection of the forest area that surrounds the quilombola community. So we recommend that Federal Government programs be implemented, focused on the social and environmental balance.

There should be an intensification of surveillance in the forest areas surrounding the community and lectures explaining how forest resources should be used to avoid causing environmental degradation. Especially in highlighting deforestation, due to the lack of environmental awareness, causing the decrease and even disappearance of species of animals and vegetables, which are of great importance for subsistence.

As well as the awareness of the preservation of the forest, there should also have the same attention about the rivers that pass through the community, because with the deforestation of the forest and withdrawal of the ciliary forest, there is as a consequence the silting of the rivers, that harms the own community. Like many traditional Amazonian peoples, quilombolas have a strong relationship with the rivers that are where they draw water that they use for various functionalities. As shown in figure 2, access to potable water has decreased considerably, still reinforcing the importance of preserving this resource in a indispensable way. In an interview with some quilombolas that are fishermen, we noticed the decrease of the fish, a very recurrent fact due to the illegal fishing during the insurance closed. One way of avoiding this problem would be to establish a partnership between the quilombolas and the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), in order to have a monitoring of the rivers during this period, and projects so that this fisherman can other forest resources.

Regarding environmental awareness, a basic work should be done with the elementary school students of the Municipal School Angelus Nascimento and how the community can take care of the environment in which they live, through the teaching of environmental education, especially with the issue of garbage, since in our walks we can observe a great amount of garbage scattered throughout the streets of the quilombola community, and this garbage could be recycled and reused for the benefit of the community itself.

Asked about the empowerment of young people and women, Ms. Roberta (Community Leader) explained to us that there is still a lot of machismo in the community, especially from the older people, however, she stressed that she is highly respected for being president of association and also by the

experience and maturity to give him / her with the pertinent subjects to the community, which corresponds, before the collected data, this differentiation throughout the periods compared (figure4).

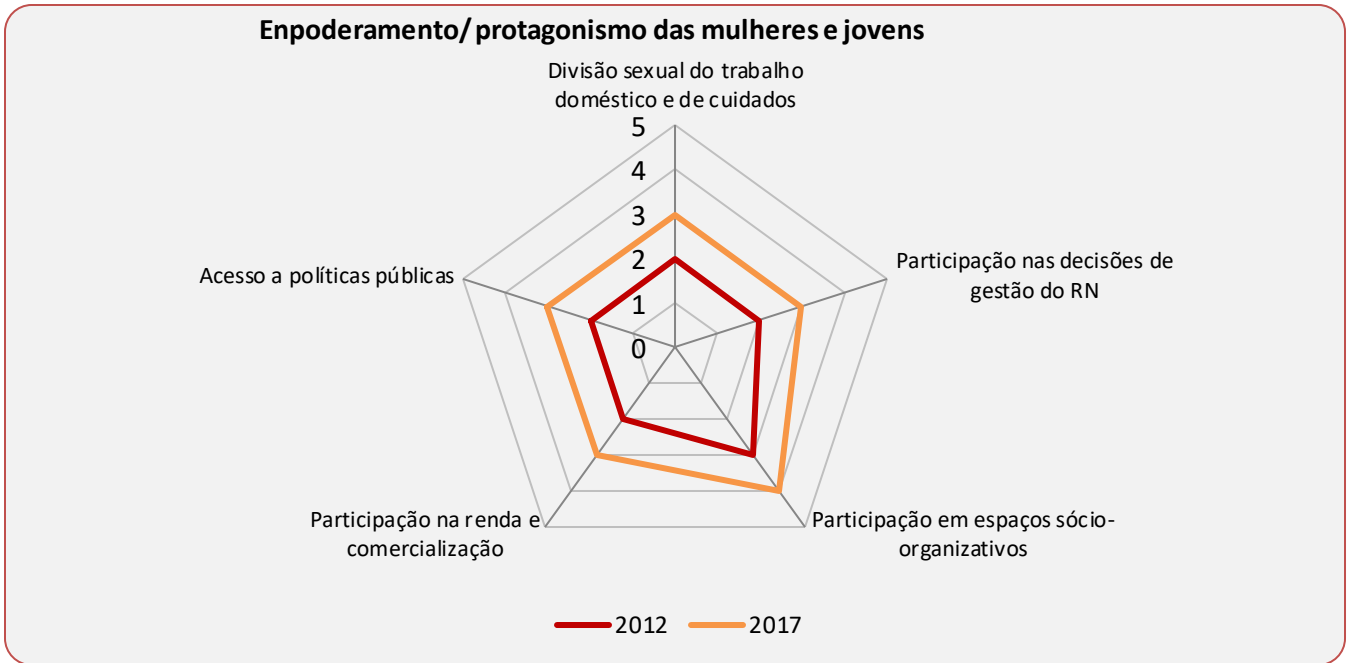


Fig.3: Empowerment / empowerment of women and youth

With the monitoring and analysis performed in the community, one can observe the intensification of access to public policies, participation in decisions, the sexual division of labor and other perspectives highlighted in figure 3, as a progressive increase from 2012 to 2017, there is still a need for greater promotion of public initiatives and the community itself for greater equity in the participation of women and young people from the quilombola community.

As an analysis, it was observed that the health services in the community are palliative, that is, the unit works only for prevention without having prompt care, causing residents of the quilombo in cases of urgency have to move to the center of the Mosqueiro District and / or the Metropolitan Region of Belém to be attended to, which is difficult because the community has many difficulties in its mobility (figure 4).

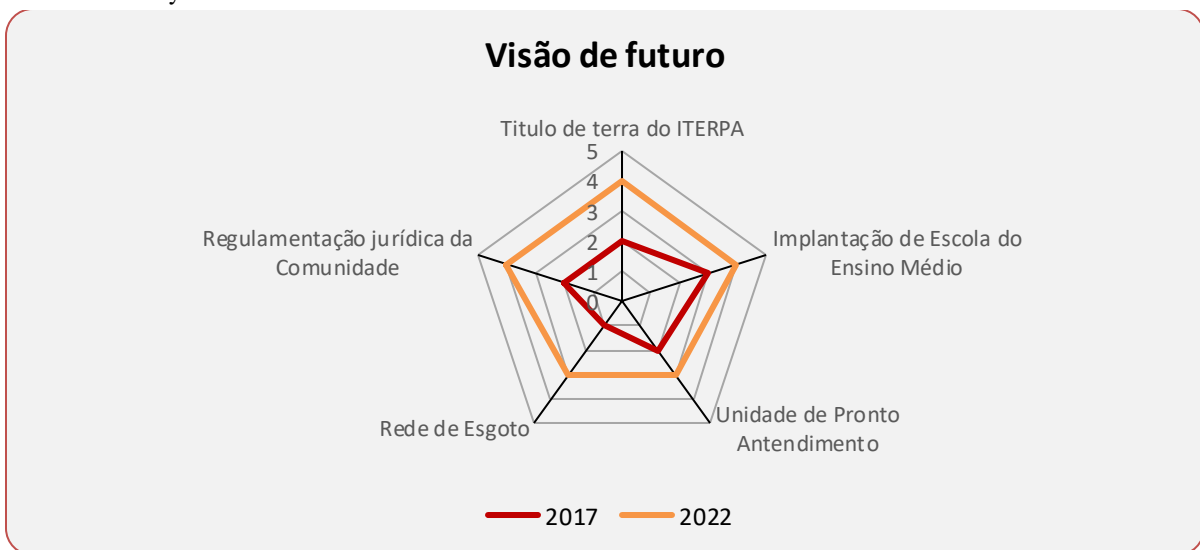


Fig.4: Future vision

In order for this demand to be met, quality health services should be expanded within the quilombo, through the implementation of Emergency Care Units (UPA). The greater number of schools, especially with modalities also focused on secondary education, sanitation and sewage and regulation on the title of land of the population of the community.

The Federal Government's integrated actions program foresees sanitation for the quilombola communities, which comes through the National Health Foundation (FUNASA), however, the quilombola community of "Sucurijuquara" has no sewage network and water supply. Having the need to mitigate such a program, community leaders need to update the responsible bodies on the quilombo sanitary situation, promoting a dialogue so that improvements can be found through the implementation of the sanitary sewage system, the largest number of schools, especially with modalities also focused on secondary education and regulation on the land titling of the community population.

#### IV. CONCLUSION

In the face of the analyzes carried out in the quilombola community of "Sucurijuquara", it is concluded that it is important to highlight elements pertinent to culture, practices and the various difficulties in the quilombo, as well as regularization of the same since ten years have passed since the moon by the titling of their lands, and from the information collected can make a future vision of the quilombola community with the regularization of the land in which they would have greater conquests for rights with the possession of title of land, improvements in education, basic sanitation, health and housing, which up to the present time, due to lack of titling of land, the acquisition of community land is carried out in a disorderly manner. Therefore, this socioeconomic analysis can subsidize and contribute to effective initiatives that can be taken to ensure better conditions and practices in the quilombola community of Sucurijuquara.

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# Labor Remuneration in the Production of Ornamental Plants

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**Abstract** — *The objective of this experiment was to compare employment contract systems based of hourly pay and payment for piecework in relation to the main activities performed in an ornamental plants production company. The experimental design was completely randomized, with four treatments and five repetitions. The treatments consisted of hourly payment in the first year and piecework in the following three years. The analyzed variables were the results regarding the numbers of containers (trays/pots)  $h^{-1}$  and the employee's payment in US\$  $h^{-1}$ ; the movement of containers; the spacing of plant containers; the removal of flowers/leaves; and pruning. Both the number of processed containers and the remuneration significantly increased for all the evaluated activities when the company started to use pay staff based on productivity.*

**Keywords**— *flowers; hourly pay; piecework; vase.*

## I. INTRODUCTION

In the capitalist production system, the relationship between employees and companies assumes the existence of an agreement that establishes the conditions of the employment relationship. One of the points in this agreement is the wage that is paid by the company for the services provided by the workers (Bernardim and Araújo, 2016).

Wages can be provided in many forms, mainly by basic remuneration, incentives and benefits. Basic remuneration is composed of a fixed, base salary, which can be paid per month or hour worked. Salary incentives are intended to reward employees for good performance and can be offered in the form of bonuses, which are based on the profits and results of the company. Benefits are provided such as paid vacations, life insurance, transport and subsidized meals (Favarim, 2011).

The payment systems most commonly used for agricultural labor in the United States are payment per hour and piecework (Shi, 2010). Remuneration per hour means

that employees earn a value for each hour worked (Poli Neto *et al.*, 2016). In the piecework system, payment is based on the production of pieces (Carraro *et al.*, 2014).

An advantage of the fixed, base salary system is that it provides more balance for company budgets, using a system of roles and salaries. This method of payment allows employers to compare salaries within the market. It also leads to a feeling of justice among workers due to the standardization of remuneration. However, in this system, workers do not feel motivated to increase their productivity because they will earn the same salary whether they work hard or not (Chiavenato, 2002).

The piecework system provides some advantages and disadvantages for companies. In terms of advantages, it adjusts payment according to performance; it acts as a motivational factor, it focuses on targets and results, it allows workers to evaluate their own performance, and it does not influence the fixed costs of the organization. However, it also brings some disadvantages because it requires a certain disorganization within the administration of the company; it destabilizes logical and rigid salary structures; it reduces the centralized control of salaries, as well as causing complaints from employees who do not benefit from the system, union pressures, decreases in the quality of products, and increases in absences from work due to overwork (Araújo, 2006).

Shirom *et al.* (1999) studied the emotional state of 2,747 employees from 21 companies using different forms of payment and found that those who were paid by piecework suffered from higher levels of depression and somatic complaints compared to those who were paid hourly, .

Shi (2010) compared hourly pay and piecework in the area of plant pruning and concluded that payment based on piecework increased productivity by around 20%. The author also found that there was no decrease in the quality of the service.

Kube *et al.* (2013) found that changing the forms of payment to workers within a company resulted in a reduction in productivity of up to 20%. However, equivalent wage increases did not result in increased productivity. Monetary incentives to workers depending on performance highlighted the productive potential to be exploited.

Kandilov and Tomislav (2016) studied agricultural workers and reported that forms of payment were related to the characteristics of the professional. Conservative people opted for the traditional payment system, whereas more adventurous people preferred the piecework system.

The objective of this experiment was to compare employment contract systems based on hourly pay and payment for piecework in the main activities performed in an ornamental plant production company.

## II. MATERIAL AND METHODS

The experiment was carried out in a company that produces ornamental plants. The company was founded 35 years ago; it has more than 2,000 customers and employs around 150 employees.

The company had always worked with contracts that remunerated workers based on the number of hours worked. The piecework system was introduced in the company in order to create a situation of mutual gain. The objective of the enterprise was to reduce labor costs and to provide better remuneration for the more efficient employees, without affecting the rest time and the quality of work.

The experimental design was completely randomized, with four treatments and five repetitions. The treatments consisted of hourly payment in the first year and piecework in the second, third and fourth years. The analyzed variables were the containers that were worked on (trays  $h^{-1}$  and pots  $h^{-1}$ ) and the hourly remuneration paid to the workers in relation to the movement of containers (trays/pots), spacing between containers, flower and leaf removal per container, plant pruning and plant selection per container. The repetitions occurred with the agglutination of the data in five periods of the year, with an average of 73 days of activities for each analyzed variable.

The movement of containers (trays/pots) was necessary for the full development of the plants. This activity involved the transport of containers (trays/pots) between greenhouses and courtyards with solar radiation.

The work to alter the spacing between the plants was necessary to supply the needs of area and light for the development of the plants. The containers were placed on the floor and on holders.

The flower/leaf removal consisted of removing specific parts of the plants for their adequate growth and also because of market preferences. Depending on the type of work to be done, it was necessary to use a special pruning tool and extra material to raise the plants to an adequate height.

Each worker had the following duties: to choose the plants using quality control (color, shape, size); clean the plants; remove the weeds; separate the containers in batches; water the plants; classify them; put bar codes on the plants; and organize the distribution location.

Each worker had the duty to choose the plants following a quality control (color, shape, size), clean the dirt, remove the weeds, separate containers in batches, irrigate, classify, put bar codes and organize the distribution place.

In implementing the new remuneration system, the company determined the following rules: a) every worker had the right to be paid based on productivity; b) all the activities were to be performed with efficiency and quality; c) the moments for meals and breaks were to be strictly respected; d) all safety rules were to be followed; e) the areas of work were always to be clean and organized.

The obtained values were submitted to Hartley's tests to verify the homoscedasticity of variance, and Shapiro Wilk tests to examine the normality of the data. For the analysis of variance, the Fisher-Snedecor test and polynomial regression were used with a level of confidence higher than 95% of probability.

## III. RESULTS AND DISCUSSION

The data tabulation showed that plant selection (trays/pots) consumed 49% of the workers' time. The pruning 28%, removal of flowers / leaves consumed 14%, movement of containers took 6% and spacing between plants 3%.

Hartley's test demonstrated the homoscedasticity of variances and the Shapiro Wilk test proved the normality of the data; therefore, the transformation of these data was not necessary. Studying the results regarding the containers, (trays  $h^{-1}$  and pots  $h^{-1}$ ), an increase in productivity could be observed for all the activities (Fig. 1).

The piecework system increased the rate of movement of containers (trays/pots) by 137%; spacing between containers by 141%; flower/leaf removal by 54%; pruning by 62% and plant selection by 75% compared to the hourly pay system. These results corroborate the conclusions of Shi (2010) and indicate the productive potential of the workers to be exploited, as emphasized by Chiavenato (2002) and Kube *et al.* (2013).

The polynomial regression that best fit the data was the quadratic one, highlighting a reduction in the productivity of the workers over the years. The motives may be associated with the caveats of the system quoted by Araújo (2006) and Shirom *et al.* (1999). Even after two years using the piecework system, the worst performance compared to the hourly pay system was still 33% more in relation to flower/leaf removal.

The statistical analysis indicated a significant increase in remuneration for workers using the piecework system (Fig. 2). The comparison between the first year (hourly pay) and second year (piecework system) showed that in the second year the workers' earnings rose (US\$ h<sup>-1</sup>) by 48% for container movement (trays/pots), 49% for container spacing, 39% for flower/leaf removal, 29% for pruning and 25% for plant selection.

The workers interest in increasing their earnings was very evident with the change to the piecework system. These results emphasize the advantages of the system for both companies and employees, as proposed by Araújo (2006) and Kube *et al.* (2013).

The regressions were quadratic for the five studied activities. After the enthusiasm generated by the change in the payment system, there was a downward trend in pay per piece worked over the years. The reasons may have been related to increased illness due to overwork at the activities, as well as higher levels of depression and somatic complaints; as highlighted by Shirom *et al.* (1999) and Araújo (2006).

Despite the fall in enthusiasm of the workers over the years, their salaries were on average 33% higher in the piecework system than in the hourly pay system. The values were 20% higher than the earnings cited by Shi (2010) in a pruning company. Thus, in addition to the professional characteristics mentioned by Kandilov and Tomislav (2016), the piecework system increased the employees earnings.

#### IV. CONCLUSIONS

The income from the activities carried out and the remuneration rose significantly for all the evaluated variables when the company began to use the piecework system.

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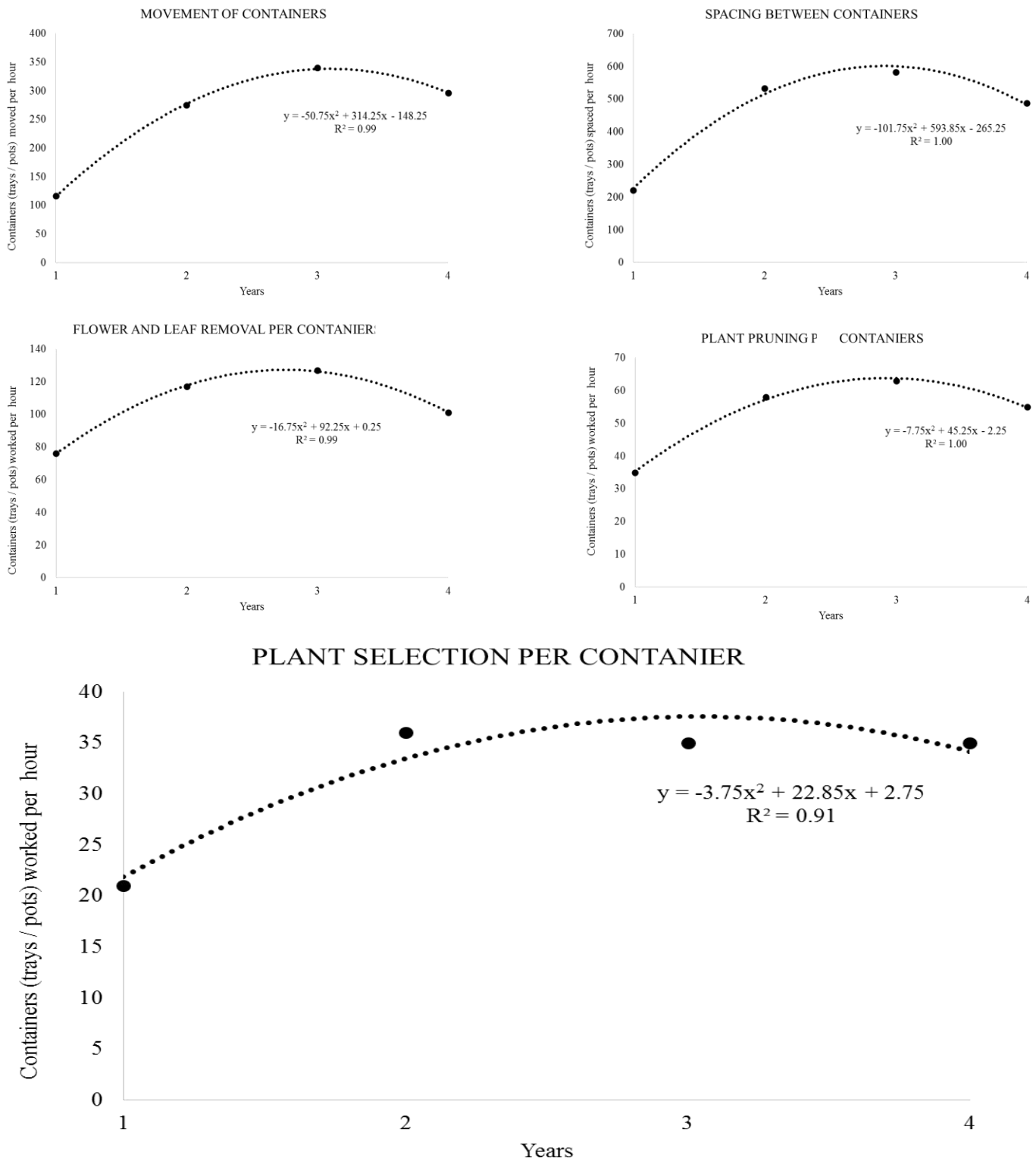


Fig. 1: Handling of containers (trays/pots)  $h^{-1}$  in employee remuneration systems of hourly pay (first year) and piecework (second to fourth year) in a company producing ornamental plants in the USA.

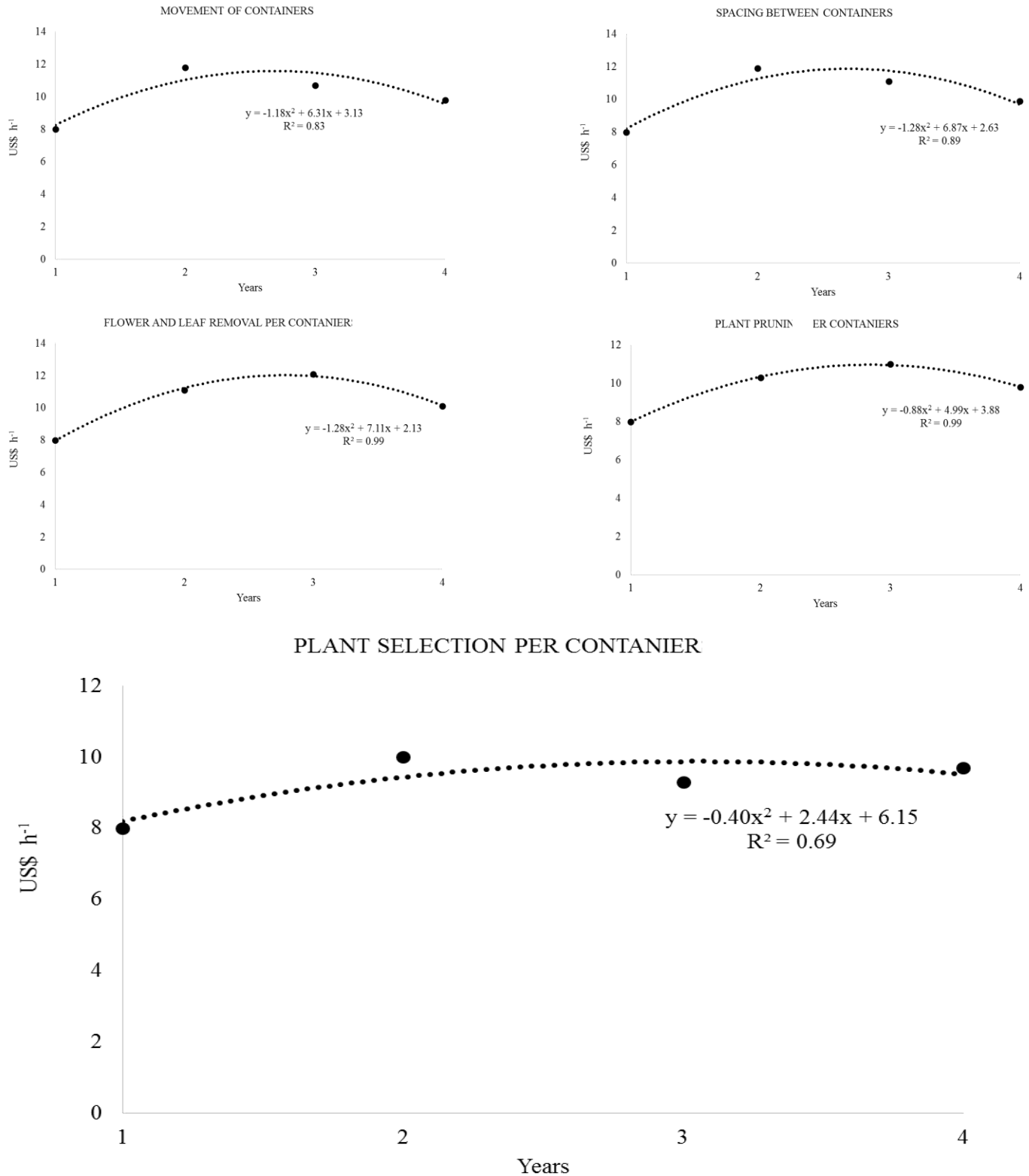


Fig. 2: Remuneration, in US\$ h<sup>-1</sup>, in the system of hourly pay (first year) and piecework (second to fourth year) in a company producing ornamental plants in the USA.



# Production of Pressed Brick of Cement Soil Manufactured with Addition of Construction and Demolition Waste

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**Abstract**— In this work the scientific study of the technical feasibility of the use of the soil of the city of Manaus for the production of soil-cement brick with addition of Construction and Demolition Residues (RCD) is verified. The soil characterization classified it as being clayey. For this soil to be employed it is necessary to correct it. In this context, as presented in the literature review, it is observed that Manaus produces large amounts of RCD, therefore it was decided to use the waste, as possible material to be used in soil correction. As presented in results and discussions, it is verified that the compressive strength of the bricks with RCD present values higher than the minimum values foreseen in standard. With these results obtained in the CP's and the adoption of the ideal trace, it is verified that the use of the RCD adapts the negative characteristics of the soil, demonstrating the viability of the production of soil-cement brick with addition of RCD.

**Keywords**— Solo, RCD, Cement.

## PRODUÇÃO DE TIJOLO PENSADO DE SOLO CIMENTO FABRICADO COM ADIÇÃO DE RESÍDUOS DE CONSTRUÇÃO E DEMOLIÇÃO

**Resumo:** Neste trabalho verifica-se o estudo científico da viabilidade técnica da utilização do solo da cidade de Manaus para a produção de tijolo solo-cimento com adição de Resíduos de Construção e Demolição (RCD). A caracterização realizada no solo classificou-o como sendo argiloso. Para que este solo seja empregado faz-se necessário a correção do mesmo. Neste contexto, conforme presente na revisão bibliográfica, observa-se que Manaus produz grandes quantidades de RCD, portanto optou-se pela utilização dos resíduos, como possível material a ser utilizado na correção do solo. Conforme presente em resultados e discussões, constata-se que a resistência à compressão dos tijolos com RCD apresentam valores maiores do que os valores mínimos previstos em norma. Com estes resultados obtidos nos

CP's e a adoção do traço ideal verifica-se que a utilização do RCD adapta as características negativas do solo, demonstrando a viabilidade da produção de tijolo de solo-cimento com adição de RCD.

**Palavras-chave:** Solo, RCD, Cimento.

## I. INTRODUÇÃO

O conceito de sustentabilidade ambiental tem sido discutido desde a década de 1960, conforme relatado por LIMA (2013), com o Clube de Roma que debatia as questões ambientais, neste ínterim alguns estudiosos em várias partes do planeta esboçavam os primeiros comentários sobre questões que envolviam o tema. Em seu primeiro relatório o Clube de Roma (Limits to Growth de 1972) impactou a comunidade científica ao apresentar cenários bastante catastróficos sobre o futuro do planeta, se o padrão desenvolvimentista continuasse nos mesmos moldes vigentes da época que se iniciou as discussões.

SILVA *et al.* (2014) relata que uma das formas para diminuir esse problema e a reciclagem e a reutilização desses resíduos, que ao longo dos últimos anos tornou-se prática importante para a redução dos impactos ambientais ocasionados ao meio ambiente.

O Conselho Nacional de Meio Ambiente (CONAMA), por meio da Resolução nº 307, afirma que cabe aos municípios a definição de uma política municipal para os resíduos da construção civil (RCD), sendo fundamental a reciclagem da fração mineral que representa 90% da massa desse resíduo.

BASTOS (2016) relata que no Brasil, assim como em muitos outros países, a fração mineral do RCD é reutilizada para aplicação como agregado para pavimentação e enchimento de aterros, no entanto, representa apenas cerca de 20% do mercado de produtos à base de cimento.

Como alternativa para o uso racional dos recursos naturais, a reutilização de RCD surge como alternativa cada vez mais viável para ser adicionado ao processo de fabricação de tijolo de solo-cimento, contribuindo para o

gerenciamento dos resíduos sólidos, sejam em escala municipal, estadual e federal (RIBEIRO, 2013).

RIBEIRO (2013) afirma ainda que o estudo da utilização de técnicas construtivas sustentáveis, como a utilização de tijolos de solo-cimento com uso de RCD, objeto deste estudo, fabricados com a intenção de preservação do meio ambiente e redução de impactos ambientais devem ser encarados como materiais do futuro a serem utilizados na construção de habitações e edificações de pequeno porte. Neste contexto, segundo MOTA (2014) a quantidade de resíduos da construção civil que são descartados em Manaus é bastante elevado, dados da Secretaria Municipal de Limpeza e Serviços Públicos - SEMULSP informam no período de maio a outubro de 2013 foram descartadas cerca de 10.905,865 toneladas sem a correta destinação final.

A cidade de Manaus, assim como o resto do país passaram por um crescimento econômico expressivo nos últimos anos, com um grave declínio em seguida, contudo as tratativas referentes aos resíduos da construção civil

não evoluíram de forma prática em nosso estado. Em face desta realidade, este trabalho pretende estudar a utilização de resíduos de construção e demolição (RCD) para a produção experimental de tijolos de solo cimento, de forma a apresentar alternativa de reciclagem dos materiais descartados dando uma nova empregabilidade, contribuindo positivamente para a mitigação de impactos ambientais causados ao meio ambiente, assim como para comprovação da viabilidade da utilização de materiais alternativos estimulando o conceito de logística reversa na construção civil.

## II. METODOLOGIA

### 2.1 SOLO

O solo utilizado para o presente estudo foi escolhido aleatoriamente e coletado nos dias 04.11.2017 e 11.11.2017, em área próxima ao Campus da Universidade Federal do Amazonas - UFAM, no Conjunto Nova República, bairro Japiim, conforme demonstrado na Figura 2.1 abaixo:



Figura 2.1 – Localização dos furos perfurados para coleta de amostras de solo em área próxima ao Campus da UFAM.

#### 2.1.1 Sondagem a trado

Foram executados 05 furos no solo, sendo que 03 furos foram perfurados no dia 04.11.2017 (dia chuvoso) e os outros 02 furos foram perfurados no dia 11.11.2017 (dia seco). Os dois últimos furos foram executados devido a verificação de perda significativa de volume do solo coletado, ocorrida provavelmente pela saturação deste e posterior redução da umidade natural, proveniente da

forte influência da variação climática que ocorre sazonalmente na região, nos meses de novembro a janeiro de cada ano, conforme verificado na Figura acima.

A abertura dos furos foi executada com auxílio de 02 técnicos em pavimentação, obedecendo aos critérios preconizados na NBR 9603/88.

As Figuras 2.2 e 2.3 demonstram a execução da coleta de amostras de solo na área de estudo:



Figura 2.2 - Perfuração do solo com trado.



Figura 2.3 – Furo para coleta.

### 2.1.2 Ensaios de caracterização física do solo

#### a. Umidade higroscópica

Para obtenção da umidade higroscópica do solo deixou-se a amostra secar ao ar por um longo período. Entretanto, essa redução normalmente se dá até um certo limite. Ou seja, mesmo que se deixe a amostra secar por um longo período, sempre permanecerá uma umidade residual.

O teor de umidade higroscópica tende a ser maior à medida que o solo for mais argiloso, conforme preconizado pela NBR 6457/2016. Nos solos de granulação grossa (areias e pedregulhos) ela é praticamente desprezível. O procedimento de determinação e cálculo da umidade higroscópica é similar ao da umidade natural.

#### b. Ensaios de Consistência (Limite de Liquidez, Limite de Plasticidade e Índice de Consistência)

Para definição do ensaio baseia-se na determinação do número de golpes necessários para fechar um sulco padrão, efetuado no solo colocado na concha. O ensaio foi executado diversas vezes, fazendo-se variar o teor de umidade da amostra.

O limite de liquidez corresponde a umidade que determina o fechamento do sulco com 25 golpes. A norma NBR 6459/2016 prescreve os diversos passos do ensaio de determinação do limite de liquidez. Em cada execução do ensaio, contou-se o número de golpes necessários para fechar o sulco. Adicionalmente, coleta-se em uma cápsula o solo das bordas que se uniram, para a determinação da umidade. A Figura 2.4 demonstram a preparação e execução do ensaio de LL.



Figura 2.4 – Preparação e execução do ensaio de LL.

Para o ensaio de limite de plasticidade moldou-se bastões de 3 mm de diâmetro, até que se quebrassem em pequenas peças, encontrando assim o menor teor de umidade em que o solo se comporta plasticamente. Sendo o LL em %, obtido com auxílio da reta ajustada do gráfico a ser apresentado com os dados obtidos e o LP em % definido pela média de umidade desprezando valores diferidos de 5%.

#### c. Peso específico dos grãos

O peso específico real dos grãos ( $\gamma_g$ ) consistiu na relação entre o peso e o volume de uma partícula individual de solo. Para a obtenção do peso específico real dos grãos, foi necessário conhecer o volume ocupado pelos grãos. No laboratório, isso tornou-se possível com base no princípio de que um corpo imerso em água desloca um certo volume de líquido. Esse volume foi obtido indiretamente através de uma relação com o peso da água deslocada. A execução do ensaio exige o uso de recipientes com volume conhecido (picnômetro).

A norma NBR 6508/1984 define o método para a obtenção do peso específico real dos grãos. Alternativamente, devido à maior simplicidade, recomenda-se também o procedimento do DNER – DPT M 93-64.

#### d. Análise granulométrica por peneiramento

O ensaio de granulometria foi utilizado para determinar a distribuição granulométrica do solo, ou seja, a percentagem em peso que cada faixa especificada de tamanho de grãos representa na massa total seca utilizada no ensaio.

Através dos resultados obtidos desse ensaio foi possível a construção da curva de distribuição granulométrica, que possui fundamental importância na caracterização geotécnica do solo.

A forma mais direta de obter o diâmetro dos grãos é passando-os através de uma série de peneiras, com aberturas conhecidas. Esse procedimento permite conhecer os diâmetros dos grãos superiores a 0,075 mm, que é a menor abertura de peneira disponível. Para os grãos inferiores a essa dimensão, utiliza-se o processo da sedimentação. Esse método baseia-se no princípio de que, dispersando-se as partículas de solo em água, a velocidade de sedimentação dos grãos aumenta com o diâmetro deles. (Lei de Stokes).

O método para análise granulométrica é prescrito pela NBR 7181/2016. A Figura 2.5 demonstra a separação de peneiras para realização de ensaio.



Figura 2.5– Separação de peneiras para realização do ensaio.

#### e. Ensaio de Compactação

Através do ensaio de compactação é possível obter a correlação entre o teor de umidade e o peso específico seco de um solo quando compactado com determinada energia. Com os resultados obtidos no ensaio de compactação são efetuados cálculos para a determinação do peso específico aparente seco ( $\gamma_d$ ) e a determinação da curva de saturação.

A compactação do material para a confecção do corpo de prova seguiu a NBR 7182/2016, aplicando 26 golpes por camada, sendo 03 camadas, com um soquete de massa de 2,5kg caindo a 30,5cm, com energia de compactação normal.

Experimentalmente, é possível constatar que a adição de água a um solo seco facilita a sua compactação. Conclui-se que cada vez que se adiciona água a esse solo pouco úmido, a densidade final do material compactado aumenta.

A Figura 2.6 mostra a preparação do cilindro para a realização do Ensaio de Proctor.



Figura 2.6 – Preparo de corpo de prova para o ensaio de Compactação.

Para a determinação de umidade ótima ( $W_{ótima}$ ) e densidade máxima aparente seca ( $\gamma_s$ ) devem ser utilizadas amostras, conforme previsto na NBR 6457/2016.

#### f. Ensaio de Índice Suporte Califórnia (ISC)

Para a realização do Ensaio de ISC adotou-se os critérios estabelecidos na NBR 9895/2017, Norma DNIT 172/2016-ME e a NBR 7182/2016.

Foram moldados 03 (três) corpos de prova com energia de compactação normal, sendo 12 golpes para cada camada, totalizando 05 (cinco) camadas. Os corpos de prova foram imersos em tanque de água por 05 (cinco) dias, tendo sido realizadas 05 (cinco) leituras a cada 24 horas para medir a expansão do solo, conforme previsto na NBR 7182/2016.

Após o período de imersão em tanque os corpos de prova foram colocados ao ar livre para secagem por 15 (quinze) minutos, para preparação e início do ensaio de penetração, onde foram realizadas leituras no tempo máximo de 10 minutos, sendo que cada leitura considerada no extensômetro do anel foi função de uma penetração do pistão no solo e de um tempo especificado para o ensaio.

#### g. Classificação dos Solos (HRB e SUCS)

Para a classificação do solo em estudo adotou-se 02 (dois) métodos: o método de Classificação Rodoviário (AASHTO) e o método de Classificação Unificada (SUCS).

Segundo PINTO (2016), ambos os métodos de classificação se baseiam principalmente na granulometria

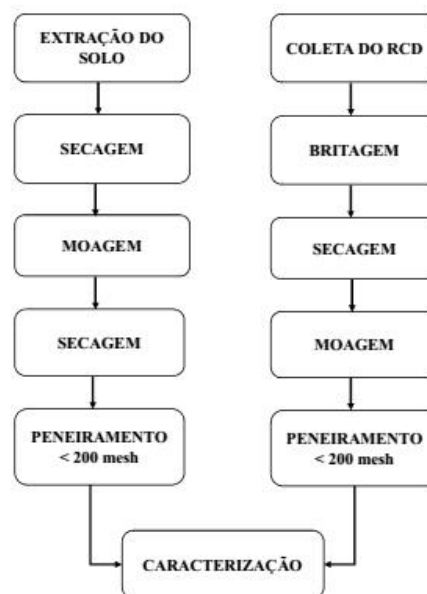
do solo e nos Limites de Atterberg, ou seja índices de consistência.

## 2.2. PROCESSOS DE FABRICAÇÃO

### 2.2.1 Corpo de provas (CP)

Os ensaios experimentais foram realizados na Usina de Materiais, localizada no laboratório da Faculdade de Engenharia Química – UFPA.

Na Figura 2.7 é observado um esquema simplificado das etapas iniciais, as quais os materiais foram submetidos.



Na Figura 2.8 podem ser observados os equipamentos utilizados na etapa de cominuição dos materiais.

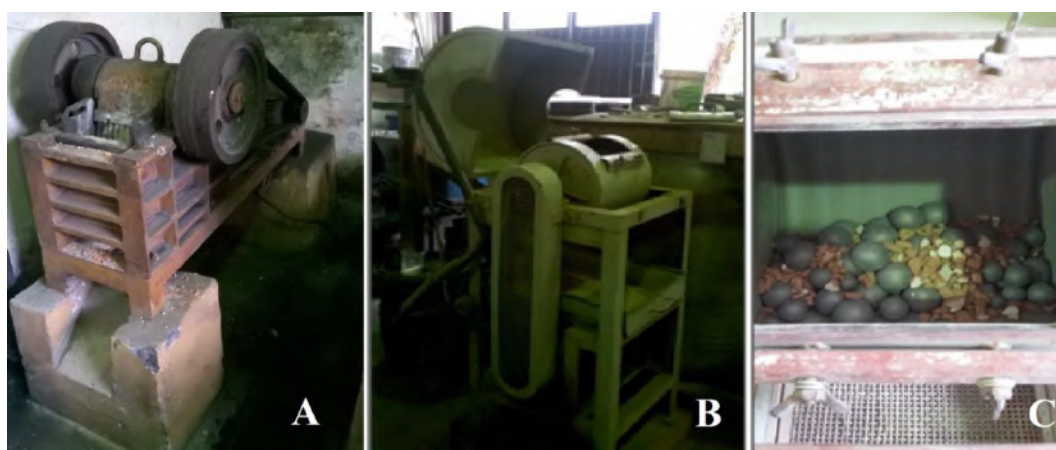


Figura 2.8 – (A) britador de mandíbula, (B) moinho de bolas e (C) material em processo de fragmentação.

Após as etapas de cominuição, o solo e o RCD foram classificados pela operação de peneiramento nas peneiras da ABNT, conforme verificado na Figura 2.9.



Figura 2.9 – Operação de peneiramento.

A Figura 2.10 mostra o solo, RCD e o cimento após os processos de secagem, cominuição e peneiramento.

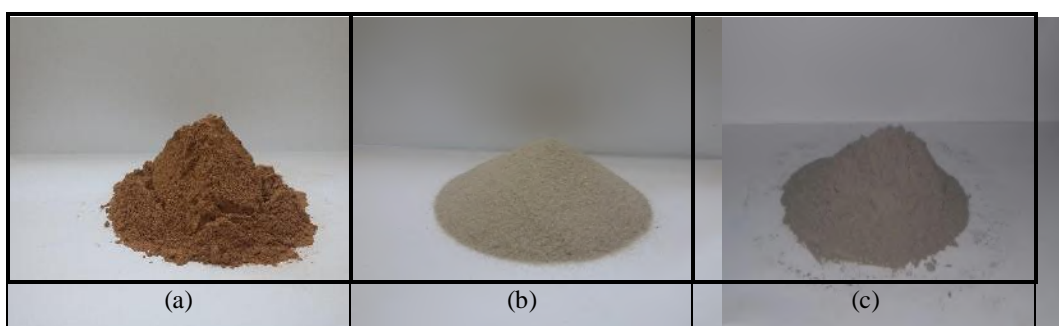


Figura 2.10 – RCD seco, moído e peneirado (a). Solo (b). Cimento (c).

Posteriormente às etapas iniciais os materiais (solo e RCD) foram submetidos as etapas descritas na Figura 2.10.

Como pode ser observado na Figura 2.10 os materiais sofreram um novo processo de peneiramento. Todos os tijolos solo-cimento foram produzidos com as granulometrias dos materiais abaixo da peneira de mesh 14, visando comparação com os trabalhos existentes na literatura. A Figura 2.11 que segue abaixo, demonstra o fluxograma das etapas finais após o peneiramento do solo e do RCD, ocorrendo as misturas para confecção dos corpos de prova.



Figura 2.11 – Fluxograma das etapas finais de procedimento experimental.

Após a definição dos percentuais dos materiais a serem utilizados na elaboração dos traços, partiu-se para a confecção dos corpos-de-prova. Conforme demonstrado no fluxograma da Figura 2.11, antes da confecção dos CP'S, existem duas etapas, a mistura 01 e a mistura 02. A fase de mistura 01 consiste em combinar o solo e o cimento até que a massa formada obtenha uma coloração homogênea. Em seguida, é adicionado a essa massa de

coloração homogênea o RCD, misturando-o até obtermos a homogeneidade requerida (mistura 02).

Para a confecção dos corpos de prova, utilizou-se formas cilíndricas de policloreto de vinila (PVC) com dimensões de 10 cm de altura e 5 cm de diâmetro conforme recomendado pela Norma NBR 7215/1991.

Na Figura 2.12 pode ser observado os moldes dos corpos de prova cilíndricos.

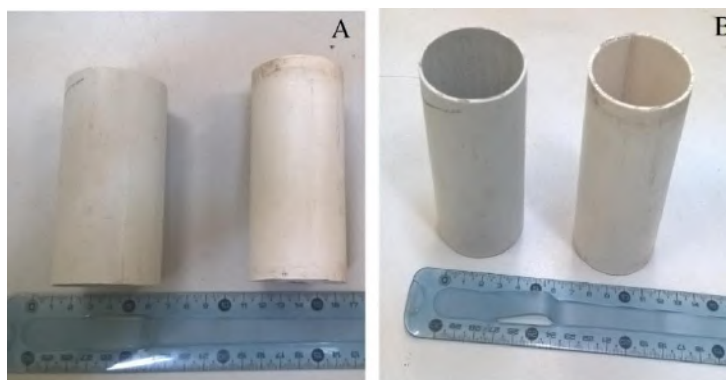


Figura 2.12 – Moldes dos CP'S cilíndricos (A) e (B) elaborados com PVC.

De acordo com a Tabela 3.1, foram elaborados 5 traços (Tr<sub>0</sub>, Tr<sub>10</sub>, Tr<sub>20</sub>, Tr<sub>30</sub> e Tr<sub>40</sub>). Para cada traço foram moldados 5 corpos-de-prova (CP's). A massa de cada CP elaborado e a massa da mistura total utilizada para a confecção dos 5 CP's, podem ser vistas nas Tabelas 2.1 e 2.2, respectivamente.

Tabela 2.1- Massa utilizada para elaboração dos CP's

Corpos-de-prova	Massa (g)
1 corpo-de-prova	250
5 corpos-de-prova	1.250

Tabela 2.2 - Massa da mistura total utilizada para a elaboração dos CP's.

	Solo (g)	RCD (g)	Cimento (g)	Massa total (g)	% Água
Tr <sub>0</sub>	1.125	0	125	1250	16
Tr <sub>1</sub>	1000	125	125	1250	16
Tr <sub>2</sub>	875	250	125	1250	16
Tr <sub>3</sub>	750	375	125	1250	16
Tr <sub>4</sub>	625	500	125	1250	16

A água utilizada foi dosada em torno de 16% da massa total da mistura de cada traço. Após a conformação dos CP's, os mesmos foram submetidos ao processo de cura em câmara úmida por um período de 28 dias. Após os 28 dias de cura os CP's foram desmoldados e submetidos aos testes de resistência a compressão.

Os ensaios de resistências à compressão dos CP's foram realizados de acordo com a NBR 7215/1997 e NBR 12253/2012, após 28 dias de cura, utilizando-se uma prensa modelo EMIC SSH300 do Laboratório de Materiais de Engenharia Civil (LEC) da Universidade

Federal do Pará, conforme demonstrado na Figura 2.13.



Figura 2.13 – Prensa modelo EMIC SSH300.

A resistência a compressão axial de cada CP é obtida dividindo-se a carga de ruptura pela área da seção transversal dos CP's. Neste estudo, foram obtidos os valores das resistências para 3 CP's confeccionados, obtendo-se um valor médio para a resistência a compressão axial.

### 2.2.3 Tijolos maciços produzidos com traço ideal adotado

Os tijolos foram produzidos com base no traço ideal obtido (50% solo + 40% RCD + 10% cimento) após a cura de 28 dias e rompimento dos corpos de prova. Foram produzidos tijolos de forma retangular de acordo com gabarito (espessura de 10cm) em uma prensa manual, controlando-se a energia de compactação e a quantidade de material colocada em cada amostra, conforme Figura 2.14 que segue abaixo:



Figura 2.14 – Tijolos maciços produzidos com traço

adotado.

Após a moldagem desses tijolos, estes foram levados para a cura de 28 dias em câmara úmida, assim como ocorreu com os corpos de prova.

Após a cura estes foram submetidos aos ensaios de resistência a compressão utilizando-se uma prensa modelo EMIC SSH300 do Laboratório de Materiais de Engenharia Civil (LEC) da Universidade Federal do Pará, conforme Figura 3.14.

A resistência a compressão axial de cada tijolo foi obtida dividindo-se a carga de ruptura pela área da seção transversal, conforme previstos nas normas NBR 7215/1996, NBR 12253/2012 e NBR 8492/2012

### 2.2.4 Tratamento estatístico dos resultados obtidos

Para o tratamento dos valores obtidos para os corpos de prova e para os tijolos experimentais produzidos foram calculados o desvio padrão e o coeficiente de correlação do espaço amostral resultante da quantidade de resultados provenientes da prensagem após a cura de 28 dias.

## 2.3. RESÍDUOS DE CONSTRUÇÃO E DEMOLIÇÃO (RCD)

O resíduo utilizado foi coletado nas dependência do Laboratório de Engenharia Civil da Universidade Federal do Pará, o qual é proveniente dos ensaios de resistência aplicado em blocos de concretos que serão comercializados na região metropolitana de Belém.

## 2.4. CIMENTO PORTLAND CP II E-32

O cimento utilizado para a produção do tijolo solo-cimento foi o cimento Portland tipo CP II E-32.

## 2.5. ÁGUA

Neste trabalho foi utilizada água potável coletada normalmente da rede de distribuição de água do município de Belém do estado do Pará, fornecida pela Companhia de Águas de Belém.



### III. RESULTADOS

#### 3.1. CARACTERIZAÇÃO FÍSICA DOS SOLOS

##### 3.1.1 Umidade higroscópica

Para o ensaio de teor de umidade para cada cápsula de amostra de solo, foram obtidos os dados descritos na Tabela 3.1:

Tabela 3.1 – Teor de Umidade higroscópica do solo em estudo.

Cápsula Nº	Umidade Higroscópica (W%)	
	18	44
Peso Cápsula Nº (g)	17,56	17,56
Cápsula e Solo Úmido (g)	79,83	79,83
Cápsula e Solo Seco (g)	74,98	74,98
Solo Seco (g)	57,42	57,42
Água (g)	<b>4,77</b>	<b>4,85</b>
Umidade Higroscópica (%)	8,30	8,45
Fator de Correção	0,9233	0,9221
<b>Média de valores (W%) 8,375%</b>		

##### 3.1.2 Ensaios de Consistência

Após a realização do ensaio de Limite de Liquidez (LL) foram obtidos os dados apresentados na Tabela 3.2 a seguir:

Tabela 3.2 – Limite de Liquidez do solo em estudo.

Cápsula Nº	Limite de Liquidez (LL %)				
	1	2	3	4	5
Peso da cápsula solo úmido	18,22	16,17	17,40	17,21	17,91
Peso da cápsula solo seco	15,66	13,98	15,05	14,84	15,11
Peso da cápsula	7,92	8,49	9,25	9,17	9,26
Peso da Água	2,56	2,19	2,35	2,37	2,80
Peso do solo seco	7,74	5,49	5,80	5,67	5,85
Teor de Umidade	33,07	39,89	40,52	41,80	47,86
Nº de golpes	<b>9</b>	<b>17</b>	<b>25</b>	<b>34</b>	<b>42</b>

Neste contexto, o limite de liquidez do solo corresponde ao teor de umidade referente a 25 golpes, obtidos com base na reta ajustada, é igual a 40,52%, conforme a Figura 3.1 abaixo:

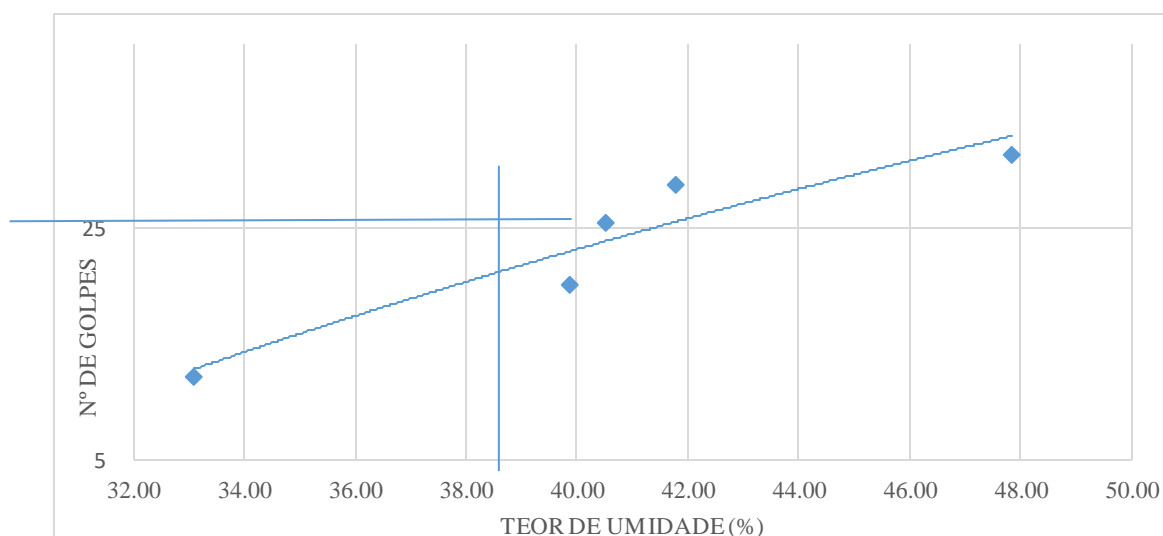


Figura 3.1 – Reta ajustada para determinação do Teor de Umidade.

Para a determinação do LP foram gerados os dados demonstrados na Tabela 3.3 que segue abaixo:

Tabela 3.3 – Limite de Plasticidade do solo em estudo.

Limite de Plasticidade (LP %)					
Cápsula N°	1	2	3	4	5
Peso da cápsula solo úmido	14,53	14,92	17,43	16,32	15,95
Peso da cápsula solo seco	13,49	13,96	16,02	14,92	14,80
Peso da cápsula	8,34	9,21	9,19	8,31	9,28
Peso da Água	1,04	0,96	1,41	1,40	1,15
Peso do solo seco	5,15	4,75	6,83	6,61	5,52
Teor de Umidade	<b>20,19</b>	<b>20,21</b>	<b>20,64</b>	<b>21,18</b>	<b>20,83</b>

Sendo o LL = 40,52%, obtido com auxílio da reta ajustada do gráfico 4.1 e o LP = 20,19% definido pela média de umidade desprezando valores diferidos de 5%.

Obtendo-se os valores descritos na Tabela 3.4 a seguir:

Tabela 3.4 – Índices de Consistência (LL, LP e IP).

Limite de Liquidez (LL %)	40,52
Limite de Plasticidade (LP %)	20,19
Índice de Plasticidade (IP %)	20,33

### 3.1.3 Peso específico dos grãos

Com base na equação citada no capítulo anterior, utilizando os dados coletados em laboratório tem-se como resultados os valores descritos na Tabela 3.5:

Tabela 3.5 – Densidade real do solo em estudo.

Densidade Real ( $\gamma_g = \text{g/cm}^3$ )		
N° do Recipiente	20	9
Peso do Recipiente (a)	34,85	33,42
Peso do Recipiente + água (b)	87,14	87,14
Peso do Recipiente + amostra (c)	68,16	67,59
Peso do Recipiente + amostra + água (d)	107,48	107,93
Densidade	2,57	2,55
<b>Média de valores <math>\gamma_g</math></b>	<b>2,56</b>	

### 3.1.4 Análise granulométrica por peneiramento

Os resultados dos ensaios de granulometria podem ser verificados nas Tabelas 3.6 e 3.7 que seguem abaixo:

Tabela 3.6 – Ensaio de análise granulométrica por peneiramento da amostra 01.

Amostra Total Seca	Umidade Higroscópica	Resumo Granulometria			
Amostra Total					
	Cápsula N°	44,00	Pedregulho (>4,8mm)	0,0%	
Úmida (g)	104,08	Peso Cápsula N° (g)	17,56	Areia Grossa	
Retido n° 10 (g)	0,0	Cápsula e Solo Úmido (g)	79,83	4,8 - 2,0mm	0,0%
Passando N° 10					
Úmida (g)	104,1	Cápsula e Solo Seco (g)	74,98	Areia Média	
Água (g)		Solo Seco			
		(g)	57,42	2,0 - 0,42mm	4,6%
		Água			
	6,4	(g)	4,85	Areia Fina	
Passando N° 10	97,7	Umidade Higroscópica	8,45	0,42 - 0,074mm	3,0%

Seca (g)	(%)				
<b>Amostra Total</b>				Silte+Argila(<0,074mm)	92,4%
<b>Seca (g)</b>	<b>97,7</b>	<b>Fator de Correção</b>	<b>0,9221</b>	<b>Total .....</b>	<b>100,0%</b>

Tabela 3.7 – Ensaio de análise granulométrica por peneiramento da amostra 02.

Amostra Total Seca		Umidade Higroscópica		Resumo Granulometria	
Amostra Total		Cápsula N°	18,00	Pedregulho (>4,8mm)	0,0%
Úmida (g)	104,08	Peso Cápsula N° (g)	17,56	Areia Grossa	
Retido n° 10 (g)	0,0	Cápsula e Solo Úmido (g)	79,83	4,8 - 2,0mm	0,0%
Passando N° 10 Úmida (g)	104,1	Cápsula e Solo Seco (g)	74,98	Areia Média	
Água (g)		Solo Seco (g)	57,42	2,0 - 0,42mm	4,9%
	5,9	Água (g)	4,85	Areia Fina	
Passando N° 10 Seca (g)	98,1	Umidade Higroscópica (%)	8,45	0,42 - 0,074mm	2,7%
<b>Amostra Total</b>				Silte+Argila(<0,074mm)	92,4%
<b>Seca (g)</b>	<b>98,1</b>	<b>Fator de Correção</b>	<b>0,9221</b>	<b>Total .....</b>	<b>100,0%</b>

As Figuras 3.2 e 3.3 demonstram a curva granulométrica das duas amostras de solo.

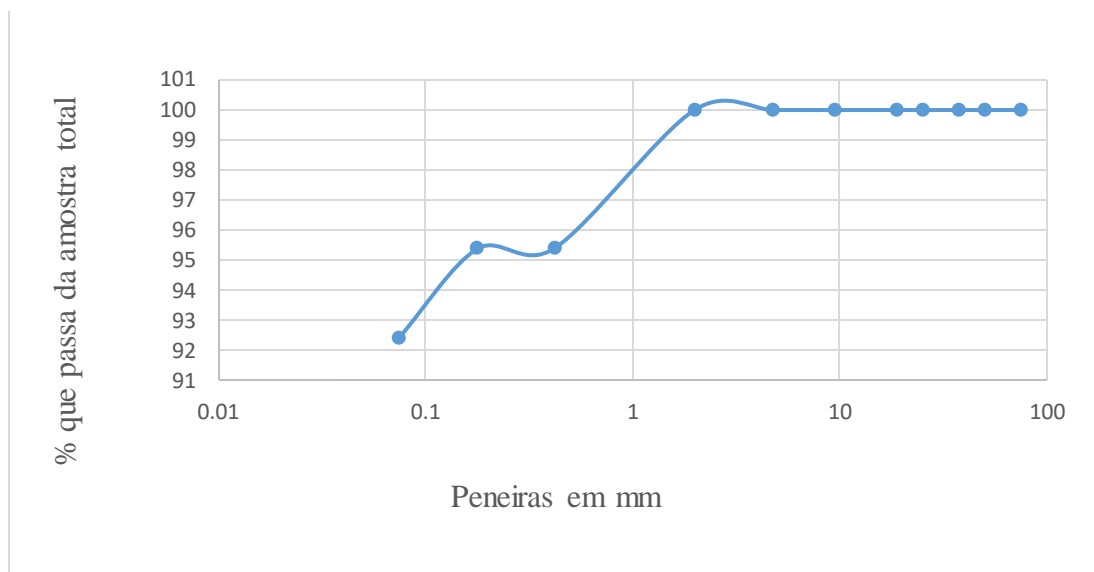


Figura 3.2 – Análise granulométrica da amostra 01.

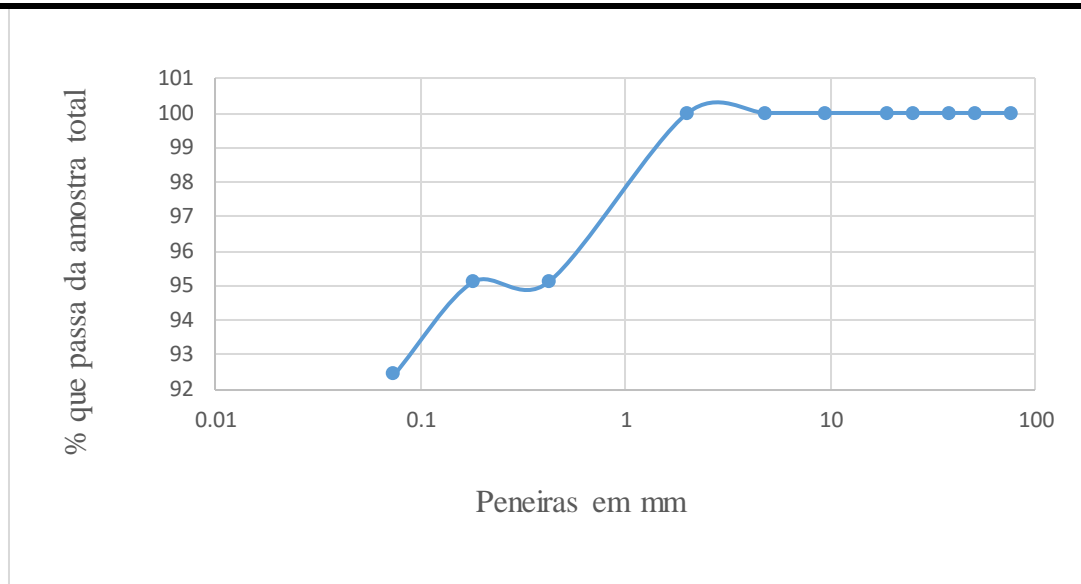


Figura 3.3 – Análise granulométrica da amostra 02.

### 3.1.5 Ensaio de Compactação

Para os valores de umidade ótima ( $W_{ótima}$ ) e Densidade máxima aparente seca ( $\gamma_s$ ), a Figura 3.4 demonstra o tratamento de dados do ensaio realizado.

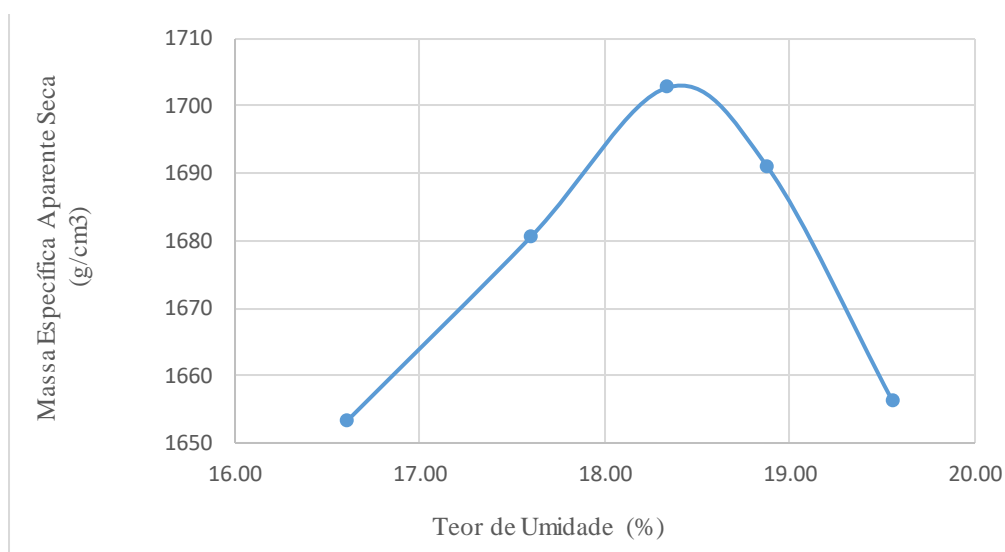


Figura 3.4 – Curva de compactação do solo analisado.

Neste contexto, obteve-se como resultado para o solo analisado os dados apresentados na Tabela 3.8:

Tabela 3.8 – Valores de umidade ótima ( $W_{ótima}$ ) e Densidade máxima aparente seca ( $\gamma_s$ ).

Densidade máxima aparente seca ( $\gamma_s$ )	1,703 (g/cm³)
Umidade Ótima ( $W_{ótima}$ )	18,04%

### 3.1.6 Ensaio de Índice de Suporte Califórnia (ISC)

A NBR 9895/2017 e a Norma DNIT 172/2016-ME definem que os resultados do ensaio de ISC devem plotados em gráficos interligados e correspondentes conforme demonstrado na Figura 3.5 que segue abaixo:

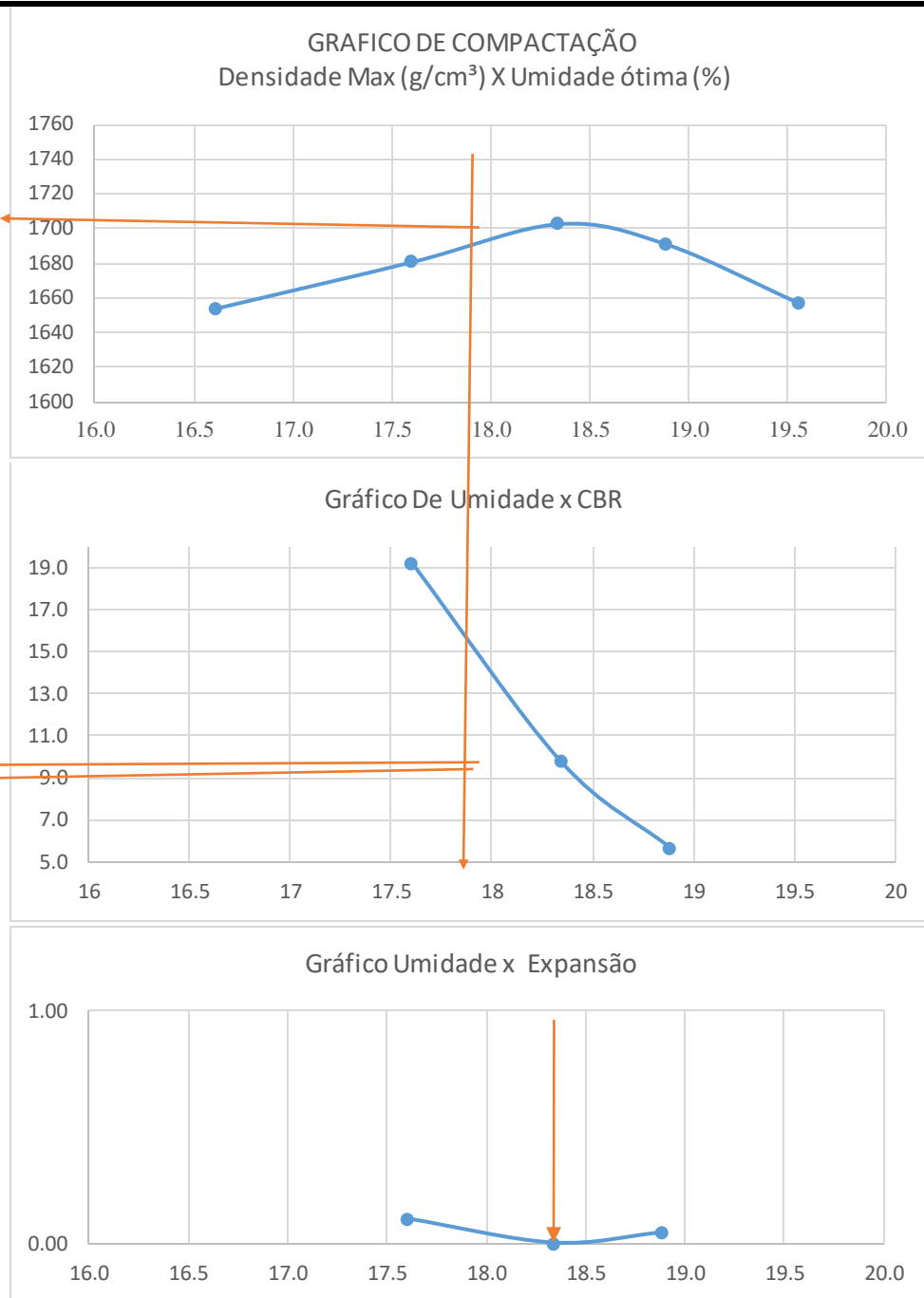


Figura 3.5 – Resultados do ensaio de ISC.

Os resultados obtidos podem ser verificados na Tabela 3.9 que segue abaixo.

Tabela 3.9 – Resultados obtidos para o ensaio de ISC% das amostras.

Corpo de prova (ISC 01%)	5,6
Corpo de prova (ISC 02%)	9,7
Corpo de prova (ISC 03%)	19,2

### 3.1.7 Classificação dos solos (AASHTO e SUCS)

Após o término dos ensaios de caracterização física e utilização destes dados do solo foi possível classificá-lo, conforme dados que seguem abaixo nas Tabelas 3.10 e 3.11.

Tabela 3.10 – Resultados para classificação do solo pelo método AASHTO.

% Passa Peneira 4 (4,8mm)	100
% Passa Peneira 10 (2,0mm)	100
% Passa Peneira 40 (0,42mm)	95,4
% Passa Peneira 200 (0,075mm)	92,4

Tabela 3.11 – Resultados para classificação do solo pelo método SUCS.

% Passa Peneira 4 (4,8mm)	100
% Passa Peneira 10 (2,0mm)	100
% Passa Peneira 40 (0,42mm)	95,4
% Passa Peneira 200 (0,075mm)	92,4
Índice de Grupo (IG)	12,8

Terminadas as análises o solo foi classificado como sendo: *Argila baixa compressibilidade*, conforme enquadramento que segue em Tabela abaixo:

Tabela 3.12 – Enquadramento do solo utilizando os métodos de classificação.

CLASSIFICAÇÃO "AASHTO"	A-7-6 ( <i>solo argiloso – fraco a pobre</i> )
CLASSIFICAÇÃO "SUCS"	CL ( <i>argila baixa compressibilidade</i> )

### 3.2. ANÁLISE DA RESISTÊNCIA DA MISTURA SOLO-CIMENTO + RCD E DOS TIJOLOS PRODUZIDOS

Os percentuais dos materiais utilizados para as etapas de misturas 01 e 02 utilizadas para a elaboração dos traços adotados para a obtenção dos corpos-de-prova (CP's) foram definidas de acordo com a Tabela 3.13 que segue exemplificada abaixo.

Tabela 3.13 - Percentuais dos materiais utilizados na produção do tijolo solo-cimento.

Materiais	Traços para fabricação de tijolo de solo-cimento (TR)				
	Tr <sub>0</sub>	Tr <sub>1</sub>	Tr <sub>2</sub>	Tr <sub>3</sub>	Tr <sub>4</sub>
Solo (%)	90	80	70	60	50
RCD (%)	0	10	20	30	40
Cimento (%)	10	10	10	10	10

#### 3.2.1 Resistência à compressão da mistura solo-cimento e RCD

A Tabela 3.14 demonstra os resultados obtidos após a realização do ensaio de resistência à compressão em 3 CP's moldados, curados e rompidos aos 28 dias.

Tabela 3.14 – Resultados do ensaio de resistência à compressão da mistura.

TRAÇO	Resistência aos 28 dias (MPa)			
	CP 1	CP 2	CP 3	Média
90% solo + 10% cimento	2,64	2,36	2,9	2,63
80% solo + 10% RCD + 10% cimento	3,29	2,95	2,92	3,05
70% solo + 20% RCD + 10% cimento	4,6	4,42	4,42	4,48
60% solo + 30% RCD + 10% cimento	4,65	4,57	4,95	4,72
50% solo + 40% RCD + 10% cimento	5,88	4,96	5,82	5,55

As Figuras 3.6 e 3.7 demonstram os resultados obtidos para as resistências individuais dos corpos de prova e a para resistência média da amostra.

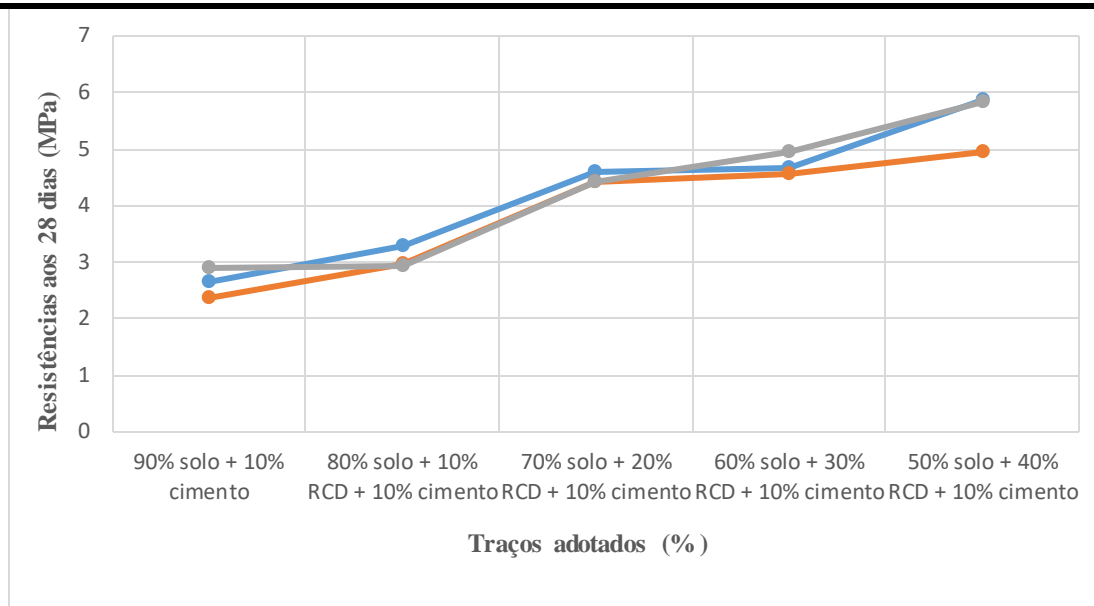


Figura 3.6 – Resistências à compressão individuais dos CPs aos 28 dias.

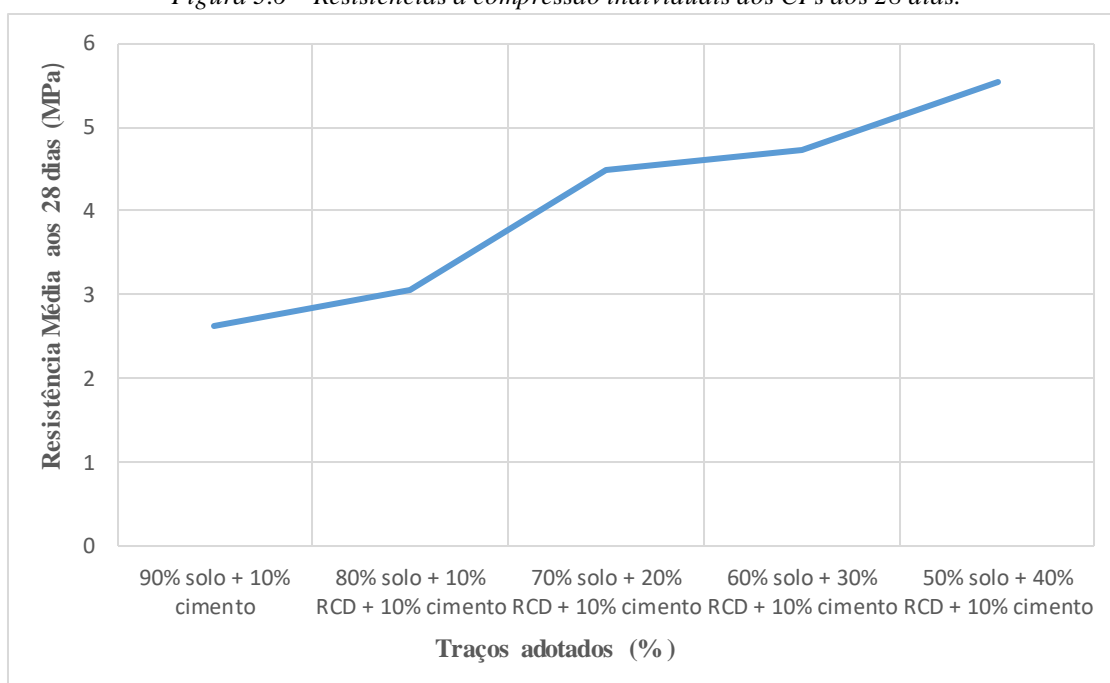


Figura 3.7 – Resistência à compressão média dos CPs aos 28 dias.

A Tabela 3.15 demonstra o coeficiente de variação calculado para a amostra, sendo o maior valor igual a 8,38% garantindo a aceitabilidade dos dados obtidos para os CP's.

Tabela 3.15 – Tratamento estatístico da resistência à compressão dos CP's.

TRAÇO	Resistência aos 28 dias (MPa)				Desvio Padrão (MPa)	Coeficiente de Variação (%)
	CP 1	CP 2	CP 3	Média		
90% solo + 10% cimento	2,64	2,36	2,9	2,63	0,22	8,38
80% solo + 10% RCD + 10% cimento	3,29	2,95	2,92	3,05	0,17	5,50
70% solo + 20% RCD + 10% cimento	4,6	4,42	4,42	4,48	0,08	1,89
60% solo + 30% RCD + 10% cimento	4,65	4,57	4,95	4,72	0,16	3,47
50% solo + 40% RCD + 10% cimento	5,88	4,96	5,82	5,55	0,42	7,57

O gráfico de dispersão dos dados obtidos pode ser observado na Figura 3.8 que expressa a baixa dispersão do coeficiente de variação da amostra.

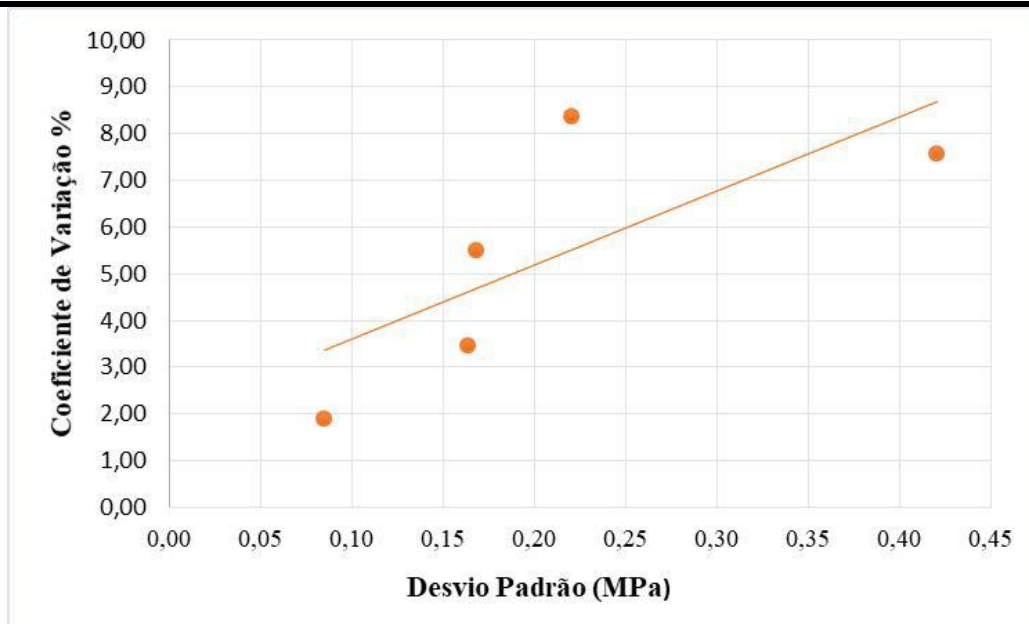


Figura 4.8 – Gráfico do coeficiente de variação (CV).

### 3.2.2 Resistência à compressão dos tijolos produzidos

Os resultados de resistência a compressão para os tijolos maciços de solo-cimento com adição de RCD foram obtidos após a cura de 28 dias e prensagem mecânica prevista em norma, de acordo com os dados que seguem abaixo na Tabela 3.16.

Tabela 3.16 – Resultados do ensaio de resistência a compressão dos tijolos.

TRAÇO ADOTADO	Resistência aos 28 dias (MPa)				
	TJ 1	TJ 2	TJ 3	TJ 3.1	Média
50% solo + 40% RCD + 10% cimento	5,65	5,76	5,45	5,49	5,57

Resultados com o traço ideal conforme observado na Figura 3.9 que segue abaixo:

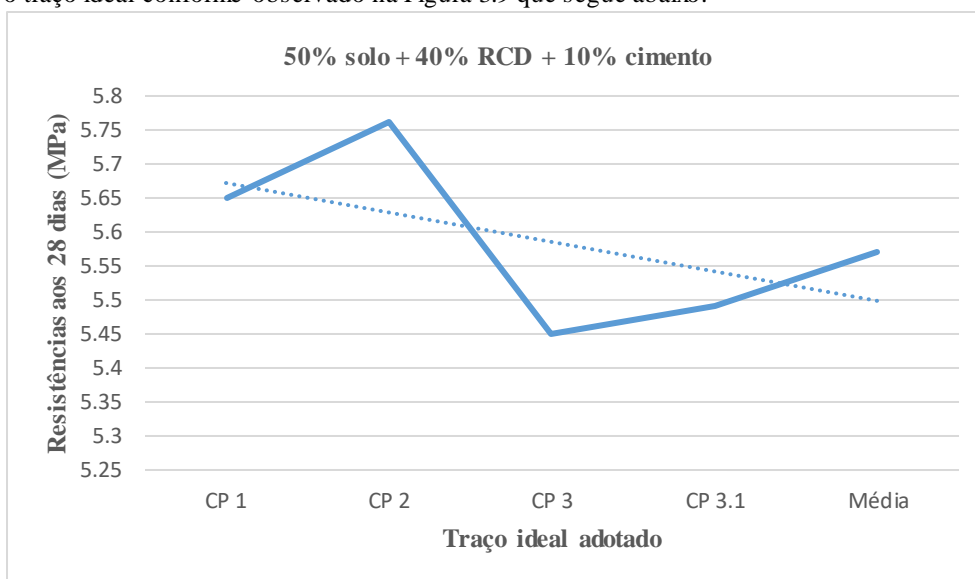


Figura 3.9 – Gráfico de resistência a compressão do tijolo produzido.

A Tabela 3.17 e a Figura 3.10 demonstram o tratamento estatístico dos resultados obtidos.



Tabela 3.17 – Tratamento estatístico da resistência a compressão dos tijolos.

TRAÇO	Resistência aos 28 dias (MPa)				Média	DP (MPa)	CV (%)
	CP 1	CP 2	CP 3	CP 3.1			
50% solo + 40% RCD + 10% cimento	5,65	5,76	5,45	5,49	5,57	0,12	2,24

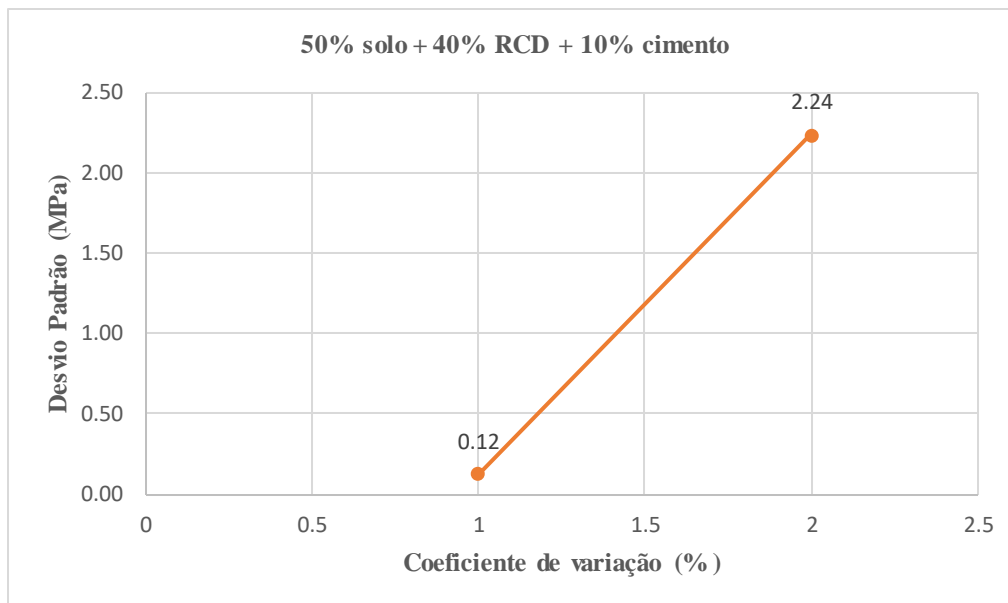


Figura 3.10 – Gráfico do coeficiente de variação (CV).

#### IV. DISCUSSÃO

##### 4.1 CARACTERIZAÇÃO FÍSICA DOS SOLOS

###### 4.1.1 Umidade higroscópica

Para o ensaio de teor de umidade para cada cápsula de amostra de solo, foram obtidos os dados descritos acima. Segundo PINTO (2016), o teor de umidade médio obtido neste estudo caracterizaria o solo como sendo do tipo: areia silto-argiloso (residual de granito), tendo como parâmetro resultados obtidos para os diversos solos brasileiros.

###### 4.1.2 Ensaio de Consistência

Após a realização do ensaio de Limite de Liquidez (LL) foram obtidos os dados apresentados na Tabela 4.2. Em seguida a realização do ensaio, elaborou-se um gráfico, no eixo das abcissas (em escala linear) os teores de umidade e no eixo das ordenadas (em escala logarítmica) o número de golpes. Aos pontos assim obtidos ajustou-se uma reta. Pontos que, eventualmente, estiverem muito afastados da tendência dos demais, foram desprezados, segundo critérios da norma.

Neste contexto, o limite de liquidez do solo corresponde ao teor de umidade referente a 25 golpes, obtidos com base na reta ajustada, é igual a 40,52%,

Sendo o LL = 40,52%, obtido com auxílio da reta ajustada do gráfico 4.1 e o LP = 20,19% definido pela média de umidade desprezando valores diferidos de 5%.

PINHEIRO (2013) ressalta em seus estudos para fabricação de tijolo de solo-cimento utilizando o “grits” como resíduo, que os valores ideais a serem obtidos para o LL e o IP do solo e do resíduo utilizado, não devem ultrapassar os limites estabelecidos em norma.

A NBR 10832/2012 afirma que para a fabricação de tijolo de solo-cimento o solo utilizado deverá apresentar os seguintes parâmetros: LL deve ser menor ou igual a 45% e o IP menor ou igual 18%, neste contexto percebe-se que o solo em estudo não atende totalmente ao previsto em norma.

###### 4.1.3 Peso específico dos grãos

Com base na equação citada no capítulo anterior, utilizando os dados coletados em laboratório tem-se como resultados os valores descritos na Tabela 4.5:

Tabela 4.5 – Densidade real do solo em estudo.

Densidade Real ( $\gamma_g = \text{g/cm}^3$ )		
Nº do Recipiente	20	9
Peso do Recipiente (a)	34,85	33,42
Peso do Recipiente + água (b)	87,14	87,14
Peso do Recipiente + amostra (c)	68,16	67,59
Peso do Recipiente + amostra + água (d)	107,48	107,93
Densidade	2,57	2,55
<b>Média de valores <math>\gamma_g</math></b>	<b>2,56</b>	

PINTO (2016) descreve que para melhor caracterizar um solo quando não se tem o peso específico dos grãos deve adotar o valor de  $27\text{KN/m}^3$ , contudo costuma-se caracterizar as argilas quando seus pesos específicos variam de  $2,56\text{g/cm}^3$  a  $3,0\text{g/cm}^3$ . O valor obtido para o solo em estudo inicialmente pode classifica-lo como sendo um solo argiloso lateríticos, proveniente da deposição de sais de ferro durante a sua formação.

#### 4.1.4 Análise granulométrica por peneiramento

Para a análise granulométrica do solo, utilizou-se 02 (duas) amostras a partir dos valores calculados traçou-se a curva de distribuição granulométrica, marcando-se no eixo das abcissas, em escala logarítmica, os “diâmetros” das partículas e no eixo das ordenadas, em escala natural, os percentuais das partículas menores do que os diâmetros considerados, isto é, os percentuais de solo que passam nas peneiras.

Para uma amostra de solo ser aceita no processo de fabricação de tijolo de solo cimento é necessário que a distribuição granulométrica esteja de acordo com os critérios da ABCP, ou seja AMARAL (2014) informa que a fração de argila deve estar entre 10% a 20%, a fração de silte entre 10% a 20% e a fração de areia entre 50% a 70%, em resumo o teor de argila deve ser inferior a 20%. A NBR 10832/2012 afirma que o solo mais adequado para utilização em tijolos de solo-cimento deve possuir as seguintes características: 100% passante na peneira de abertura de malha 4,8mm e de 10 a 50% passante na peneira de abertura de malha 0,075mm, neste contexto observa-se que o solo em estudo atende parcialmente aos parâmetros descritos por autores e pela norma, conforme pode ser verificado nas Tabelas citadas acima.

#### 4.1.5 Ensaio de Compactação

CASTRO (2016) descreve que o teor de umidade ótima ideal para solos utilizados na fabricação de tijolo de solo-cimento, deve ser em torno de 12,7%, enquanto que para solo-cimento com a adição de resíduo, este valor obtido varia em torno de 13%, ou seja a umidade ótima encontrada influencia na qualidade final do produto, bem como em um menor índice de absorção.

Alcançado o valor da umidade ótima do solo, tem o peso específico aparente seco máximo que levará a maior resistência do solo a ser utilizado, no estudo em questão os resultados alcançados demonstraram que o solo não é o ideal para a fabricação de tijolo de solo-cimento, pelo fato de caracteriza-se como um solo predominantemente arenoso. (FERRARI, 2014).

#### 4.1.6 Ensaio de Índice de Suporte Califórnia (ISC)

Com os dados obtidos para os 03 corpos de prova verificou-se que o ISC% das amostras apresentaram valores baixos, TEIXEIRA (2014) relata que valores baixos de ISC caracterizam solos com capacidade de suporte reduzida e baixa compressibilidade. Os resultados obtidos podem ser verificados na Tabela 4.9 que segue abaixo.

#### 4.1.7 Classificação dos solos (AASHTO e SUCS)

Terminadas as análises o solo foi classificado como sendo: *Argila baixa compressibilidade*, conforme enquadramento que segue em Tabela abaixo:

A NBR 10832/2012 afirma que o solo mais adequado para utilização em tijolos de solo-cimento deve apresentar características de um solo arenoso, o solo utilizado para o presente estudo não atende totalmente aos critérios da norma, conforme demonstrado nas Tabelas anteriormente citadas.

## 4.2 ANÁLISE DA RESISTÊNCIA DA MISTURA SOLO-CIMENTO + RCD E DOS TIJOLOS PRODUZIDOS

Os percentuais dos materiais utilizados para as etapas de misturas 01 e 02 utilizadas para a elaboração dos traços adotados para a obtenção dos corpos-de-prova (CP's). A NBR 12253/2012 recomenda que sejam produzidos no mínimo 03 corpos de prova para a determinação da resistência a compressão da amostra a ser analisada, contudo a NBR 8492/2012 indica que deverão ser confeccionados no mínimo 7 corpos de prova para que os resultados encontrados sejam significativos do ponto de vista estatístico.

#### 4.2.1 Resistência à compressão da mistura solo-cimento e RCD

Pode ser visto que proporcionalmente quanto maior a quantidade de RCD e menor a quantidade de solo utilizado maior a resistência à compressão adquirida para a mistura. A norma NBR 10834/2013 afirma que o valor mínimo médio para a resistência à compressão deve ser  $\geq 2,0$  MPa e para valores individuais deve ser  $\geq 1,7$  MPa.

FERRARI (2014) demonstrou em seu estudo que quanto maior a quantidade de cimento utilizada em substituição a cinza, resíduo estudado em seu experimento, menor era a sua resistência resultante, contudo no presente estudo a relação de cimento manteve-se constante, porém ao aumentar a quantidade de resíduo ocorreu significativo aumento de resistência a compressão da mistura, como pode ser constatado na Tabela demonstrada acima no quinto traço estudado.

A norma NBR 10834/2013 relata que aos 28 dias de cura os corpos de prova de solo cimento praticamente atingem sua resistência máxima, pois o cimento atingiu sua hidratação completa, por isso pode-se considerar como aceitáveis os resultados obtidos no ensaio de compressão da amostra em estudo.

A norma NBR 8491/2012 também adota os parâmetros de resistência à compressão da NBR 10834/2013 para confecção de tijolos de solo-cimento, contudo em analogia ao tijolo de solo-cimento tem-se que para a utilização de blocos cerâmicos de vedação com furos verticais, a resistência mínima média estabelecida é de 3,0 MPa, de acordo com a NBR 15270-1/2005 e para blocos cerâmicos estruturais a NBR 15270-2/2005 estabelece o mesmo valor característico de 3,0 MPa.

Contudo, PINTO (2016) afirma que tendo em vista os parâmetros estabelecidos de resistência à compressão para blocos estruturais e de vedação serem valores relativamente baixos, para a utilização de solos estabilizados pode-se considerar valores maiores para a resistência mecânica, considerando a analogia a resistência característica do próprio cimento, quando utilizado isoladamente.

Para o tratamento estatístico dos dados obtidos, PINTO (2016) descreve que amostras que apresentam coeficientes de variação  $CV \leq 15\%$  podem ser consideradas de baixa dispersão, ou seja amostra aceitável.

O gráfico de dispersão dos dados obtidos pode ser observado na Figura 4.8 que expressa a baixa dispersão do coeficiente de variação da amostra.

#### 4.2.2 Resistência à compressão dos tijolos produzidos

Dos resultados obtidos para o traço ideal adotado de 50% solo + 40% RCD + 10% cimento, constatou-se novamente que as resistências a compressão encontradas

tanto individuais quanto a média de valores são maiores que os valores previstos em norma. Para tanto, faz-se necessário citar novamente que a NBR 10834/2013 informa que para valores individuais a resistência deve ser  $\geq 1,7$  MPa e para valores médios  $\geq 2,0$  MPa.

A NBR 15270-1/2005 e a NBR 15270-2/2005 preconizam que para tijolos cerâmicos comuns utilizados para alvenaria de vedação e estrutural a resistência mínima a ser considerada deve ser  $\geq 1,5$  MPa para tijolos com furos na horizontal, e para tijolos com furos na vertical deve ser  $\geq 3,0$  MPa.

Por este fato verifica-se que os tijolos maciços de solo-cimento com adição de RCD produzidos com o traço ideal adotado podem ser utilizados com grande margem de segurança, uma vez que o menor valor obtido foi igual a 5,45 MPa.

A NBR 10834/2012 prescreve que os tijolos de solo-cimento podem ser utilizados para alvenaria sem função estrutural desde que sua resistência seja  $\geq 2,0$  MPa, neste contexto constatou-se que a adição de RCD ao tijolo produzido pode garantir a adoção do traço estudado para a fabricação de tijolo de solo-cimento.

AMARAL (2014) e PINTO (2016) relatam que tijolos de solo-cimento com ou sem adição de resíduos sólidos que apresentam resistências a compressão elevadas podem ser utilizados normalmente em alvenaria de vedação sem função estrutural e para serem utilizados em alvenaria estrutural deverá haver maior controle tecnológico durante o processo e fabricação de forma a atender as prescrições mínimas da NBR 15270-1/2005, da NBR 15270-2/2005 e da NBR 15270-3/2005.

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# A Bibliometric Study about Internet of Things

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**Abstract**—The objective of this study was to map the scientific production on the Internet of Things (IoT), through a bibliometric analysis. The methodological procedures were delineated by a quantitative approach, the research involved data taken from the scientific database of the Web of Science. The keyword "internet of things" was used for the searches in said database, within a period of 09 years, between the period from 2010 to 2018. In the searches 2,446 publications related to the topic were identified, an average of 271.7 articles published per year. The year with the highest number of publications was the year 2018, with 932 publications. The author with the largest number of publications was the Chinese researcher Zhang Y, of Jiangnan University, School of Internet of Thing Engineering, with 21 articles published. As for the article's publication areas, the ones that stood out the most were the following: Telecommunications, Computer Science Information Systems and Engineering Electrical Electronic, with 1,002; 940; and 811 published articles respectively. Among the journals, the ones that had the largest number of publications were: the IEEE Access and the IEEE Internet of Things Journal, both with 157 publications. Regarding the educational institutions, the highlights with regard to the number of articles published, were to the institutions: Chinese Academy of Sciences, Beijing University of Posts Telecommunications and King Saud University. The country with the largest number of publications in the area was China, with 783 publications. It should be noted that most of the publications were written in English, with a total of 2,402 publications in English.

**Keywords**—Bibliometrics, Scientific Production, Internet of Things.

## I. INTRODUCTION

It is noticeable the significant increase in the use of technologies in the day to day of people: cell phones,

notebooks, tablets, among other electronic devices. In most cases these devices are connected to the internet, enabling interaction and communication between people in different parts of the world. The speed in communication is a characteristic of our daily life, information is available at the same time as it happens and all this computerization and interconnectivity have been changing the way we live in society.

The use of the Internet for communication between people is a consolidated reality, however, the trend points to a communication between objects and electronic equipment, capable of processing data and returning information to its users, called the Internet of Things (IoT).

Internet of Things (IoT) is when devices are connected to the Internet and can communicate with each other without human intervention. In this way, Mota and Batista [1] affirm that communications will be conceived not only between humans, but also between humans and things, and between things without interaction with humans.

The Internet of Things (IoT) aims to interconnect all the electronic equipment and objects (things) that are used in the everyday of the people to the internet, with the use of sensor networks, in order to process this information and return benefits to its users [2].

Teixeira et al. [6] states that in the Internet of Things (IoT) "things", objects or devices, become active participants in the informational and social business processes, being able to interact and communicate among themselves, exchanging information collected from the environment and reacting autonomously to the events of reality, as well as influencing in the social context without the intervention of the human.

In this sense, it is expected that there will be between 26 and 50 billion connected objects by the year 2020, reaching one trillion by 2025, 40% of which will be in emerging countries, such as Brazil and India [9],



generating approximately US\$ 14.4 trillion direct in IoT projects [11].

Therefore, the objective of this research was to analyze the academic scientific production related to the Internet of Things (IoT) in the last 9 years (from 2010 to 2018), providing researchers and academia with an overview of the studies and scientific technological developments in this area.

This article is divided into five sections. The first section presents an introduction on the topic covered in this research. The second section presents a brief review of the literature related to the subjects of bibliometric and Internet of Things (IoT). The third section shows the methodology used in the development of this research. The fourth section presents the analysis of the data obtained in the research. The fifth section brings the final considerations on the research.

## II. REVIEW OF LITERATURE

### Internet of Things (IoT)

Teixeira [6] states that the Internet of Things (IoT) is a dynamic, global network infrastructure with self-configuration capabilities based on standardized and interoperable communication protocols where physical and virtual "things" have identities, physical attributes and virtual personalities.

According to Maeda [8] the Internet of Things (IoT) is nothing more than the continuation of the digitalization and digital transformation movement, it is the Internet invading the physical world and connecting everything. According to Evans [20], the Internet of Things (IoT) represents a real evolution of the Internet, a major advance in the ability to collect, analyze and distribute data, representing a breakthrough that will lead to the use of revolutionary applications.

According to Lu and Singh [21], the Internet of Things (IoT) is a worldwide network of interconnected objects, with specific address based on standard communication protocols. Miorandi et al. [22], in turn, ensures that the Internet of Things (IoT) is based on three pillars, regarding intelligent: identifiable objects; communicable; and interaction between them, with several networks of objects interconnected with end users.

The application of the Internet of Things (IoT) can be understood by the interaction between objects, systems, services and people, represented by a basic infrastructure, which supports the development of complex platforms, allowing an environment and a more intelligent society [23].

The IoT consists of the network interconnection of the objects used in our daily life, equipped with intelligence, allowing to integrate all objects through embedded systems [24].

It is a revolution that is made possible by the combination of technologies, sensors, processors, cloud computing and wireless connectivity [25].

It is a new form of information and communication technology that differs from the traditional one, where people communicate with other people. Things can now also communicate with people and other connected objects [26].

### Bibliometrics

According to Silva et al. [14] "The term bibliometric is derived from the fusion of the suffix "metric" with bibliography, information, science and library respectively, are analogous or very close in nature, objectives and applications."

Table.1: shows some of the main bibliometric indicators, according to Splitter, Rosa and Borba [17]:

Table. 1: Adapted from Splitter, Rosa and Borba (2012).

INDICATORS	CONCEPTS
Lotka's Law	Investigates the frequency distributions of the author of articles of a certain theme/area.
Bradford's Law	It investigates the frequency distributions of the number of articles published by periodicals of a certain theme/area.
Zipf's Law	It investigates the frequency distributions of the vocabulary of texts of a certain theme/area.
Number of publications by author, journal, institution or subject	Investigates the volume of publications of authors, periodicals, institutions or subjects of a certain area.
Number of co-authors/collaborators	It investigates the dynamics of the volume of research carried out in a collaborative way, either between individual or group research, or national and international.
Co-publications: publication with authors of different countries, institutions	It investigates the cooperation between representatives of entities and countries, in joint research, with the purpose of creating a matrix that shows the main partners and provides the description of the scientific network.
Number of citations	It investigates the impact of articles, journals and researchers on the basis of the

	number of citations.
Affinity Index	It investigates the relative rate of scientific exchange (between countries, institutions) by means of quotations.
Scientific links	Investigates and measures the influence of networks between different scientific communities.
Co-citations	It investigates the number of times that two or more articles are quoted simultaneously in one article.

It is worth to mentioning that for Vanti [18], the Bradford Law or Dispersion Law allows the measurement of journal productivity in order to establish the nucleus and dispersion areas on a given subject in the same set of journals.

The most popular indicators in bibliometric articles are based on counting the number of articles, journals, authors, authorships, institutions or quotes. Affinity indices, scientific links, and co-citations are rarely used, as are the frequency distributions used in the Lotka Laws of Bradford and Zipf [17].

Bibliometrics as a method has the advantage of softening the elements of judgment and generating quantitative results that tend to be the sum of many small judgments and judgments made by several people [13].

The bibliometric studies are used to evaluate the productivity and the quality of the research of the scientists, through the measurement based on the numbers of publications and quotations of the diverse researchers [18].

A bibliometric research allows the identification and description of a series of patterns in the production of scientific knowledge. In addition, it serves to estimate with quality and quantity, the production of published scientific articles on a particular theme, highlighting the main authors (researchers and institutions) involved in this process, who collaborate for the aggrandizement of science [4].

At the beginning of the 21st century, two phenomena occurred that modified the way researchers are using bibliometric indicators. One of them was the development of the open *Google Scholar* search engine, from 2004, by *Google* and the creation of *Microsoft Academic Search*, created in 2006 and relaunched as *Microsoft Academic*, in 2016. In addition to the two search engines mentioned, there is also the free software *Harzing's Publish or Perish*, created by the Australian researcher Anne-Will

Harzing, and developed based on the *Google Scholar* platform.

All these search mechanisms have been helping researchers in the development of bibliometric researches, allowing the use of several types of bibliometric indicators related to a particular theme.

The second phenomenon responsible for this change, in the form of the use of bibliometric indicators by researchers, was the indexing of journals in large international databases, which has been occurring over the years individually or collectively [15].

Unfortunately, in Brazil, the lack of indexation of Brazilian journals in various areas of knowledge in the large scientific databases has discouraged the creation of a culture of more sophisticated bibliometric indicators by the Brazilian research community until the beginning of the century XXI [15].

### III. METHODOLOGY

The methodology used in this research had a quantitative and descriptive character, which initially undertook on a bibliographical research on the subjects bibliometrics and Internet of Things (IoT), carried out through research in scientific articles, dissertations, theses, seminars and periodicals of the area.

According to Cervo and Bervian [5], the method materializes as a set of several steps that must be followed to carry out a research and that configure the techniques. Then, bibliometric researches were carried out in the Web of Science's scientific production database, based on articles published in periodicals and annals of indexed congresses related to the Internet of Things (IoT) theme. The time cut used in this research comprised the period from 2010 to 2018.

Bibliometric research is widely used to quantify the processes of written communication related to a particular topic [12].

The quantitative technique seeks the theoretical basis in bibliometric laws and principles, detailing and outlining the paths that must be taken to map the scientific production [19]. Filho, Junior and Siqueira [7], affirm that the principle of bibliometrics is to analyze the scientific activity by the quantitative study of the publications.

Bibliometric studies also allow the measurement of the content of theses, articles published in annals and periodicals, among others, by means of analyzes referring to authors, citations and methodology [3].

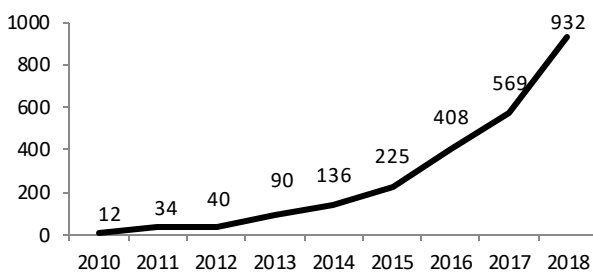
In this regard, the bibliometric research developed in this work had the following process steps: definition of the research theme; choice of the database; elaboration of the search criteria; data collection and analysis of the search results.

As for the search criteria used in the academic production databases, the keyword "internet of things" was inserted in the "title" field of the Web of Science database, obeying the time interval established by the research, between 2010 and 2018.

After the data collection, the data were transported to a spreadsheet, where they were processed, organized and tabulated, generating statistical graphs related to the bibliometric indicators related to the topic addressed in this research.

**IV. DATA ANALYSIS**

The findings about the volume of articles related to the theme "internet of things" published in the database of the Web of Science platform, from 2010 to 2018 are illustrated in the Graph 1.



Graphic. 1: Number of publications with the title internet of things in the Web of Science database. Prepared by the authors (2019).

According to the data collected, 2,446 publications were identified over the analyzed period (8 years). This is equivalent to an average of 271.7 articles published per year. On the other side, these figures show that studies in this area have grown over the years, arousing the interest of researchers and institutions for the subject.

Table 2 presents the authors with the highest indexes of publications related to the Internet of Things (IoT) theme in the Web of Science database within the analyzed period.

Table. 2: Authors with the highest indexes of publications on the topic "internet of things" in the Web of Science database. Prepared by the authors (2019).

AUTHORS WHO PUBLISH THE MOST	NUMBER OF PUBLICATIONS
ZHANG Y	21
QIU T	17
CHOO KKR	16
NING HS	16
XU LD	16
LI X	15
VASILAKOS AV	15
ZEADALLY S	15

ATZORI L	13
KIM J	13

The prominence with regard to the number of articles published is for the Chinese researcher Zhang Y, from the Jiangnan University, School of Internet of Thing Engineering, with 21 published articles.

Other authors worth mentioning, in relation to the number of articles published in the area of internet of things, based on the Web of Science, were: QIU T, with 17 articles; CHOO KKR, NING HS and XU LD, with 16 articles; and LI X, with 15 articles published in the area.

The areas of greatest coverage of the published articles on the subject of internet of things in the Web of Science database are shown in Table 3. The highlight in relation to the number of publications was for the Telecommunications areas; Computer Science Information Systems; Engineering Electrical Electronic; Computer Science Hardware Architecture and Computer Science Theory Methods.

Table. 3: Areas with the largest number of publications on the topic "internet of things" in the Web of Science database. Prepared by the authors (2019).

AREAS	AMOUNT	%
Telecommunications	1.002	40,96%
Computer Science Information Systems	940	38,43%
Engineering Electrical Electronic	811	33,15%
Computer Science Hardware Architecture	221	9,03%
Computer Science Theory Methods	210	8,58%
Computer Science Interdisciplinary Applications	193	7,89%
Computer Science Software Engineering	177	7,23%
Instruments Instrumentation	174	7,11%
Chemistry Analytical	120	4,90%
Electrochemistry	119	4,86%

Also, the journals that had the highest number of articles published on the subject of internet of things in the Web of Science database are shown in Table 4. The highlights with regard to the number of articles published were to the periodicals: IEEE Access and IEEE Internet of Things Journal, with 157 publications each; and Sensors, with 115 published articles.

Table 4: Periodicals with the largest number of publications on the topic "internet of things" in the Web of Science database. Prepared by the authors (2019).

MAGAZINES AND NEWSPAPERS	NUMBER OF PUBLICATIONS
IEEE Access	157
IEEE Internet of Things Journal	157
Sensors	115
International Journal of Distributed Sensor Networks	83
Future Generation Computer Systems the International Journal of eScience	71
IEEE Communications Magazine	60
IEEE Transactions on Industrial Informatics	45
Wireless Personal Communications	41
International Journal of Online Engineering	32
Computers Electrical Engineering	28

IEEE Access is an open access online journal of the Institute for Electrical and Electronics Engineers (IEEE). Created in May 2013, IEEE Access is a multidisciplinary journal that publishes original articles in all IEEE fields of interest. All articles published in IEEE Access have a global reach, through the IEEE Xplore digital library for free. The editor-in-chief of the foundation was Michael Pecht and the current editor-in-chief is Derek Abbott. The magazine won the PROSE Award in 2015 for being the best new journal in the STM (International Association of Scientific, Technical, and Medical Publishers).

IEEE Internet of Things is one of the important, cross-disciplinary and cross-platform initiatives of the IEEE. The Internet of Things (IoT) is one of the most exciting technological developments in the world today and the global technical community is gathering around the leading thinking content, resources and collaboration opportunities provided by the IEEE IoT Initiative.

Information about the Internet of Things and its potential in transforming the way we communicate with machines is revealed daily. To bring clarity and dissemination of information globally, the IEEE Internet of Things serves as a home to the global community of engineering and technology professionals in the industry, academia, and to governments working on related technologies.

Sensors is a leading international open access journal on sensor science and technology, as well as biosensors, is published online every six months by the MDPI (Multidisciplinary Digital Publishing Institute). The magazine Sensors aims to encourage scientists to publish their experimental and theoretical results in as much detail as possible.

According to the research the most prominent educational institutions in relation to the volume of articles published in the area of internet of things. In the relationship of these institutions it is possible to identify the domain of Chinese institutions on this subject, as it can be seen in Table 5.

Table 5: Educational institutions with the largest number of publications on the topic "internet of things" in the Web of Science database. Prepared by the authors (2019).

INSTITUTION / ORGANIZATION	NUMBER OF PUBLICATIONS
Chinese Academy of Sciences	73
Beijing University of Posts Telecommunications	64
King Saud University	39
Vellore Institute of Technology	33
Dalian University of Technology	31
University of Electronic Science Technology of China	30
Beihang University	27
Huazhong University of Science Technology	27
Shanghai Jiao Tong University	27
University of Science Technology Beijing	27

The highlight of the number of publications was the Chinese Academy of Sciences, an institution of the Beijing-based China Council of State. Followed by the Beijing University of Posts Telecommunications, which stands out for teaching and research in the field of cable communications, wireless communications, computing and electronic engineering.

In the third position in the ranking is King Saud University, a public institution of Arab higher education founded in 1957. This teaching institution was created by King Saud to meet the need for skilled labor in Saudi Arabia and is currently among the most prestigious universities in the Arab world. Currently has 37,874 students.

Table 6 shows the countries that had the largest number of publications on the topic internet of things in the Web of Science database. The ranking of the five countries with the highest number of publications is led by China, with



scientific productions, taking into account quantitative and qualitative metrics.

In this research, 2,446 publications related to the topic Internet of Things (IoT) were identified over the analyzed period, which is equivalent to an average of 271.7 articles published per year. The year with the highest volume of publications on the subject was 2018, with 932 publications.

All the articles identified in this research were analyzed according to the following criteria: authors, areas of knowledge, periodicals where they were published, institutions authoring articles, countries that published the articles and languages that were written.

With regard to the authors, the highlight is the Chinese researcher Zhang Y, from Jiangnan University, School of Internet of Thing Engineering, with 21 articles published in the area.

As for the areas of publication of the articles, it was observed that in the areas of Telecommunications, Computer Science Information Systems and Engineering Electrical Electronic, the most outstanding were, respectively, 1,002 (40.96%), 940 (38.43%), and 811 (33.15%) publications related to the research topic.

Among the journals identified in the research, it was verified that the ones that had the most prominence regarding the number of publications in the web of Science database were: IEEE Access and IEEE Internet of Things Journal, both with 157 publications. In addition to these two journals, it is also worth mentioning the journal Sensors, with 115 articles published in the IoT area.

In relation to the educational institutions identified in the research, the highlight in relation to the number of articles published in the area of internet of things (IoT) were for the following institutions: Chinese Academy of Sciences (China - 73 publications), Beijing University of Posts Telecommunications (China - with 64 publications) and King Saud University (Saudi Arabia - with 39 publications).

In the survey, five countries stood out for the number of publications in the IoT area: China (783 publications), United States (428 publications), South Korea (246 publications), England (196 publications) and India publications).

It is worth mentioning that most of the publications in the IoT area were written in English, with 2,402 publications made in that language.

This research shows a significant increase in the number of scientific publications related to the Internet Thing (IoT) theme, evidencing the importance of studies of this technology for the world technological development.

Through this study, it is hoped to have contributed to the evolution of the researched subject, and that the results of

this research can benefit researchers and scholars of the area, arousing interest in new studies in this technological area.

For future work, this study proposes the use of other databases of scientific research data and the use of new keywords related to the IoT theme.

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# Decision Making in the Management of Vineyards Cultivation Systems

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**Abstract**— *The objective of this research was to identify the variables that interfere in the winemaker's decision-making during the management of the wine growing system. To characterize the winemaker's decision-making in the management of the vineyard cultivation system, the procedures were: analysis of the selection criteria of the managers before the conventional and biodynamic systems of vinifera cultivation, considering the questions of opportunity costs of production as criterion evaluation of alternatives. It is an exploratory and descriptive study which contains both qualitative and quantitative analysis, from an intentional sample, for convenience and non-probabilistic. It has been discovered that vineyard management is a complex task, which requires information, technical follow-up, and farmers who are willing to realize that production alternatives go beyond the boundaries of the property's gateway. Finally, it was evidenced that management requires the commitment of all the factors, which are part of the productive chain, so the whole production system can remain competitive and attentive to the different opportunities that using the soil can provide.*

**Keywords**— *biodynamic agriculture; contingency theory; management.*

## I. INTRODUCTION

The humanity's concern with the readiness of productive resources, there are some years where it already consists of agronomists' studies, sociologists,

biologists, administrators, economists and professionals of many other study areas. Moreover, this concern can be observed in David Ricardo's thought (1996), which considers that agriculture would be linked to the readiness of the natural resources to the forms of different uses of the earth and his/her working power.

For Ricardo (1996), an economist from the century XVIII, there would only be an advantage in using fertile lands. The nonfertile lands should not be used for agriculture, because they would cause the loss of competitiveness in the market. Moreover, they would demand more investments to make them more productive. Initially, in the century XIX Malthus (1983), for his/her time he/she received attention because of the excessive increase with the population. This attention could also happen due to the lack of foods; therefore, the lands of inferior fertility would also end being explored, to deal with the growing demand for foods. However, Boserup (1987) considers that the capacity of fertility of the soil can be regulated by the independent of natural sanctions human actions. For him, the working power is associated with the agricultural methods. Like this, the subject of limitation of natural resources passed to be overcome with the technical progress. For instance, to the if it introduces new production techniques, it is possible to increase the productive potential of lands that initially were less fertile. Therefore, the introduction of new technologies can contribute to softening the duality: resources scarce versus limitless human needs.



The technological innovation in the production, for Schumpeter (1982), consists of incorporating new techniques, using new combinations of productive systems, promoting, like these changes of habits, habits, and faiths. Rosenberg (1982) also understands that the technical progress is grouped knowledge which makes it possible for the production to begin from a limited amount of resources, and of a larger volume of products or of products superior qualitativamente. However, for this to happen, the administration of the choices, which are considered as great or good for appropriately using the natural resources and of new practices of handling of the soil they demand, at least, two fundamental elements, that are information and knowledge.

Nevertheless, because of the difficulty in finding and implementing the great choices or even sub great, the tomador of necessary decisions to support in a model of decision that contemplates a group of variables. Thus, it is this tomador of decisions, which executes their activities innovatively and strategically, and also in a dynamic and complex atmosphere. Parallel, to this it involves economic subjects and socioambientais, and it did necessarily by using a systemic glance of the possible alternatives. Such care would aid in search of choices you/they provide for the alignment among institutional and empiric subjects, and the conditions that allow to evaluate risks and uncertainties in a scenery globalizado and dynamic, in that the decisions unchain systemic effect in the productive segment.

Before the complex situations and multifactorial are implemented, Simon (1979) demonstrate how the process decisório needs to be built differently from the classical economists, which considers the man as being rational his/her fullness and continuously. For him, the idea of the dynamics of the socket of decision is sustained over time, through a continuous sequence of interrelated decisions. In the case of the socket of the farmer's decision, the complexity is demonstrated prior to the influences as being: the tradition, the learning, the culture, the Etnia, and the subjects as social, environmental, economic, infrastructure, politics and of persuasion, soon it is a process that requests a systemic reading of the atmosphere so much external as the organizational.

In the specific case of the section of the wine growing, the challenges of the new times are related to the shortage of productive (earth, work hand, capital) resources. In some areas of vitivinícolas, a lot of what he/she is due regarding the climatic alterations of the planet, to continuously use the chemical inputs and reduce the planting areas. In this function, the viticulture needs to look for new production systems to make possible for him/her to soften the adversities and to align the subjects economical, social, environmental and cultural in the viníferas production.

However, the adoption of systems of cultivation of *Vitis viníferas* with smaller environmental impact is presenting better results in the vinificação, showing the characteristics of the ecosystem of each location in an accentuated way as having a larger persistence in the identity of the products. These results are waking up the interest of the linked segments to the viticulture, from small producers to great companies vitícolas with production in industrial scale.

The section, as a whole, lived together with new behaviors of the appreciators of the drink, that look for an only wine, that it is capable of surprising and to count history in their smell characteristics, degustation and visual. Before this new behavior of the consumers, the viticultores noticed the importance of their histories and the specific history of the cultivation of the grapevine.

In Serra Gaúcho's area, is one of the most important in the national production vitivinícola, for different reasons. In Garibaldi, is a municipal district in this area, and generally he/she is located where the Wine-producing Cooperative Garibaldi (CVG), which counts with a picture of 400 associated families, being 236 producing of grapes (WINE-PRODUCING GARIBALDI, 2016). In 2018 the planted area was 900 hectares, and the given amount in CVG was of 20 million kilos of grapes. For the current President, Oscar Ló, "the Cooperativa Garibaldi it is constituted of farming families, that the removal of the earth for his/her sustenance and they trust in the wine production to build his/her future and one of the next generations. Our commitment is to work for those people, to offer them more and more and better-growing conditions and development" (WINE-PRODUCING GARIBALDI, 2018).

The Wine-producing Cooperative Garibaldi (CVG) is promoting projects, which are designed to motivate the use of systems of cultivation of low environmental impact with their associates and cooperated. Moreover, he/she will make the information of techniques and handling available, for the contribution of with the appropriate use of the soil and natural resources. One project in environmental sustainability is the system of cultivation viníferas biodinâmico Chardonnay for the elaboration of foamy.

Before of that scenery, the subject norteadora of the present study is: What does characterize the socket of the decision of the viticulture in the administration of the system of cultivation of vineyards? To answer this question, he/she decided on the following objective, which was to identify the variables that interfere in the socket of decisions of the viticulture and the administration system for the cultivation of vitícola. For instance, the characteristics of choice are analyzed in systems in conventional cultivation and viníferas

biodinâmico. The following discussion accomplished the search for fundamentação theories of "limited rationality" (SIMON, 1979) and in the "empiric administration" (PFEFFER and SUTTON, 2007). Regarding the characteristics of the tomador decision, the information was considered to access the effects in the choices of systems and cultivation practices in the transport of the vineyard and, in matter, to evaluate "what to do" and "as to do", as being part of the structure of Vereijken (1997).

## II. LITERATURE REVIEW

The theoretical support is leaning in two themes: the process of the socket of the decision and the administration of the systems of viníferas cultivation.

### 2.1. Decision Making

Over time, some observe that the process managerial decision making has been studied by several authors, such as Simon and March (1976), Mintzberg,

Raisinghani and Théorêt, (1976), Gontijo and Maia (2004), Fernandes et al. (2007), Albuquerque and Clerk Filho (2005), Shimizu (2001) and Yu (2011). These authors evaluate the individuals who make the decisions inside the organizations in elapsing of the time. Moreover, it has been noticed that the criteria and the process of decision making are dynamic and that, in each discussion or study, they happen new approaches and definitions as being the human that makes the choices.

The majority of the time, in this view, the decisions are passed to be guided by the searching for alternatives, which are sufficiently good, and have no obligation to search for the best alternative. Simon (1979) highlights that, besides the information that is available for us to look for these sufficiently good alternatives, the tomadores in charge of the decisions require knowledge, intuition, and perception, that you join to form what one can call theoretical model.

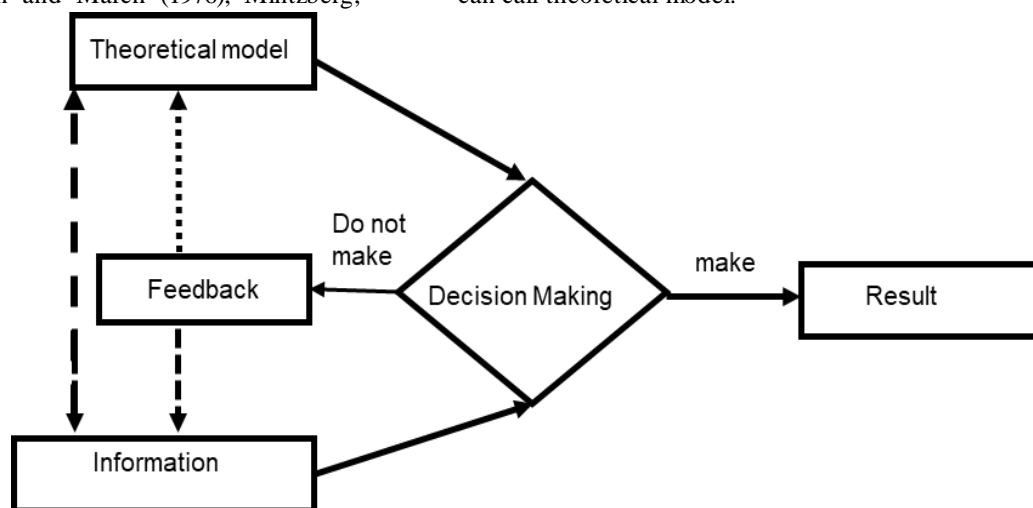


Fig.1: Model Theoretical of Analysis (initial relationships)

Source: Authors (2018).

The model here proposed leans towards a double group of elements. The first is the theoretical model formed by the variables that the decision considers as relevant for that decision. The second is the volume of information you/they feed the own theoretical model and, direct impact during the process of making of the decision, such as previous experiences, habits, habits, and cultures that can aid in their decisions. The model proposes an interconnection between an empiric administration and an administration based on criteria or an institutionalized norm.

The decision maker can often consider intuition, but also his rationality may be limited to a certain field of perception, as well as in the seemingly dual interlocution of that knowledge. Parallel, the proposed model is uncertain and situational, because it considers the theory of the contingency (everything depends). In the functional

atmosphere, the explanations can be looked for in the "cause relationship and effect," therefore, the decisions depend on their causes and of the intended effect and or expected result.

Another characteristic considered in the model is that the process of decision, that results in not to "do" or to "do" something. Moreover, it is generated by his/her own dynamics, an alavancagem of the decision knowledge and, this way, opportunity-him the search of a better future result. In the specific case of "not doing," the feedback of the process (to model more theoretical information) qualifies as their theoretical process (Fig. 1).

In the theory of the contingency, for Chandler (1998), the environment influences the organizations, more specifically their strategies, and the dimension of the own organization (Puch et al., 1969; Blau and Schoenherr, 1971) the technology (Woodward, 1958;

Perrow and Schwartz, 1972), the nature of the environmental uncertainty (Thompson, 1967), the structures (Bruns and Stalker, 1961), and the connection interns (Lawrence and Lorsch, 1973). The authors try to analyze the relationships inside of the systems and between the subsystems and the relationship of the involved factors and their characteristics.

The theory of the contingency consists of selecting the choice, which is a better solution for each situation. For this, the environmental analysis is made necessary to understand the dynamics of the production systems and the cultivation subsystems, that are open, interrelated, but are also interdependent amongst themselves. Thus, the proposed model acquires a systemic configuration and to appropriately assist to the theory of the contingency. Moreover, it can be considered that the results of implementing the decisions can feed the own

theoretical model, to validate him/it or to alter him/it, and to feed the bank of information of the decision (Fig. 3).

The healthy farmer's decisions are based, in most cases, by using common sense and in the accumulated empiric knowledge (Troian and Arbage, 2016). Here, Pfeffer and Sutton (2007) propose what call "empiric administration" for making decisions. For them, the model should "be created" starting from the own facts and not of cause-effect relationships with base in theory. On the other hand, Bazerman (2015) it analyzes that the intelligence limitations and of perceptions they restrict the capacity of the decisions to they look for criteria to identify the great solution starting from the information that is available and, still, they consider those limitations impede them of making great decisions that the rational model presupposes.

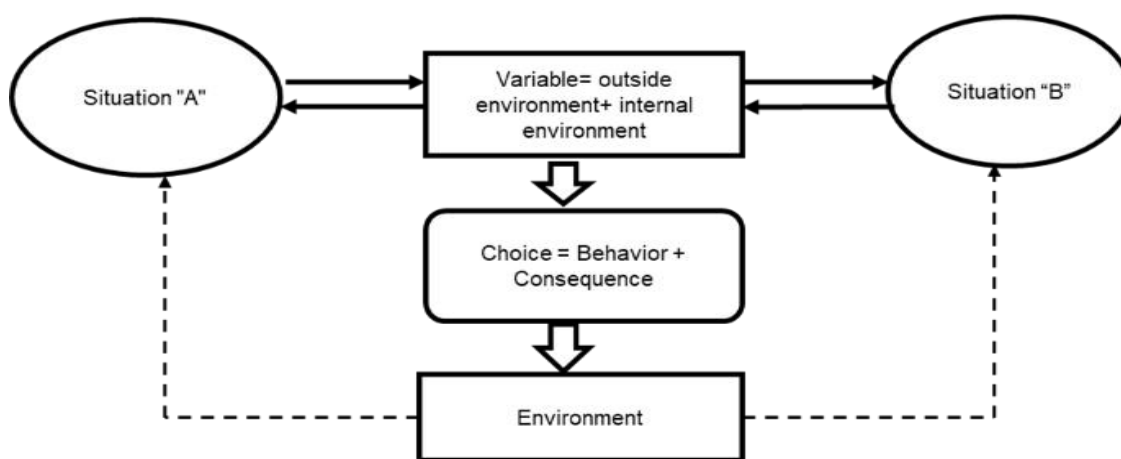


Fig.2: Behavior decisional

Source: Authors (2018).

Remaining on the topic of the dynamics of the proposed systemic model, it is has highlighted behavior can result in an event, that will cause action and reaction. For this to happen, the decision accesses groups of variables activated by a group of indicators, that you/they come in situation form "THE" or situation "B," (or both) and such variables can be lenses or subjective (Fermaud et al., 2016). In those groups, consolidated in situations, the decision looks for an alignment form with their characteristics and his/her perceptive capacity.

In the administration of the farm, the decisions perpassam for the intuitive order of information, faiths, habits, habits that can favor when developing strategies and criteria for functional decisions. Therefore, a circle of formal and informal information that interrelate and are fed by internal (previous decisions to do or not to do) elements and for external elements noticed by the decision maker.

Furthermore, the choice is the consequence of a group of convenient variables that, in some way, reflects what she can summarize in "behavior more foreseen" consequences. Thus, making decisions is represented as the dynamics and processes sustained at the time (Bellman, 1956; Mjelde, 1986; Osman, 2010). Moreover, it means that, in each apprenticeship, the technical coefficients are updated to continue for the next round of behavior, because the decision can choose the group of variables you/they are part of his/her theoretical model, and this choice is a direct function of his/her behavior, that can be, for instance, more or less conservative.

During the decision-making process, the decoder will wait for a certain result, or better alternative: a group of results associates the group of probabilities and objectives. Therefore, the consequences of a decision will affect him/her regarding what to "do" or not to "do," and they can be considered as being "foreseen."

Remembering, for Simon (1979), the decisions, most of the time, are satisfied with a satisfactory alternative in function of available information in that situation (time and place).

After the decision has been made, it is implemented and generates results and impacts in the atmosphere. However, when dictated differently: the decisions are not neutral about the modifications or preservation of the environmental conditions. Still: implementation of decisions will feed the group of variables you/they were used for the own choice, generating a system, which can signal for the success of the choice or that changes can be accomplished for the choice generates a closer result of the wanted situation

(Bazerman, 2015; Tichy, and Bennis, 2009; Ragsdale, 2009).

The force or the influence of information in the decision, in this case, also depends on the characteristics of the farmers' administration. Moreover, in their theoretical models, formal or not. Individuals who have a more conservative profile generally make choices guided by their traditions, habits, and production requirements. Furthermore, it can be argued that they base on the empiricism and in the intuition. Other, less conservative and potentially more innovative individual, tend to make decisions leaning towards theoretical information and to trust in his/her limited rationality, but that is sufficiently satisfactory (Kulikand Baker, 2008).

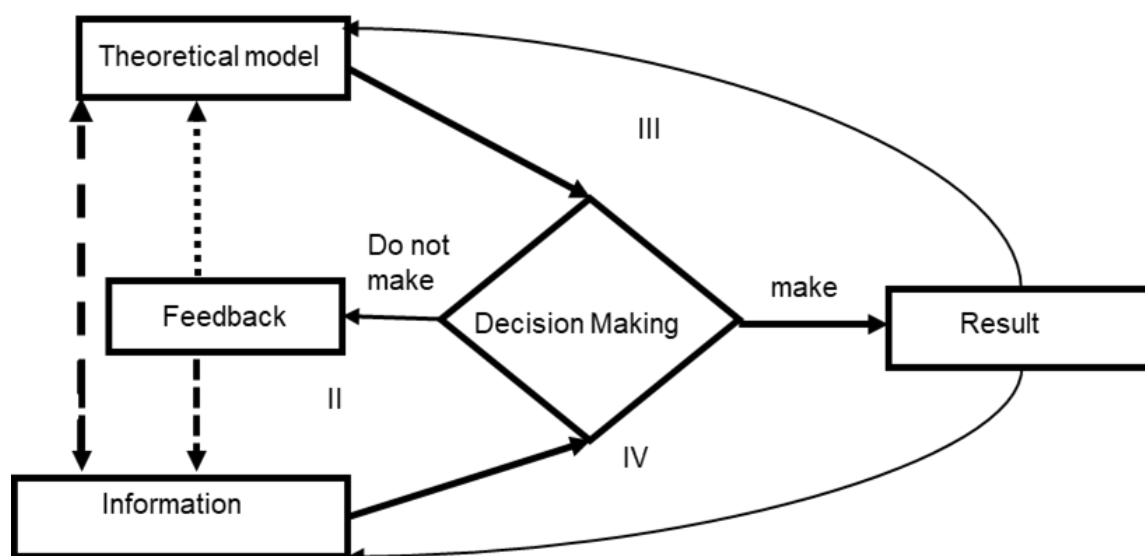


Fig.3: Model Rational of the Making of Decision (cycles reinforcing)

Source: Authors (2018).

- I. Validation Cycle interns in the theoretical model;
- II. Accumulation Cycle interns of information;
- III. Validation Cycle expresses the theoretical model and the function of the results;
- IV. Accumulation Cycle expresses information and the function of the results.

The model proposed decision is structured and consequential (Fig. 3). The decision needs to look for collaborative information for the identification of variables you/they need to be analyzed in agreement with previously criteria established by a group of guidelines of the established administration system by the organization. The results promoted by deciding to generate knowledge that will validate or no his/her theoretical model or I model theoretical of the organization and that, it will supply new information for future choices decisórias. Here, it can be noticed the influence of the theory of Simon's limited rationality (1979), and the ones that base

the decisions based in facts, pieces of evidence and previous experiences (PfeffeR and Sutton, 2007).

In the specific case of the analyzed universe, agricultural organization, Vereijken (1997) he/she gains attention for the capacity of the farmers' adaptation about the processes decisórios of the administration of the property. The behavior in that situation is restrictive because it requests the economic and environmental decisions to involve the use and allocation of scarce resources, which can be optimized to obtain the expected results. They are, still, decisions that involve approaches bio-decisórias, that is, related to the administration of the farm: the tactical choices, what to do" and "as to do."

For the viticultures they be adapted to the new challenges and new systems of cultivation of the vineyard, it is had that the decisions become complex, that, in agreement with Rossing et al. (1997), Romera et al. (2004), Bergez et al. (2010), they ask this for the attention regarding the choices, because the limitations at

the time and costs can lead to uncertainties due to limitations of information available.

In this sense, Martin et al. (2013) understand that it is the organized farm with practices that guarantee the agricultural production which begins from a biophysical context. For Robert et al. (2016), the problem of decision

making at a farm should be modeled using a structure of modelling integrative that includes sequential aspects during the decision making process, including the adaptive capacity, and farmers' reactivity for us to approach changes in his/her atmosphere (Fig. 4).

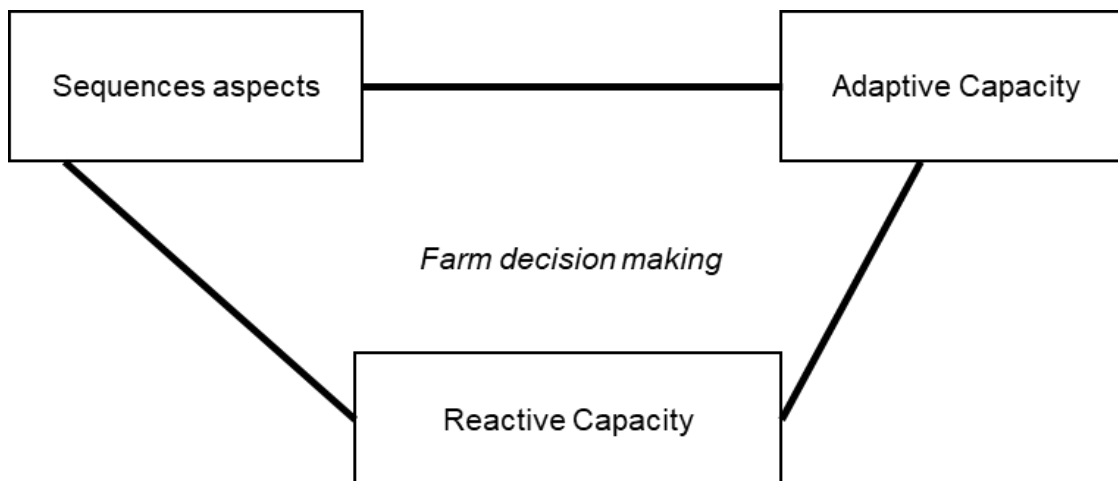


Fig.4: Making of the decision in Finance

Source: Authors (2018), based on Robert et al. (2016).

The systemic configuration of the analysis model here proposes and builds the idea that (Fig. 3) he/she depends on the three elements suggested by Robert et al. (2016), that, and they dynamically participate in the decision-making process (Fig. 4). The first element, being the sequential aspects, is part of the structure which has its systemic model, while the capacities adapt and reactivate to highlight the operative aspects in the model, and more specifically, the stages of the decision.

The decision making process requests variables to lead toward an appropriate choice. The specificities of the chosen universe show that the most appropriate variables are: the) internal dependent variables: (The one what to produce? How to produce?); and b) the independent external variables (How much to produce? When to produce?). These variables mean that to understand production, he/she needs to know the type and the characteristics of the soil, the resources natural, economic and social available in his/her property. Additionally, he/she needs, has to look for external information to the property, as access to the innovation of cultivation techniques, to the change of experiences, technologies, and market to know as and when it produces.

## 2.2 Administration of the Systems of Cultivation of Viníferas

The production system is composed by the group of cultivation systems and/or of creation in the extent of rural property, defined starts from the production (earth,

capital and work for hand) factors and interlinked for the administration process (Bertalanffy 1976). The cultivation system consists of the common practices of handling, which are associated to a certain vegetable species, and his/her production begins with a logical and orderly combination of a group of resources, activities, and operations (Sebillotte, 1990).

The system of cultivation of vineyards can be conventional, organic or biodinâmico, for the viticulture to choose which the most appropriate, needs to combine knowledge, functionality, technical capacity and characteristics of the environment allied with the efficiency and productivity. For this, he/she needs to drift and to maintain flexible before the uncertainties and the risks of the viníferas production. Therefore, it is necessary to understand that some practices of cultivation of vineyards demonstrate the significant dualities in his/her practice, as the conventional agriculture with chemical treatments and fitossanitários and the agriculture biodinâmicos with using prepared and fitoterápicos when treating the soil.

The system of cultivation biodinâmico arrived at Brazil in 1973, when the Beneficent Association Tobias, of São Paulo, acquired an area of 169 hectares Botucatu, and one which was 230 km in São Paulo and established the Estância Demétria. The agricultural property returned to the production of vegetables, medicinal herbs, fruits, annual cultures, cattle breeding and production of dairy products. In the system for biochemical cultivation, the

agricultural property is treated as an alive and systemic organism, and he/she is considered that any alteration in which one element will affect all the others. This requests handling to make it possible to strengthen the plants and the present microorganisms in the soil so that the main objective it is the prevention of diseases and ecological unbalances (Ehlers, 2017).

The vineyard biodinâmico, in comparison with the conventional methods, to reduce the use of machines and eliminate the agroquímicos use, the treatments of the soil are accomplished with mixtures produced in the agricultural property, respecting an understanding of a system autosustentável, and it requests a larger contact of the human with the vineyards, it is necessary to involve with the agricultural organism.

On the other hand, White (1995), Hassall et al. (2005), Badgley et al. (2007), Seufert et al. (2012) they get the attention so that, despite the attractive earnings in the commercialization of the wines and in the reduction of inputs, it can happen a significant reduction in the volume of the production of grapes picked in this system. The obtained wines, however, they are of exceptional quality in what says respect to the highest concentration of properties that they accentuate the good quality, and that, parallel, it is configured in an only product.

Studies already accomplished tell that the mixtures biodinâmicos can contribute with the vitality of the soil and of wines with more sensitive characteristics to the environmental influences (Carpenter-Boggs et al., 2000; Reeve et al., 2005). For Villanueva-Rey et al. (2014), the wines obtained with practice biodynamics present peculiar characteristics, that they are resultants of the system of handling of the vineyard, such as the low sulfites concentration and the great quality organoléptica. Even before such benefits, for the practice, the same authors notice that the environmental benefits of applying those techniques, in what concern the climatic alterations or the toxicity levels, they are still uncertain.

The reader needs and to innovate agricultural practices in the wine growing requests effort, information, and constant planning. With this, it can be walked towards the environmental and economic sustainability in the long period (Turineket al. 2009). Provost and Pedneault (2016) they notice that the cultivation of vineyards can provoke a soil loss and water, often causing the erosion, and is considered an agricultural practice of high environmental impact. Therefore, he/she becomes necessary to drift and to analyze strategies to make the choices in the administration of cultivation systems, because the vineyard doesn't just have the function of producing grapes for processing and consumption, but many starts to be part of the landscapes of many areas and to join a patrimonial value for their communities.

In this case, he/she suits to remember that the selection of lands for the wine growing should be made with rigidity and the adoption of practices of conservation of the soil. In agreement with the Instruction Normative no. 10, of June 14, 2005, the soil types recommended for the healthy planting of grapes: the) type 2: soils with clay tenor between 15 and 35% and less than 70% of sand, with depth same or superior the 50 cm; and b) type 3: I) soils with tenor of larger clay than 35%, with depth same or superior the 50 cm; and II) soils with less than 35% of clay and less than 15% of sand (texture siltosa), with depth same or superior the 50 cm, they are considered more efficient for the propensity of the grape of larger quality (Brasil 2005).

Furthermore, the soil should regulate the elements imposed by the climate starting from their properties, such as retention capacity, capillarity, thickness, specific heat, exhibition in the sun, physical properties, and mainly the control of the feeding hídrica, that is the decisive factor for the quality of the cycle of the grape. He/she should be areno-loamy, with pH in the strip of 5 a 6, and inferior steepness to 20%, with a spacing of 2 x 2 or 3 x 3, but could vary depending on the form of the cultivation (Tonietto, 2001). Grant (2010), in this senses, argues that he/she gains the attention for the use of the analysis physicist soil chemistry as a tool of administration of cultivation system because she makes possible that is known the soil type and his/her readiness of nutritious. It is the first step for determining the appropriate dose of treatments and type of cultivation systems, what contributes to minimizing the losses and the environmental contamination of the natural resources.

The making of decision, as for the system of viníferas cultivation, therefore, it's extenuating to determine the characteristics of a vintage and besides the winegrower type, because, the choice of the handling technique can show the profile of the agricultural system and their managers, that finally, they will be shown in the characteristics of the vineyard and the result of the wine. For Sebillotte (1990), the farmer plans their interventions in the time and space of his/her farm, with base in a group of variables you/they draw when making decisions. Before this, it is also of extreme importance an agronomist's orientation, because it allows the viticulture to execute technical interventions in an aligned way to the soil characteristics, climate and environment and, like this, plan results about each particularity of the cultivation system.

### III. MATERIALS AND METHODS

The research was an exploratory and descriptive study which used qualitative and quantitative analysis. Gil (2008), contains an exploratory research study where the main objective to develop, to explain and to modify

concepts and ideas. The sample was intentional, for convenience and not problematic. Whereas, Levine et al. (2008) samples which were problematic can offer certain advantages, such as convenience, speed, and low cost. Initially, it looked for to adapt to the concepts and models of the making of decision and administration.

The stages of the study were: rising of bibliographical data; mapeamento of producers in the mountain gaúcho to identify the systems and types of viníferas cultivation, and selection of the viticulture to participate in the study. The choice criterion was that the producers worked with the vine breed for Chardonnay, due to cultivation method with this vine as part of the experimental project, and for the cultivation system of biochemicals in Wine-producing Cooperative Garibaldi, being this the locus of the research. Obeying this requirement, eighteen vineyards of the system of conventional cultivation and two of cultivation biodinâmico were found, totaling 21 vineyards.

The interviews were accomplished individually in visits to the viticulture at their properties between June 06 on June 28 of 2018. From these interviews, it was possible to accomplish a direct and extensive observation. The structured questionnaire contained 78 closed and open subjects related to the aspects sociocultural, environmental and economical, adapted from the study which was validated by Dalcin (2010).

For Gil (2008), the interview means to make the people's direct interrogation whose behavior is wanted to know. Here, when making decisions relating to what, how, how much and when to produce? By doing it in this way, it was possible to consider the variables related to production possibilities, which illustrate opportunities to the manager for the type of cultivation system can make possible since he considers the factors to be part of his/her production system. Shortly after, the analysis of the data was accomplished by using the Correlation of Pearson (Siegel, 1975), and Software Nvivo's use Plus 11 (Edhlund and Mcdougall, 2016). Moreover, for analysis of qualitative data in the managers' communication that, through triangulation of the results, it was made possible

for the identification of variables that interfere with the choices of the viticulture in the administration of the cultivation.

#### IV. ANALYSIS AND DISCUSSION

Serra Gaúcho's area, is one of the most important in the national production vitivinícola, for different reasons. The area is classified by the active participation in the specific section vitivinícola the Wine-producing Cooperative Garibaldi promoting projects with permanent investments in types of equipment, technology, training and infrastructure in the improvement of productive processes and the valorization of the viticulture as participant element in the planting and cares with the vineyard. An example is mentioned: the a) motivate new practice of systems for cleaner cultivation; b) systems of cultivation of organic vineyards; c) systems of cultivation biodinâmico.

The cooperation depends on agronomists and agricultural technicians that you/they work and guides the associates in how to do her the conversion of conventional vineyards for systems which use cleaner cultivations and more harmonic ambientalmente with the system. They also suggest that the viticulture use her/its own grapes, adapted for each microrregião, guaranteeing the productivity" potential, he/she attests his/her president. As the vinífera Chardonnay for the production of foamy, that is cultivated in the conventional system, and two vineyards of that breed are part of the experimental project with the cultivation biochemical.

The vineyards with conventional cultivation and biochemical systems are characterized with cultivation areas that vary from a hectare (there be) to 25 there is (total) being with an average of 5,6 there is of the planted area (table 1). The vineyards selected for the study are located geographically in the state of Rio Grande do Sul, and in the mountain gaúcho, in the municipal districts of: Garibaldi, Colonel Pilar, Bento Gonçalves, Farroupilha, Santa Teresa, Beautiful Monte of the South and also in the southeast area of the State, in the municipal district of Caçapava of the South.

*Table.1: Characterization of the properties of viníferas of the selected sample*

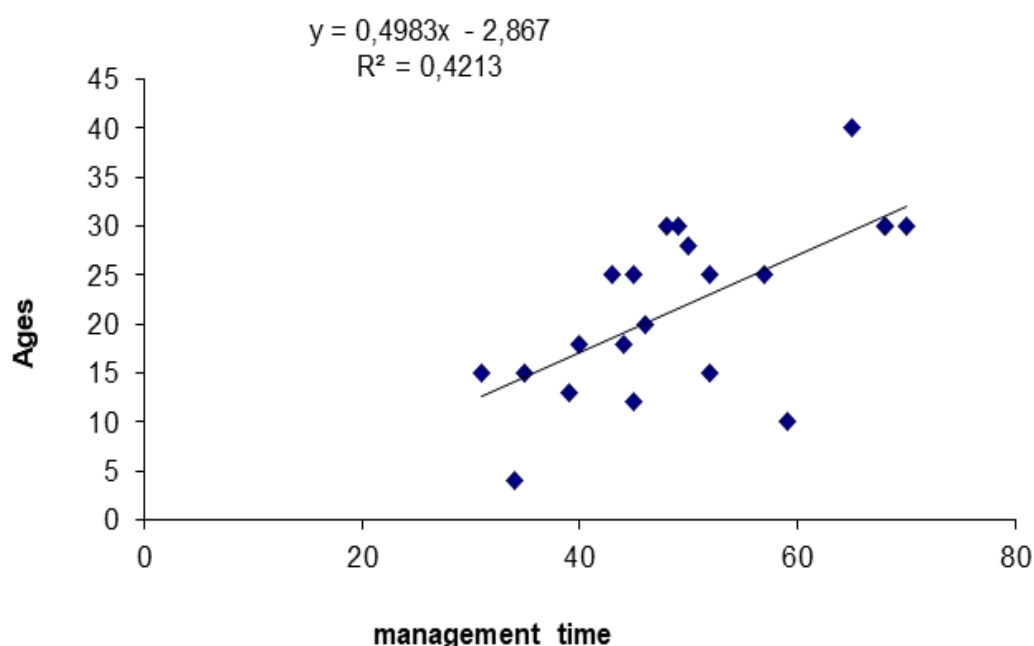
	Minimum	Maximum	Mean	Std. Deviation
The total area of the Property (hectares)	7	40	16,95	9,452
Time of residence (years)	0	65	30,81	15,648
The managers' of the vineyards age	31	70	49,52	11,457
Time of Administration (years)	4	40	21,81	8,796
Area planted with grapes viníferas (there be)	1,0	25,0	5,643	5,6660
Age of Viníferas Chardonnay (years)	0	20	9,10	5,691
Valid N	21			

Source: Data of the research (2018).

Regarding the managers' age, the average is 49 years, and one of the residents is 31 years old; and the time of administration of the property is in on average 22 year-olds. The results show the many assumptions regarding the administration of the property after they constitute his/her family or in their predecessors' absence (Table 2), this is in the origin of the property, and 57% are inherited. The decision, then, went to give continuity to the family tradition. Therefore it can just extenuatefactor the percentile of 67% with the fundamental teaching. With secondary teaching, they are 24%, and the ones with a superior formation accompany the same percentile of the ones that they have leased property: 9,5%. The with formation academic, same being a percentile one low, they show a possible configuration

of new incoming in the production system. The viticulture that you/they use leasing lands act: 9.5%. This figure means that the choice of opportunities for production possibilities. The global results show the importance and the technical support need, in function of the low education of some and also in function of the identified ones as new incoming.

To confirm the relationship between the time of administration and age, it was made the use of the test parametric correlation of Pearson (Siegel, 1975). The result was a moderate correlation of  $R^2 = 0,4213$ , positively perfect, in other words, the managers' age explains 42,13% of the time in the administration of the vineyard. (Graphic 1).



Graph 1. Correlation between the time of administration and the age of the managers amostrados

Source: Data of the research (2018).

The origin of the property shows that 58% are inherited, that 32% are bought and that 10% are leased, it also shows that already happened a family succession. The medium time in the administration of the property is of 23 years. As for the process of decision, it is had that 86% of the interviewees confirmed that the decisions are made in the way shared with the other members of the family, with the technicians of CVG, and with the change of information with the neighbors. These answers evidence the sociocultural factor of the area, that leans on in the different social actors' permanent social interaction.

As the objective of the study was the decision-making process for the administration of systems of viníferas cultivation, to identify what characterizes the way of choice of the viticulture, the subjects of

production possibility were applied: The something? How much? How? When to produce? They are establishing combinations of internal and external variables aligned with factors economic, environmental and sociocultural that allow the dynamics of the system of the agricultural property.

The interviewees confirmed, in their speeches, the concern in their choices with: the) cares with soil; b) concerns with the climatic conditions and, c) technical support. Another concern of the detected viticultures was that the vinífera type and the technique of adopted production need to assist the market demand, according to display the cloud of words. (Cloud 1; Cloud 2; Cloud 4; and Cloud 5)



Cloud 1. Internal Variables: What to Produce



Source: Data of the research (2018).

As for the subject "the one what to produce? ", they can meet shreds of evidence of the search for orientations for best to do the use of their experiences (Cloud 1). In the subject "as to do?" It was possible to identify a concern with climatic conditions, I sole, family tradition, financial resources, and the technical support. It was possible to identify 52% of the respondents decide in agreement with the one that the market is asking, and or,

with the needs of the Wine-producing Cooperative Garibaldi, being his/her main one receiving of his/her production of grapes viníferas (Cloud 3). This shows the profile adaptation of the viticulture, and the existence executes of the cycles of the model decision making (FIG.4)

Cloud 2. Internal Variables: How to Produce



Source: Data of the research (2018).

For the behavior of the decision maker, they were noticed aspects sequential, operative and of decision that you/they can be influenced by internal and external variables to the property. In the administration of vineyards, the choices of the decision (as and when) are aligned the group of external factors his/her property. The external variables are evident in the process decisório, where market, climate, and demand if they stand out concerning the others (Cloud 3; and Cloud 4). In the subject of "how

much to produce? ", the considered criteria are related to the climate, to the fertility of the soil, to the market and the demand. In the subjects that involve factors related to the "when to produce? ", even the grapevine of a long cycle of life, the relevant factors repeat. These factors as being the propellers for changing the subjects, such as the) when it innovates in techniques and systems; and b) when it invests in new cultivation areas and or new breeds.



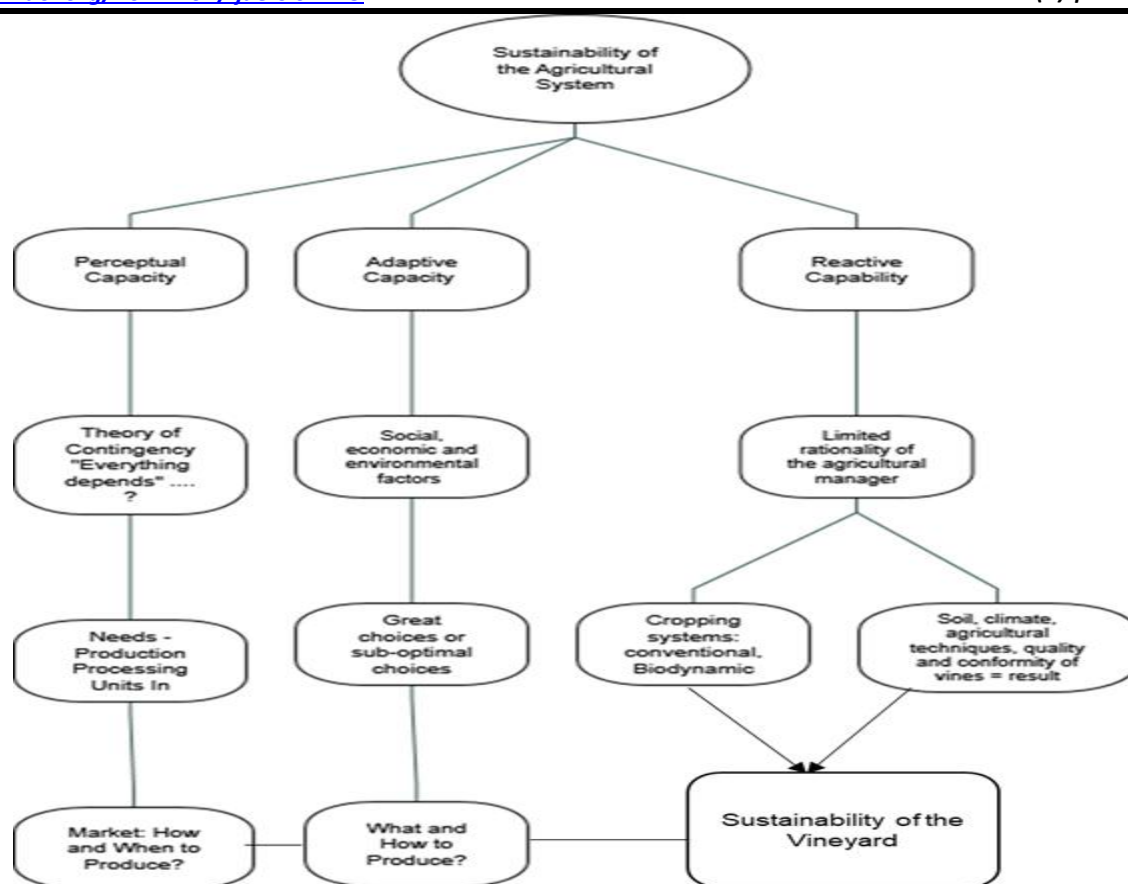


Fig.5: The model of decided- the Interface of the Sustainability of the System

Source: Authors (2018), based on Robert et al. (2016).

The illustration 5 display the choice process considering the theory of Simon's limited rationality (1979), and the ones that base the decisions based in facts, evidence and previous experiences (Pfeffer and Sutton, 2007). As with the case of the agricultural unit because the group of information that needs to be considered in making decisions, often he/she comes complex because of the knowledge absence or of the technical attendance that can aid the viticulture, what can develop a capacity reactivates dual to the result wanted by the system, causing bottle mouths and restrictions of capacity adaptative.

In this sense, it passes the pertinent being the use of tools as using the soil analysis, that makes possible technical and practical information of handling and that you/they allow making choices in agreement with the needs of the agricultural soil for the transport of the production system. As well as in agreement with Robert et al. (2016), the decision needs to understand and to adapt their choices in a structure integrative with the macroambiente of the productive chain.

The alignment of the perceptive capacities reactivates, and adaptative harmonically and dynamically makes it possible to reach the sustainability of the agricultural organism. However, he/she calls himself attention for the manager's limited rationality, but this

will depend on the atmosphere in that it will be predisposed to information it makes possible him/her the "great" choice in the transport of the vineyard, taking to wanted results and a better use of the natural resources, humans and economical.

In this sense, the internal and external variables become factor influenced, and they will receive influences in the transport of the administration of the rural property, but, for this, it is necessary to work systemically with the other agents part of the production chain.

## V. FINAL CONSIDERATIONS

In synthesis, in making decisions as the viticulture, is characterized of form holística in the choice of systems of cultivation of grapevines, internal factors act to the property and external, independent of the cultivation system to be conventional or biodinámico. On the other hand, the environmental subjects are just considered to assist the expectations of the commercialization and demand, following by the sociocultural subjects, that win significância to allow to access information also to make possible economical results.

Therefore, the administration of vineyards is a complex task it requests information, technical

attendance, for instance, using a tool, that can be considered in the biophysical subject of the agricultural unit that is the decision of soil analysis. The same can be a starting point to organize, to drift and to verify the needs of the cultivation system and to evaluate the handling results and of chosen agricultural practice.

Also, it was verified that the farmers in his/her majority, will notice and practices and cultivation systems that allow a balanced conviviality with the environment to discuss, with the social and economic subjects. What identified as the managers' of vineyards profile, it is that their making of decision characterize with a larger concern with more maintainable handling of the natural resources, but also, the market disputes at the moment. Besides, he/she noticed, the tendency in looking for practices of treatments and cares with the plantations of less conventional and more traditional viníferas, as using agriculture biodynamics for production of grapes.

However, the found difficulties and the concerns in adapting in a system of less conventional cultivation, he/she is due to the climatic conditions and of the soil of the areas vitícolas in the study. However, the reduction of chemical treatments in the grapevines is happening gradually in the participant properties of this study considered in the transition process for the cultivation biodinâmico. On the other hand, the vineyards of conventional cultivation, still, dependent on chemical products for the control of curses and of the cleaning among lines of the grapevines.

It concluded that, for deciding it is necessary to manage information and for this, it requests compromising and alignment of objectives and results of the productive chain.

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# Bot use Dimensions for Business Performance: use Perspectives and Acceptance

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**Abstract**— *The aim of the present study is to analyze the use of the artificial intelligence Bot and its relation to business benefits, with emphasis on understanding acceptance and use factors based on clients' perspectives. In order to do so, a case study was carried out in a benchmark company of the private pension sector in Brazil. The Simplified Model of Dimensions of Information Technology Use for Business Benefit and the Unified Theory of Acceptance and Use of Technology (UTAUT2 – for consumers) were adopted as analysis method. Results pointed out that using Bot as business strategy brings benefits to quality, product and service flexibility, and to innovation, as well as that factors linked to social network use, experience and to the widespread of internet infrastructure in smartphones are responsible for low effort expectations, high performance expectations and for facilitating conditions favorable for Bot use.*

**Keywords**— *Bot, Artificial Intelligence, Private Pension, Technology Use and Acceptance, Business Innovation.*

## I. INTRODUCTION

The technological innovation known as Internet of Things (IoT) has been gaining more room; according to [4], it is featured by processes involving devices connected to networks that communicate to each other and produce and/or process real time information in an autonomous way. Data digitalization allows information to be democratized and cheap; therefore, it opens room for a new web system, for a new way of thinking and setting new relationships.

Accordingly, companies have become more digital given the use of emerging exponential technologies of continuous learning [6, 7]. This transformation demanded changes in business models applied to this new ecosystem. Exponential changes in business models happen when technology meets business innovation. Information Technology (IT) and Operational Technology (OT) convergence in the IoT ecosystem enables data integration.

Artificial Intelligence has been gaining room among current technologies as a business strategy, since its use

brings benefits for business performance. In order to reach the expected benefits, it is necessary managing IT and making quite high investments in it, besides identifying the real contributions this technology gives to companies; although companies end up depending on it.

In [3] suggest the application of five IT use dimensions:

- (i) IT use;
- (ii) Benefits from it;
- (iii) Its contribution to business performance;
- (iv) Governance and IT management;
- (v) The role played by managers and the relation between the 5 dimensions.

The study on IT use dimensions is an important subsidy for company plans and actions focused on institutional targets.

Factors encouraging individuals to accept and use new technologies are relevant aspects to be understood. If one takes into account the business environment, organizations must know whether innovation - applied as business strategy - is accepted and used by consumers. Thus, the aim of the present study was to analyze the artificial intelligence use dimension through Bot adoption and its relation to business benefits, with emphasis on understanding acceptance and use factors based on clients' perspectives. In order to do so, a case study was carried out with a benchmark company of the private pension sector in Brazil.

Internal documents and reports of the company were analyzed, and interviews were conducted with a product specialist and with the leader of the Bot development project. The Simplified Model of Dimensions of Information Technology Use for Business Benefits by [2] and the Unified Theory of Acceptance and Use of Technology (UTAUT – 2) for consumers by [10] were adopted as analysis method. Results pointed out that Bot use as business strategy brings benefits related to quality, product and service flexibility, and to innovation, as well as that factors linked to social network use, experience, and to widespread internet infrastructure in smartphones are responsible for low effort expectations, for high performance expectations and for facilitating conditions favorable for Bot use.

The present article is divided as follows: Section 2 – presents concepts related to the herein addressed subject and describes the Simplified Model of Dimensions of Information Technology Use for Business Benefits and the UTAUT – 2 Theory; Section 3 presents the methodologies; Sections 4 and 5 address the results; finally, Section 6 presents the conclusions about the analyses.

## II. THEORETICAL BASIS

This section introduces the concepts of instrument chosen for the analyses applied to artificial intelligence use through Bot to achieve business benefits and to assess factors influencing the use and acceptance of new technologies by consumers.

### 2.1 IT use Dimensions

At [2] propose the “Simplified Model of Dimensions of Information Technology Use for Business Benefits” (Fig. 1, described below) as the way to diagnose IT use dimensions in companies.

Information Technology use in the aforementioned model is directly related to context, which is defined by organizational responses and IT use drivers. Drivers include market, organizational and individual pressures and responses, besides pressures and responses from technology itself. The value added by IT to the organization is associated with the quality of the study and with the analysis of these drivers. The market driver tends to be associated with informational and strategical use; the organizational driver concerns infrastructural and organizational use; individual driver use is linked to consumer and to strategical; and the IT driver is related to infrastructure and strategical. It is likely to have other associations besides the aforementioned ones.

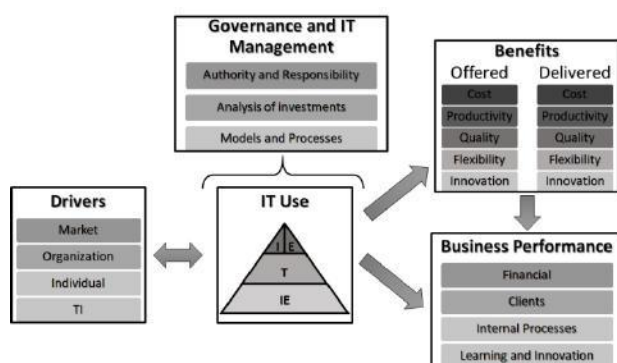


Fig. 1: Simplified Model of Dimensions of Information Technology Use for Business Benefits. Legend: IE- infrastructure; T-Transactional; I-Informational; E-strategical. Source: [3].

Information Technology use is determined by value and by how the company sees it; therefore, one must take into consideration the multiple IT applications available to

organizations at infrastructure, transactional, informational and strategical levels [2]. At [3] cite Weill and Broadbent in this model, because they analyze investments in IT as a portfolio of investments, in which each application means a certain return and corresponding risk. Similar to an investment portfolio, organizations must distribute their investments based on the expected return and risks, for instance: at infrastructure level (IE) investments are related to integration, flexibility and to IT costs; at transactional level (T) they are associated with costs and productivity; at informational level (I) they are linked to control, integration, quality and to cycle; at strategical level (E) investments include risks and returns concerning sales, competition, market, innovation and added value.

With regard to the acquired benefits, infrastructure use tends to be associated with benefits such as cost reductions, productivity and flexibility; transactional use, with costs, productivity and quality; informational use, with quality and innovation; and the strategical use is associated with quality and innovation; however, there must be some other associations. Regarding the impact of IT use on business performance, the use of infrastructure tends to influence internal processes and financial perspectives; transactional use influences internal processes and financial perspectives; informational use influences the innovation and clients' perspectives; and the strategical use influences the innovation perspectives; among others.

Finally, understanding governance and IT management can be a way to also understand other dimensions. Lack of proper procedures to analyze investments, or even failure in the existing ones, contributes to incoherence between IT use dimensions; the same happens with participants in decision-making processes about expenses, investments and IT use.

### 2.2 Unified Theory of Acceptance and Use of Technology - UTAUT2

Understanding the individual acceptance and use of Information Technologies is one of the most mature fields in information system research [5]. There are many theoretical models initially developed from psychological and sociological theories, which are applied to explain IT use acceptance. A literature review and synthesis involving right IT use theories/models resulted in the so-called “Unified Theory of Acceptance and Use of Technology – UTAUT”, by [9]. This theory has been presenting critical factors and contingences associated with the prediction of behavioral intention to use IT, mainly and first of all, in organizational contexts.

At [10] extended UTAUT to studies on technology use acceptance within consumers' context.



The UTAUT has four constructs that together influence the behavioral intention to use a certain technology, namely: performance expectation, effort expectation, social influence and facilitating conditions. These constructs were adapted to the consumers' context in UTAUT-2; three more constructs were incorporated to it: hedonic motivation, price and habit. Besides constructs, the models count on moderators (age, sex and experience), which influence either the behavioral intention or the IT use behavior constructs. The definition of each one of these constructs and of moderators' influence are shown in Chart 1. Fig. 2 depicts relations between constructs and moderators, which lead to the intention behavior and to the IT use behavior.

Chart 1. Definition of UTAUT-2 constructs – consumers' context

Construct	Description	Moderators
Performance expectation	To which extent the use of a certain technology will benefit consumers' in the performance of some activities	Age and Sex
Effort expectation	Degree of ease associated with technology use by consumers	Age, Sex and Experience
Social Influence	To which extend consumers' realize the importance some people have to them (for example, family members and friends); they believe these people must use a specific technology	Age, Sex and Experience
Facilitating Conditions	Refer to consumers' perception about the resources and support available for the adoption of a certain behavior	It affects the use behavior, it is moderated by age and experience
Hedonic motivation	Defined as leisure or pleasure resulting from the use of a certain technology	Age, Sex and Experience
Price	It is the cognitive commitment of consumers with benefits understood as resulting from the use new technologies	Age and sex

	and with the financial cost to use them. Price is positive when the benefits from using a technology are perceived to be greater than the financial cost; such price has positive impact on intention	
Experience and Habit	Experience reflects the opportunity to use a technology; it is typically operated as a time passage based on the initial use of a technology by an individual. Habit has been operated in two distinct forms: (i) habit is seen as a previous behavior; (ii) it is measured based on how an individual believes that a behavior is automatic. Accordingly, habit is the perceiving construct that reflects the outcomes of previous experiences.	To influence the behavioral intention and the use behavior: Age, Sex and Experience

Source: Elaborated from [10].

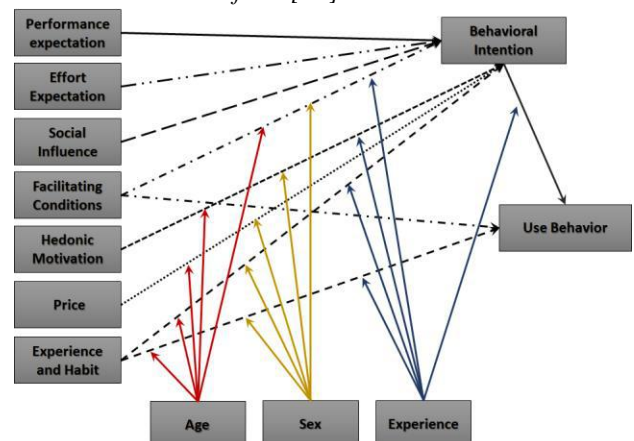


Fig. 2: UTAUT-2 Model. Source: Adapted from [10].

### III. METHODOLOGY

The strategy adopted in the current research lied on the study of a single case. The research problem can be summarized by two questions: (i) "What are the Bot use

dimensions (Artificial Intelligence) and how must the relation between them be so that Bot use can be successful? And (ii) “What are the factors influencing Bot acceptance and use behavior in consumers?”.

This is an exploratory research that demands contextualization and in-depth assessments [11]. Furthermore, there are only few studies published in this field and its research question can be of the “what” and “how” types [12].

The use of all components of a case study project [13] is enough for the project to take into account the generalization limitations and the potential biases highlighted by [14].

### 3.1 Summarized Case Description

The company chosen as case belongs to the financial services sector, it is a benchmark in its segment, mainly in private pensions - its revenue was close to R\$1.09 billion in 2016. The name of the company will be kept in secrecy due to request from its stakeholders; this company will be called “company” hereafter.

The company offers private pension products whose sales are nowadays mainly made by bank agencies, with high capillarity, which are spread throughout more than 99% of Brazilian counties. Besides purchasing these products in bank agencies, consumers can also buy them from associated brokers.

The present study was carried out between March and April 2018. The first stage of it consisted in analyzing the IT use dimensions (Bot and associated technologies) and their association with business benefits. The study focused on understanding the current situation in the company by assessing internal documents and annual reports from 2016, by interviewing the product specialist responsible for structuring the New Digital Technological Platform, and by interviewing the leader of the Bot development project. The “Simplified Model of Dimensions of Information Technology Use of Business Benefit” was used in this analysis. The second stage counted on more specific analyses about the Bot use and acceptance issue. In order to do so, information collected during the interview with the leader of the Bot development project was analyzed; results were analyzed based on the UTAUT – 2 Theory.

## IV. OVERVIEW – DIAGNOSTIC OF IT USE DIMENSIONS

Information technology use in companies can be assessed through the diagnostic of its dimensions based on the Simplified Model of Dimensions of Information Technology Use of Business Benefit. This process allows understanding the IT use situation in the market. Fig. 3 presents a synthesis of the diagnostic set for IT use dimensions applied to Bot development and use in the

company. Next, the text brings the analysis of each one of the five dimensions.

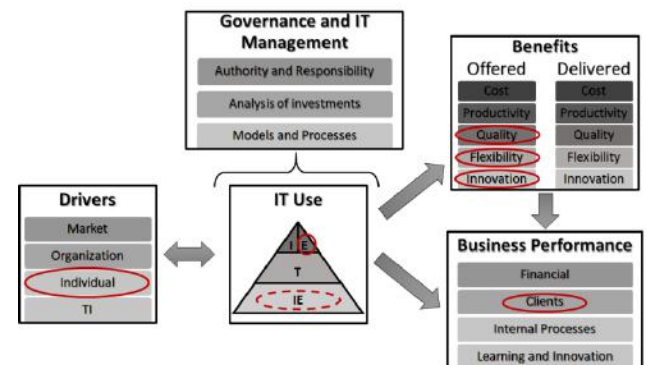


Fig. 3: Diagnostic of Information Technology use dimensions – Bot.

### 4.1 Drivers

Based on the diagnostic, a perspective focused on Client as the outcome of business performance made the company invest in Bot development. There are two main problems involving this process: clients’ satisfaction with after sales services and elimination of bank agency dependence for product sales.

Client satisfaction is related to drivers “individual” (pressure from clients) and “Organization” (business model in the digital era). Many clients declared themselves unhappy with after sales services in a previous survey; one of the surveyed clients is a good example of it, she was about to retire and got very disappointed, because the amount she received did not correspond to her expectations. Such disappointment resulted from lack of communication, she did not know that if she had invested a little bit more, she would reach the expected pension.

With regard to business model, assumingly, the company follows the Aggregation model by [8], according to description by [1]. Based on this model, bank agencies sell products to clients and intermediate the relationship between clients and the company. This process makes the company 100% dependent on this partnership; therefore, the company needed to enhance the business configuration based on Information Technology. Once products are digital (intangible), it is possible using IT to set a whole value chain for business processes in electronic environment, which is the goal of the business.

### 4.2 IT use

When it comes to IT use for Bot development, the company had to initially make a great investment in IT infrastructure, but, nowadays, the company is restructuring its technological platform. However, it still does not have a structure good enough to support the large number of process requirements given the exponential growth in the number of clients in the last

few years. The company invested in cloud computing, in relational database (Postgress), in non-relational database (Dinamo BB) and in queue cutter (SQS and RDSI) to solve this issue. The queue cutter aims at shortening the waiting time; the whole system is supported by Amazon Web Service Infrastructure, which is described in Chart 2.

Chart 2. Description of infrastructure technologies developed for Bot implementation.

Infrastructure – AWS – Amazon Web Service		
Infrastructure		Free or paid
Relational database	Postgress	Free
Non-relation database	DinamoDB	Amazon – paid
Queue cutter / micro-services	SQS	Amazon – paid
Queue cutter	RDSI	Free; a fee is paid to Amazon for RAM memory use
API	Programing language: Python	Free
Server	Amazon	Paid
Artificial Intelligence – only for natural language processing	Watson	Paid
Artificial Intelligence – other techniques, including machine learning	Developed by the company itself	Free

Not all data are stored in the Amazon server; part of them is in the company files. The Bot is located at Amazon. Security tests against invasion are often performed.

In respect of the Transactional part, wich constitutes the algorithm created for Bot development. The informational part comes from databases in the company, these data are hosted either in the company’s infrastructure or at Amazo a qualn. Specific knowledge about private pension is inserted in the Bot; this knowledge is used as “intelligence” in the Strategical driver, which is responsible for transforming data for the client. This is one of the critical factors for good Bot performance. Many meetings were necessary to define and learn the specific terms used for pension systems, and terms used in the financial sector, in order to acquire good information.

A developed Bot does not learn by itself, but the right Bot was chosen to perform the transactions. Thus, the learning process must be inserted in it in order to avoid inappropriate language use by the Bot, for example. Part of information insertion was firstly performed by software and IT developers, but the interface was adapted so any specialist in private pension products, or in business, could record new information (“intelligence”). Results in Fig. 4 point out a distribution based on higher percentages of aspects related to flexibility, standardization and to IT infrastructure integration. This distribution reaches 60% of the total time and investment needed to develop the Bot and to make it fully operational. This outcome is in compliance with the fact that the company does not have a robust technological platform composed of unified databases and integrated systems. However, it is worth highlighting the internal projects focused on defining the development and implementation stages, besides the Bot project.

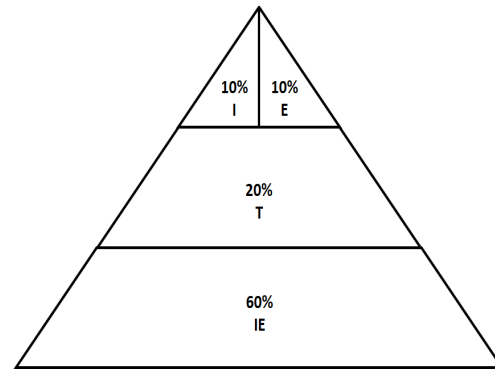


Fig. 4: IT use. Time invested in Bot development.

Legend – IE:Infrastructure; T:Transactional; I:Informational; E:Strategical

This is an IT use estimate for initial Bot delivery; the informational and strategical levels will be subjected to continuous development after Bot delivery. In informational terms, Bot rules/information about the private pension subject was incorporated during this first delivery by an IT professional; however, the developed interface allows any authorized individual (login and password) to insert “intelligence” (more information) in the Bot. Thus, when the Bot is implemented for client use, in case there are any question the Bot cannot answer, the system is notified, and the human specialist can record a new information. The next time the Bot is questioned about this same issue, it will be able to give an answer. One can observe that all investments aimed at influencing aspects such as market, sales, competition, innovation, added value and client - the last aspect (client) was the Strategical driver. Therefore, it is necessary investing in IT flexibility, standardization and infrastructure integration, in cost reduction, in operation efficiency and

productivity and in business transactions, as well as in information control, integration, cycle and quality.

### 4.3 Business benefits

By taking into account the benefits from Bot use in business, Innovation is among the ones related to protection, to competition advantage and to client satisfaction. Competition advantages brought by Bot use are benefits concerning differentiation, market participation simulations, value adding and the search for cost reduction. Client satisfaction can be achieved through products that meet their needs and that have more added value to users, without the need of additional training to employees; consequently, it leads to better revenues to stakeholders. These benefits can be measured through sales coefficients due to Bot adoption (innovation) and through returns due to innovation. This feature stands out because Bot use is not limited to its application to generate new services, but also to how the company acts in a market constantly changing the way to do business. This information is in compliance with statements by BolWijn and Kumpe (1990), cited by [3].

With respect to benefits from Flexibility, one can mention volume flexibility, which is the ability to change aggregate output levels when e-commerce sales performed by the Bot are taken into consideration; and delivery flexibility, since product contracting will be made through the Bot, right at the end of the negotiation. A bill is sent to the client at the end of the negotiation process, as long as the bill is paid, the buyer becomes a client and has access to after sale services provided by the Bot itself. This process is possible because the Bot will have previous information about the client and will be able to provide a customized environment to each client. These flexibilities, besides reducing costs and enhancing product quality, will reduce the waiting time for client assistance. Thus, product customization will be possible not only to special and influent clients, but to all clients, since it will not be necessary to have any kind of human intervention in risk analysis and in better funds, because it will be calculated by the Bot.

Bot use innovation also enables improving Quality benefits, with emphasis on the quality of services when it comes to tangibility, reliability, safety, empathy and readiness. Each client will have a customized assistance either at sales or in after sales services. The Bot will be able to assess the best investment funds for each client based on the investor's profile; thus, it will be able to make high quality analysis for all clients, 24/7, without vacations or holydays, fact that is not possible for humans. This process is the guarantee that the best options will be made available to the client, so he/she can make the best decision to change funds of investment or to increase values invested in applications, for example.

All these innovations are only possible because the company is focused on the client and on works based on a system that collects, stores and assesses clients' information through artificial intelligence techniques. It is done in order to assist clients the best way possible and to accomplish better revenues to the company in the market in comparison to its competitors.

Increased sales productivity is another benefit brought by Bot use, since sales of the company's pension services will no longer be limited to clients of the bank it is bonded to. Improvements in the sales process and in after sales services aim at increasing sales productivity and at reaching clients' satisfaction. Finally, this innovation will reduce costs and also improve the quality of products and services. This outcome will be possible due to the need of hiring less employees to assist clients. Thus, these are the benefits brought by Bot use to the company.

### 4.4 Business performance

Client satisfaction is the main business performance factor expected by the company after Bot implementation. The aspects of such factor are related to clients' perception about performance and services and their quality, to cost relation and to the prompt delivery of products and services. However, as it is herein highlighted, other performances will also be achieved.

Financial performance is the most relevant one, since it is related to business profitability and growth, to business value and to return from investments.

The last two performances would be the Internal Processes, and Learning and Innovation ones, which concern aspects focused on organizational processes that exert greater impact on client satisfaction, on the generation of new products/services and on processes and competences applied to achieve performance excellence.

### 4.5 Governance and Management of Information Technology

Direction Board support was essential for the development of the Bot project; directors were committed with critical management-success factors. It is worth highlighting that Direction Board, CEO, CIO and managers were the ones discussing with a company expert in IT solutions about issues such as client dissatisfaction, sales dependence on bank agencies, among others. Many companies worked together for a week in order to propose some solutions for these issues, and they counted on the participation of the company's Direction Board. Finally, the solution presented by one of the companies involved in the process was chosen; hereafter called X3.

X3 is a digital product studio that develops projects for different companies. They were hired by the company as outsourcing to develop the Bot. It works with a fast methodology and all problem solutions suggested for the

products, including the Bot, were discussed with the Direction Board and with the financial and products managers; all of them participated in the decision-making process. This methodology allowed the company to align business and IT strategies, in other words, to achieve integration between business and IT strategies, as well as between infrastructure and organizational processes, and infrastructure and IT processes. Furthermore, this methodology encouraged managers to act as sponsors of the Bot development project.

It is important pointing out that business managers and second sphere managers, who need the operational and informational support from this technology and from final users, also participated in the development process since they know and conduct the organizational processes. This participation was so important that during interviews conducted with the leader of the Bot development project the interviewee called the attention to the fact that these managers joined many meetings focused on better understanding aspects such as details about private pension, products (PGBL, VGBL, among others) and financial processes. Understanding these processes, and their main terms, was essential for the creation of an informational intelligence database to the Bot, which had to be accurate and aligned to the company’s strategical targets.

**V. ANALYSIS APPLIED TO BOT USE AND ACCEPTANCE FACTORS**

After analyzing the IT use dimensions for Bot development and their relation to business benefits, the present section addresses the Bot acceptance and use by clients. The herein presented perspectives were collected during the interview conducted with the leader of the Bot development project, who analyzed user clients and company employees’ perception about it. Moderator constructs of the UTAUT2 theory were taken into consideration in order to do so.

Chart 3 depicts factors influencing Bot acceptance and use.

*Chart 3. Factors influencing Bot use and adoption by company’s employees*

Constructs	Analysis
Performance expectation	Fast and high-quality assistance is the main benefit from it. Bot use will allow clients to have access to the assistance service at any time, without facing queues, such as in bank agencies. One of the topics addressed in the interview lied on the fact that maybe people want a little less human contact for things that could be made

faster, for example, matters that could be solved by the Telemarketing sector, since it follows scripts. This method can be programed by a Bot. Purchases can also be made at the end of the call. Customized assistance is another benefit from Bot adoption, since it allows each client to have a separate assistance, fact that can make the client better cared. Financial explanations by the “Bot” are not “hard”; it is developed to facilitate clients’ understanding – it does not demand a “Bot” teacher. After sales, assistance is also a customized benefit, the Bot is able to follow investment evolutions 24/7 and to provide high-quality real-time information about market changes to clients

**Effort expectations**  
The intense use of Social Networks and of WhatsApp is an advantage, since it has created a digital culture in people who use text messages. Adaptation to Bot is easy to people who have already developed this digital culture, since they will keep on texting messages to the company through the Bot. It is not necessary installing any application, not even learning a new interface, buttons, etc. The client is already used to this procedure; sending out the text message is the only action to be taken. Thus, the adaptation phase is almost null, i.e., the effort expectation is almost zero.

**Social influence**  
This factor is more closely related to Bot adoption by the company than by clients. Bot use is growing fast, and it forced the company to adopt this technology.

**Facilitating conditions**  
People already have the necessary resources, knowledge and technologies to use a Bot. It is not necessary installing any type of application. People have the internet, smartphones, tablets, notebooks or desktops.

**Hedonic motivation**  
People need to be pleased to use the Bot; therefore, it must be fun, a little funny, pleasant and have a certain degree of entertainment. In order to fulfil all these demands, the Bot uses

	information about age and sex, for example, to customize the chat based on appropriate language. For example, it will treat elderly as Mister/Miss, whereas youngsters will be called “you”. The Bot has a different answer at different moments, it will use the language the client is used to. Sometimes, even a slang is used to address a youngster, but it will make no sense for an older person.
Price	It is not necessary installing any application. Clients have no cost when they use the Bot and perform the product purchasing process through it.
Experience and habit	Since the use of social media such as Facebook and WhatsApp became popular, people are already experienced in communicating through text messages. It became a habit, i.e., it is automatic in the lives of most Brazilians.
Behavior intention and use	Once the Bot will also take care of after sales issues, it will highlight better funds of investment, i.e., it will perform a follow-up on the clients’ private pension. Due to previously described performance expectation, one can believe that clients will keep on using the Bot after purchasing the service. Because Bot’s fast and easy use involves financial resources, clients are expected to search the Bot on a daily basis, and it will approximate the relationship between clients and products – although it does not happen nowadays.

access the internet. Moreover, these individuals have sent out or received text or voice messages, or images through applications, including social networks such as Facebook and message systems like WhatsApp. This Brazilian expertise and habit, the intimacy with the technology supposed to be used as business strategy by the company, allows inferring that Bot acceptance and use will be positive and widely adopted by clients.

**VI CONCLUSION**

After detecting the client dissatisfaction with after sales services and with the dependence on bank agencies for product purchasing, the company was forced to develop strategies focused on clients’ satisfaction with business performance and with market expansion. The chosen solution lied on installing a Bot in order to acquire quality, flexibility and innovation benefits from services and products. The main factors related to clients made directors choose this solution, which is based on the UTAUT2 theory, which, in turn, addresses technology acceptance use based on consumers’ perspective. The habit of using text message tools; the fact that most Brazilians already have the necessary infrastructure such as internet, smartphones, tablets, desktops or notebooks (facilitating conditions); the unnecessary generation of a learning curve for tool use (effort expectation); the null cost with Bot use; and the benefits from a customized assistance 24/7, without the need of facing a queue and of going to a bank agency to hire the service or to gather information about the acquired product were the critical factors for technology use intention.

Organization itself was another benefit; soon the company will stop being 100% dependent on bank agencies for product sales. Moreover, the Bot will provide more appropriate assistance to clients, since it will be specifically developed for private pension products, and its attention will not have to be shared with other subjects of other clients, fact that assures high-quality assistance and final products.

Besides factors mentioned above, two others deserve attention due to the success of the herein addressed project. The first one is ‘commitment and Direction Board participation in the IT team’, because it assured the strategical alignment between business and IT. The other factor is ‘the time spent to learn and popularize the tool inside the company’, in order to minimize the gap between the technology available (the developed Bot) and the embodied technology (the effective use of the Bot by employees). At this phase, the development team made sure that the Bot will not be a mere tool lost in the organization. All employees must know how to use it, so that the company can embrace this innovation and truly apply it in order to reach the expected business benefits.

Thus, based on the analysis applied to each construct, it is possible observing that all of them are positively influenced by behavioral intention and Bot use. Influence relations of moderators ‘age’, ‘sex’ and ‘experience’ could not be analyzed in the current study; therefore, it is necessary surveying clients who use the Bot, but it remains in installation phase. However, based on data gathered so far, one can see that moderator “habit” was one of the most relevant ones when it comes to motivate behavioral intention and use.

Data in the recent Pesquisa Nacional de Amostra Por Domicílios - Pnad (National Research on Samples per Residence), which was carried out by IBGE in 2016, point out that 92.3% of Brazilians use smartphones to

The use of artificial intelligence enabled the company to achieve the expected benefits through investments in innovation. However, further studies must be carried out in order to investigate the influence on age, experience and sex moderators. This investigation will be possible after the Bot is fully operational, since it will be fed with more information and will have intelligence related to these moderators. Such future studies must aim at assuring competition advantages in order to continuously improve the quality of products and services.

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# Assessment of Potential Antifungal of new Synthetic Compounds Organotin on Penicillium Fungi Growing on Cheese Ripening Chambers

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**Abstract**— The use of organotin compounds are increasing, mainly due to their applications in various technological and industrial areas such as plant protection agents with broad application in agriculture, veterinary, pharmacy and medicine. The increase in the publication of works on applications of organotin compounds containing organic ligands is a milestone in the development of chemical organoestânic as possible research and the discovery of complex, especially in medicine. Brazil has excelled in the production of cheese, however many contamination has hindered the development of cheese with qualities, this fact affects mainly small farmers and family farming. This study aimed to evaluate the potential inhibition of mycelial average growth of fungi *Penicillium brevicompactum*, *Penicillium camembert*, *Penicillium commune*, *Penicillium expansum* and *Penicillium solitum*, collected in a cheese ripening chamber dairy from UFLA – Universidad Federal of Lavras a)  $\alpha$ -hydroxycarboxylic acid (DL-mandelic acid, benzylic acid, dl-4-bromomandelic acids acid, dl-4-methoxymandelic acid and dL-2-chloromandelic acid) at concentrations of 1 and 50 ppm; b) with trimethyltin chloride in concentrations of 1 and 50 ppm; c) the complexes derived from the reactions of  $\alpha$ -hydroxycarboxylic acids listed reacted with trimethyltin ( $[Me_2SnMand]$   $[Me_2SnBenz_2]$   $[Me_2SnBrm_2]$   $[Me_2SnMeo]$  and  $[Me_2SnClm_2]$ ) at concentrations of 1, 5, 10 and 50 ppm. The compound inhibited triorganoestânic generally, the mean mycelial fungal growth in concentrations of 1 and 50 ppm. With respect to the complex, It observed that the  $[Me_2SnClm_2]$  showed the highest overall mean percentage inhibition (90.0%), while the complex  $[Me_2SnBrm_2]$  showed the lowest average (57.3%). The inhibitory percentage was calculated on the overall average concentration of 50 ppm and fungi that have suffered greater inhibition were *Penicillium commune*

and *Penicillium solitum*. These compounds showed excellent results in the inhibition of fungi that infect cheese ripening cameras, and can be an alternative to the social improvement of Brazil, as its low cost allows small producers to make use of this technology, it is expected that this work can be the first step towards a revolution in this segment and that further research be promoted from this work. The inhibitory percentage was calculated on the overall average concentration of 50 ppm and fungi that have suffered greater inhibition were *Penicillium commune* and *Penicillium solitum*. These compounds showed excellent results in the inhibition of fungi that infect cheese ripening cameras, and can be an alternative to the social improvement of Brazil, as its low cost allows small producers to make use of this technology, it is expected that this work can be the first step towards a revolution in this segment and that further research be promoted from this work.

**Keywords**— antifungal; compounds organotin; *Penicillium fungi*.

## I. INTRODUCTION

Organotin compounds include a group of substances characterized by an organometallic tin atom covalently attached to one or more organic radicals as methyl groups, ethyl, propyl, butyl, phenyl, etc. Chemically, these compounds are represented by formulas  $R_4Sn$ ,  $R_3SnX$ ,  $R_2SnX_2$ ,  $RSnX_3$  and in which R can be any alkyl or aryl group, and X is an anionic species as halide, oxide or hydroxide, for example. Besides these, there are some organic compounds, which do not arouse chemical interests for lack of practical applications (HOCH, 2001).

In 1950, the Organic Chemistry Institute in Utrecht, the International Council for Research on Tin made the first correlations between organotin compounds



and biological effects. From this date, investigations have shown the action of these compounds in relation to fungi and bacteria, marine organisms, parasitic worms, insects and aquatic snails, among others (JONHSTON, 1976). Pesticides are currently studied compounds (fungicides, insecticides, bactericides, anthelmintics, repellents and biocides in general) with applications in agriculture, veterinary medicine and pharmacy (LUIJTEN, 1972).

The growth of fungi and molds in food constitutes one of the great problems of the food industry. In the dairy industry this fact is observed more frequently in almost all types of aged cheeses, it is difficult to prevent the deterioration of the cheese by fungi (Becker, 2017). The most common genera of molds that grow on the surface of cheeses are: *Penicillium*, *Mucor*, *Aspergillus*, *Cladosporium*, *Monilia*, *Geotrichum*. They are present in nearly every ecological niche, with many diversities, and are currently about 70,000 described species of fungus, although it is estimated that there are 1.5 million different species distributed throughout the world.

- *Penicillium brevicompactum* - colony on CYA at 25 ° C, have a diameter between 3.84.1 cm, Gray-green color, furrowed colonies, with few white mycelia at the edges. Colony in Malt Extract Agar (MEA), dense.toxic metabolites: botriodiploidina and mycophenolic acid. Found in foods, soil and fruit (PITT, 2000; SAMSON et al, 2001 and CHALFOUM, BATISTA, 2003).

- *Penicillium camembert* - colony on CYA at 25 ° C, reached a diameter between 2.3 and 5 cm. with mycelium 1 cm height. Conodióforos up to 50 microns. Found in foods, soft cheeses. As it has toxic metabolites, primarily ciclopropiazônica acid. Raper and Thom (1949) recognized two species used for the manufacture of white cheeses: *Penicillium camembert* and *Penicillium caseicola*. The two species are distinguished by the color of the mycelium (PITT, 2000; SAMSON et al, 2001 and CHALFOUM, BATISTA, 2003).

- *Penicillium commune* - colonies in CYA at 25 ° C, reach the diameter 2.53. cm In 7 days, producing gray-green spores. They occur also in yellow colonies. The ciclopropiazônica acid is its principal toxic metabolite (PITT, 2000; SAMSON et al, 2001 and CHALFOUM, BATISTA, 2003).

- *Penicillium expansum* - Colonies on CYA at 25 ° C, have diameters which can vary from 4 to 5 cm. In 14 days. Shows yellow or bluish-green color.

aromatic odor of fruits, like apple smell. Main toxic metabolites: roquefortine c and patulin, citrus. Found in foods, especially in fruits, which is primarily responsible for the rot (PITT, 2000, SAMSON et al, 2001 and CHALFOUM, BATISTA, 2003).

- *Penicillium solitum* - synonymous with *Penicillium verrucosum*. Colonies on CYA at 25 ° C, have a diameter ranging between 1.9 and 2.5 cm. gray-green color, with little white mycelium on the edges of the colonies. Found in foods, generally. Main toxic metabolites: ciclophenin, cyclophenol, viridicatol, compactin (Pitt, 2000; SAMSON et al, 2001 and CHALFOUM, BATISTA, 2003).

The exact definition of the limits of the fungus group is virtually impossible. Currently biologists use the term fungus to include "the aclorophilates bodies, nucleated spore-producers, which usually reproduce sexually or asexually and whose filamentous and branched somatic structures are surrounded by cell walls containing cellulose or chitin or both" (ALEXOUPOULOS et al , 1996).

About have 1000 species of cheese are produced in the world, most of which is made in France (BURKHALTER, KALANTZPOULOS 1981 and 1993). The cheese ripening is made in most cases, in chambers with controlled temperature and humidity, ranging 10 to 15 ° C and 80 to 85%, respectively. The maturation can be performed in two stages, since it has two maturation chambers, one with a temperature of 10 ° C and humidity of 80% and another with 14 ° C temperature and 85% humidity. This procedure is interesting because the first week of aging at lower temperature prevents violent fermentations therefore prevents the cheese stuffing. After the first week, as in higher temperature and humidity, the risk of bloating was insignificant since all of the lactose has already been fermented. It must be emphasized, however, that there is suspicion of the presence of coliform the temperature of the ripening chamber should be set at 2 to 5 ° C. (ABREU, 2000).

The literature also records the stage of monitoring of cheese ripening using ultrasound. Being a non-destructive technique allows to detect any defects arising from abnormal fermentation (BENEDITO et al, 2001).

The main process occurring in aging, especially hard cheese, is protein degradation or proteolysis effected by rennet enzyme systems, an important factor for the quality of the cheese, especially in regard to taste and consistency. In cheeses whose mass is baked at high temperatures, such as Gruyere, which is processed at 52 ° C or scalded dough in as Parmesan, plasmin is the

primary proteolytic enzyme. In semi-hard cheeses such as Tisilt, two concurrent processes occurring maturation: An usual, within the mass, where the peptide bonds of the proteins are broken, releasing short peptides and amino acids; another, on bark where proteins can be degraded to ammonia formation (BERESFORD et al, 2001).

When the mold problem in an industry becomes chronic, specifically in a chamber of maturation, it is advisable to adopt preventive measures for cheese and sanitize the cameras, after the removal of all cheeses. Two types of treatment may be applied to. Solutions of sanitized with sodium hypochlorite containing less than 400 ppm of free chlorine; spraying with quaternary ammonium solution at 800 ppm, and sprayed with an alcoholic solution containing 10 to Wellas 30% formaldehyde fumigation with formaldehyde gas, recommended for removal of the mold ripening chambers when in a room with 30 min.

Therefore, this study aimed to verify the antifungal potential of the new organotin compounds synthesized against of *Penicillium* fungi, contaminants cheese ripening chambers, where they were collected.

It was the subject also of this study was to compare the biocidal inhibitory effect of the new complex with the inhibitory effect of biocide binders.

## II. MATERIAL AND METHODS

### 2.1 - Instrumental

#### 2.1.1 - Melting point

Melting ranges without correction, they were determined on the device to determine the melting point of 340-D, Quimis of the University Vale do Rio Verde - UNINCOR, Three Hearts.

#### 2.1.2 - Analysis

Elemental analyzes of carbon and hydrogen were held in elementary equipment 2400CHN Analyzer Perkin-Elmer, the Department of the UFMG Chemistry.

#### 2.1.3 - infrared vibrational spectroscopy

Infrared spectra were obtained on a spectrophotometer Shimadzu FTIR-8201 Fourier transform (4600-400  $\text{cm}^{-1}$ ), Department of Chemistry, University of Lavras using the technique tablets with potassium bromide.

### 2.2 - Reagents

All reagents and solvents used in the experiments described in this thesis were used without further purification.

The compounds used are as follows:

- Acetonitrile,  $\text{CH}_3\text{CN}$ , Quimex;
- DL-mandelic acid,  $\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{COOH}$ , Vetec;
- DL-p-methoxymandelic acid,  $4\text{-CH}_3\text{OC}_6\text{H}_4\text{CH}(\text{OH})\text{COOH}$ , Aldrich;

- Dl - p -bromomandelic acids acid,  $4\text{-BrOC}_6\text{H}_4\text{CH}(\text{OH})\text{COOH}$ , Aldrich;
- Benzylic acid,  $(\text{C}_6\text{H}_5)_2\text{W}(\text{OH})\text{COOH}$ , Aldrich;
- DL-mandelic acid o-chloro,  $2\text{-ClC}_6\text{H}_4\text{CH}(\text{OH})\text{COOH}$ , Aldrich;
- BDA culture medium, Merck;
- Trimethyltin chloride,  $(\text{CH}_3)_3\text{SnCl}$  Aldrich;
- Dichloromethane,  $\text{CH}_2\text{Cl}_2$ , Merck;
- Phenylhydrazine,  $\text{C}_6\text{H}_5\text{NH}_2$ , Merck.

### 2.3 - Synthesis of $\alpha$ -hidroxicarboxilatos organoestânicos

#### 2.3.1 - Synthesis of $[\text{Me}_2\text{SnMand}] = \{\text{Manda } \text{C}_6\text{H}_5\text{CH}(\text{OH})\text{-COO-}\}$

In a 50 mL round bottom flask was dissolved 1.000 g (6.57 mmol) dl-mandelic acid in 30 ml of acetonitrile were added and 0.839 goftrimethyltin chloride (4.21 mmol). Was added 0.1 mL of phenylhydrazine and the system was maintained under magnetic stirring and slow reflux for an hour at  $80^\circ\text{C}$ . The volume was reduced to half the mixture and allowed to stand for one hour. The solid obtained was separated by vacuum filtration using 4 porosity funnel and washed with 3 portions of dichloromethane with 2 ml each and dried in an Abderhalden pistol at  $100^\circ\text{C}$  for 1 hour. They got up 0.670g product, 67.9% yield.

#### 2.3.2 - Synthesis of $[\text{Me}_2\text{SnBenz}_2] \text{Benz} = \{(\text{C}_6\text{H}_5)_2\text{CH}(\text{OH})\text{-COO-}\}$

Repeated the process from 2.3.1, using 1.000 g (4.38 mmol) of benzyl acid and 1.260 goftrimethyltin (6.32 mmol) chloride, replacing DL-mandelic acid. They were obtained from 0,480g of the product, 44.7% yield.

#### 2.3.3 - Synthesis of $[\text{MeSnBrm}_2] = \{4\text{-Brm } \text{BrC}_6\text{H}_4\text{CH}(\text{OH})\text{-COO-}\}$

Repeated the process from 2.3.1, using 1.000 g (4.30 mmol) of DL-p -bromomandelic acids and acid 0.713 goftrimethyltin chloride (3.66 mmol). They were obtained from 0,565g of the product, 44.7% yield.

#### 2.3.4 - Synthesis of $[\text{Me}_2\text{SnMeo}] = \{4\text{-Meo } \text{CH}_3\text{OC}_6\text{H}_4\text{CH}(\text{OH})\text{-COO-}\}$

Repeated the process from 2.3.1, using 1.000 g (5.48 mmol) of DL-p-methoxymandelic acid and 0.839 goftrimethyltin chloride (5.04 mmol). They were obtained from 0,625g of the product, 59.4% yield.

#### 2.3.5 - Synthesis of $[\text{Me}_2\text{SnClm}_2] = \{2\text{-ClC}_6\text{H}_4\text{CHClm}(\text{OH})\text{-COO-}\}$

Was repeated 2.3.1 procedure, using 1.000 g (5.36 mmol) of dl-o-chloro-mandêlico acid and 1.029 goftrimethyltin chloride (5.16 mmol). They were obtained from 0,412g of the product, 41.2% yield.

## 2.4 - Biological Activity

To evaluate the biocide effect on fungi, *Penicillium brevicompactum*, *Penicillium camembert*, *Penicillium commune*, *Penicillium expansum* and *Penicillium solitum* were used the following compounds: dl-mandelic acid, benzylic acid, dl-p -bromomandelic acids acid, dl-p- methoxymandelic acid and dL-o-chloromandelic acid and trimethyltin chloride, plus the new organotin complex prepared [Me<sub>2</sub>SnMand<sub>2</sub>] [Me<sub>2</sub>SnBenz<sub>2</sub>] [MeSnBrm<sub>2</sub>] [Me<sub>2</sub>SnMeo<sub>2</sub>] and [Me<sub>2</sub>SnClm<sub>2</sub>].

The genus *Penicillium* the above identified could be CYA or MEA, at temperatures of 25 °C and 37 °C (CHALFOUN, BATISTA, 2003).

The cultures used for the tests were obtained from a cheese ripening chamber through the collecting glass plates, which were arranged in cheese ripening chamber for five days. The bioanalytical method was used in vitro, observed growth inhibition of the microorganisms or with different concentrations of said chemical compound (GARCIA, 2018).

For each compound were prepared control a plate containing 25 ml of culture medium - BDA - and

two plates of mycelial growth tests for each of the studied concentrations (1, 5, 10, and 50 ppm). The experiment was done in triplicate. The fungi were grown with a needle at three points of the plates, which were placed in a greenhouse at a temperature between 25 °C and 30 °C for 5 days.

After this period were performed measurements of mycelial growth of the fungus, the readings taken and the results averaged growth through the area.

## III. RESULTS AND DISCUSSION

Table 1 contains the experimental data of absolute growth of *Penicillium* in the presence of the complex [Me<sub>2</sub>SnBenz<sub>2</sub>]. Numerical values representing the areas occupied by fungi cm<sup>2</sup> after 5 days incubation at the concentrations studied. These data were converted to percentage representing the relative growth of fungi and are shown in Table 2, while in Table 3, by complementarity of values, are shown in the figures for the inhibition on the growth of fungi in presence of the complex [Me<sub>2</sub>SnBenz<sub>2</sub>]. For other experiments, Tables 4 to 13 present the data already converted, expressing only the relative growth inhibition of fungi, either in the presence of the complex and in the presence of ligands.

Table.1: Development of fungi *Penicillium* in the presence of [Me<sub>2</sub>SnBenz<sub>2</sub>], concentration in ppm, in cm<sup>2</sup> area.

Concentration fungi	0	1	5	10	50
<i>Penicillium brevicompactum</i>	2.23	0.57	0.28	0.27	0.04
<i>Penicillium camembert</i>	2.23	0.71	0.62	0.55	0.08
<i>Penicillium commune</i>	2.23	2.08	1.42	0.70	0.42
<i>Penicillium expansum</i>	2.23	2.51	2.11	1.83	0.73
<i>Penicillium solitum</i>	2.23	0.41	0.37	0.30	0.06

Table.2: Percentage relative development of fungi *Penicillium* in the presence of [Me<sub>2</sub>SnBenz<sub>2</sub>], concentration in ppm.in cm<sup>2</sup> area.

Concentration fungi	0	1	5	10	50
<i>Penicillium brevicompactum</i>	100.0	25.6	12.6	12.1	1.8
<i>Penicillium camembert</i>	100.0	31.8	27.8	24.7	3.6
<i>Penicillium commune</i>	100.0	93.3	63.7	31.4	18.8
<i>Penicillium expansum</i>	100.0	99.1	94.6	82.1	32.7
<i>Penicillium solitum</i>	100.0	18.8	13.5	16.6	26.9

Table.3: Percentage inhibition relative *Penicillium*fungi in the presence of [Me<sub>2</sub>SnBenz<sub>2</sub>], concentration in ppm, in cm<sup>2</sup> area

Concentration fungi	0	1	5	10	50
<i>Penicillium brevicompactum</i>	0.0	74.4	87.4	87.9	98.2
<i>Penicillium camembert</i>	0.0	68.2	72.2	75.3	96.4
<i>Penicillium commune</i>	0.0	6.7	36.3	68.6	91.2
<i>Penicillium expansum</i>	0.0	0.9	5.4	17.9	67.3
<i>Penicillium solitum</i>	0.0	81.6	86.5	83.4	73.1

Table.4: Percentage inhibition relative *Penicillium* in the presence of  $[Me_2SnBrm_2]$ , concentration in ppm, in  $cm^2$  area

Concentration fungi	0	1	5	10	50
<i>Penicillium brevicompactum</i>	0.0	1.4	43.1	56.5	70.4
<i>Penicillium camembert</i>	0.0	1.3	9.4	10.3	41.3
<i>Penicillium commune</i>	0.0	37.2	38.1	42.2	57.0
<i>Penicillium expansum</i>	0.0	0.4	1.3	1.3	32.7
<i>Penicillium solitum</i>	0.0	3.2	4.5	9.4	51.6

Table.5: Percentage inhibition relative *Penicillium* fungi in the presence of  $[Me_2SnMeo_2]$ , concentration in ppm, in  $cm^2$  area.

Concentration fungi	0	1	5	10	50
<i>Penicillium brevicompactum</i>	0.0	28.7	86.4	88.3	95.5
<i>Penicillium camembert</i>	0.0	18.8	81.6	86.5	96.0
<i>Penicillium commune</i>	0.0	22.0	80.3	80.3	96.4
<i>Penicillium expansum</i>	0.0	35.9	48.0	48.4	67.5
<i>Penicillium solitum</i>	0.0	92.8	92.4	93.7	98.7

Table.6: Percentage inhibition relative *Penicillium* in the presence of  $[Me_2SnClm_2]$ , concentration in ppm, in  $cm^2$  area.

Concentration fungi	0	1	5	10	50
<i>Penicillium brevicompactum</i>	0.0	83.4	85.2	88.2	91.5
<i>Penicillium camembert</i>	0.0	88.0	89.3	88.4	81.2
<i>Penicillium commune</i>	0.0	81.2	86.5	82.5	94.6
<i>Penicillium expansum</i>	0.0	0.40	90.0	0.40	79.5
<i>Penicillium solitum</i>	0.0	90.1	88.8	99.5	96.0

Table.7: Percentage inhibition relative *Penicillium* fungi in the presence of  $[Me_2SnMand_2]$ , concentration in ppm, in  $cm^2$  area.

Concentration fungi	0	1	5	10	50
<i>Penicillium brevicompactum</i>	0.0	88.4	90.6	87.9	87.0
<i>Penicillium camembert</i>	0.0	67.8	77.2	69.1	90.6
<i>Penicillium commune</i>	0.0	90.6	88.4	87.5	91.1
<i>Penicillium expansum</i>	0.0	34.6	43.5	42.7	80.3
<i>Penicillium solitum</i>	0.0	92.4	91.1	90.6	88.8

Table.8: Percentage inhibition relative *Penicillium* fungi in the presence of benzyl acid concentration in ppm, in  $cm^2$  area.

Concentration fungi	0	1	50
<i>Penicillium brevicompactum</i>	0.0	52.1	56.6
<i>Penicillium camembert</i>	0.0	48.0	48.0
<i>Penicillium commune</i>	0.0	45.3	48.5
<i>Penicillium expansum</i>	0.0	2.30	7.70
<i>Penicillium solitum</i>	0.0	87.0	92.9

Table.9: Relative percentage inhibition of fungi *Penicillium* in the presence of DL-4 -bromomandelic acids acid concentration in ppm. in  $cm^2$  area.

Concentration fungi	0	1	50
<i>Penicillium brevicompactum</i>	0.0	53.9	53.9
<i>Penicillium camembert</i>	0.0	40.9	42.2
<i>Penicillium commune</i>	0.0	36.8	48.9
<i>Penicillium expansum</i>	0.0	4.50	3.20
<i>Penicillium solitum</i>	0.0	86.6	85.7

Table.10: Relative percentage inhibition of fungi *Penicillium* in the presence of DL-4-methoxymandelic acid concentration in ppm, in cm<sup>2</sup> area.

Concentrationfungi	0	1	50
<i>Penicillium brevicompactum</i>	0.0	52.5	53.0
<i>Penicillium camembert</i>	0.0	48.9	50.7
<i>Penicillium commune</i>	0.0	40.9	42.7
<i>Penicillium expansum</i>	0.0	1.40	3.20
<i>Penicillium solitum</i>	0.0	51.2	93.7

Table.11: Percentage inhibition relative *Penicillium* fungi and in the presence of DL-2-chloromandelic acid concentration in ppm.

Concentration fungi	0	1	50
<i>Penicillium brevicompactum</i>	0.0	40.9	55.7
<i>Penicillium camembert</i>	0.0	42.7	44.0
<i>Penicillium commune</i>	0.0	52.1	53.9
<i>Penicillium expansum</i>	0.0	1.40	67.3
<i>Penicillium solitum</i>	0.0	56.1	55.2

Table.12: Percentage inhibition relative *Penicillium* fungi in the presence of DL-mandelic acid concentration in ppm, in cm<sup>2</sup> area.

Concentration fungi	0	1	50
<i>Penicillium brevicompactum</i>	0.0	41.3	46.7
<i>Penicillium camembert</i>	0.0	46.2	47.6
<i>Penicillium commune</i>	0.0	36.4	38.6
<i>Penicillium expansum</i>	0.0	4.50	3.20
<i>Penicillium solitum</i>	0.0	81.2	86.1

Table.13: Percentage inhibition relative *Penicillium* fungi in the presence of trimethyltin chloride concentration in ppm.

Concentrationfungi	0	1	50
<i>Penicillium brevicompactum</i>	0.0	94.6	95.5
<i>Penicillium camembert</i>	0.0	97.3	100.0
<i>Penicillium commune</i>	0.0	97.3	100.0
<i>Penicillium expansum</i>	0.0	99.6	100.0
<i>Penicillium solitum</i>	0.0	94.6	100.0

The trimethyltin chloride, Me<sub>3</sub>SnCl, organotin precursor compound of the studied complexes were applied to cultures of fungi *Penicillium brevicompactum*, *Penicillium camembert*, *Penicillium commune*, *Penicillium Penicillium expansum*, *Penicillium solitum* in two replicates at concentrations of 1 and 50 ppm. The relative percentage inhibition data for growth of said fungi are shown in Table 6, with observed overall growth inhibition at the concentration of 50 ppm over the mold *Penicillium camembert* *Penicillium comune*, *Penicillium expansum*, *Penicillium solitum*, while for the *Penicillium brevicompactum*, the inhibition was not total, but was above 95%.

About cultures of the same yeast were also applied DL-mandelic acid, DL-4 -bromomandelic acids, DL-4-methoxymandelic, benzyl and DL-o-chloromandelic also precursors of ligands studied in concentrations of 1 and 50 ppm in two replicates. Tables

8 to 12 are shown the results observed relative growth inhibition of fungi. It has been observed that the benzylic acid, dl-4 -bromomandelic acids, DL-4-methoxymandelic acid, 2-chloromandelic acid and dl-mandelic, Tables 8, 9, 10, 11 and 12 respectively, had a higher inhibitory effect of growth of the fungus *Penicillium solitum* and less effect on the fungus *Penicillium expansum*.

The novel organotin complex [Me<sub>2</sub>SnMand<sub>2</sub>] [Me<sub>2</sub>SnBenz<sub>2</sub>] [MeSnBrm<sub>2</sub>] [Me<sub>2</sub>SnMeo<sub>2</sub>] [Me<sub>2</sub>SnClm<sub>2</sub>] were applied to the fungi studied. The complex [Me<sub>2</sub>SnBenz<sub>2</sub>] Table 3 showed greater inhibitory power on the growth of *Penicilliumbrevicompactum* and less inhibitory power over the fungus *Penicilliumexpansum*.

The [MeSnBrm<sub>2</sub>] complex in comparison with other complexes synthesized and applied studies on fungi showed the lowest power inhibition of fungi, the results as shown in Table 4. The fungus with more complex growth was affected by *Penicillium brevicompactum*,

which development reached about 70%. In contrast, the inhibition was less effect on *Penicillium expansum*, whose development has reached about 32%.

For [Me<sub>2</sub>SnMeo<sub>2</sub>] complex, according to data presented in Table 5, the growth inhibition is nearly complete for all fungi except *Penicillium expansum* whose inhibition percentage was 67.5%, and the most satisfactory result on *Penicillium solitum* to 1ppm.

The complexes [Me<sub>2</sub>SnMand<sub>2</sub>] and [Me<sub>2</sub>SnClm<sub>2</sub>] According to data presented in Tables 6 and 7, showed similar behavior to each other, having a lesser effect on the fungus *Penicillium expansum*. The complex [Me<sub>2</sub>SnBenz<sub>2</sub>] showed high inhibiting power of *Penicillium solitum*, to 5ppm with the 81.6% rate in excess of 50 ppm, which was 73.1%.

Importantly, trimethyltin chloride, Me<sub>3</sub>SnCl, the precursor of the complexes studied, even being the most effective compound in inhibiting the growth of fungi studied presents some drawbacks for use as a sanitizing agent can chambers mature cheese. In addition to being a very toxic compound has odor intense irritating and that would certainly be absorbed by the cheese maturing.

Moreover, even with a lower efficiency in inhibiting the growth of fungi studied, both the synthesized complexes, such as acids α-hydroxycarboxylic that gave rise to it, we obtained an inhibition in different ways to the growth of several fungi.

This work aims to support new investigations, with the synthesis of other complex series to work in any structural changes that might produce selective compounds for various fungi. As well as performing appraisal toxicity, and a new series of complexes.

#### IV. FINAL CONSIDERATIONS

(A) trimethyl tin chloride and acid α-hidrocarboxílicos (dl-mandelic acid, benzylic acid, dl-4-methoxymandelic acid, DL-2-chloromandelic acid and 4-dl acid - bromomandelic acids) used as precursors of the complexes studied showed inhibition of growth on the fungi *Penicillium brevicompactum*, *Penicillium camemberti*, *Penicillium commune*, *Penicillium Penicillium* obtained in cheese ripening chamber.

(B) The inhibitory effect on the growth of fungi studied observed by use of acids α-hidrocarboxílicos was generally smaller than the effect of the new organotin complexes described in this thesis.

(C) trimethyltin chloride showed to be highly effective in completely inhibiting growth of the fungus *Penicillium camemberti*, *Penicillium commune*, *expansum* *Penicillium solitum*, while for the *Penicillium brevicompact* with inhibition was higher than 95%.

(D) new organotin complex prepared inhibited mycelial growth of fungi studied, and the mean percentage

inhibition above 50%. The inhibitory complex with greater overall average was [Me<sub>2</sub>SnClm<sub>2</sub>], about 90.0% inhibition, while the average was less complex [Me<sub>2</sub>SnBrm<sub>2</sub>], which was 57 3% inhibition.

(E) The paper should be continued with the suggestion synthesis of new members of the series of complexes described in this thesis, aiming structural correlations of these compounds with selective inhibition of growth of fungi and other microorganisms, and especially the study of the toxicity there.

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# Distortion and Misinformation in the Television Journalism about the Brazilian Semiárido

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**Abstract**— *The distorted and stereotyped view of the Brazilian Semiárido insists on predominating in journalistic productions on these territories. On TV, the treatment of the news culminates in misinformation. This article intends to show how the re-signification of a content can completely alter the initial proposal of a journalistic production, after the re-editing of the content to fit it within the desired editorial line. Two subjects were analyzed, the original, produced by TV Caatinga and the version of the aforementioned report republished by TV Cultura. To do so, we used the Contrastive Ethno-research to deepen the studied phenomenon in order to understand it jointly apprehend it, create relationships, encompass, combine and conjugate it. At the end of the analysis, it was observed a complete adulteration of the original version, which not only compromised the proposal of the initial content, as drastically altered its meaning to reinforce a negative and distorted image on the semiárido territories.*

**Keywords**— *Journalism Contextualized with the Brazilian Semiárido, Brazilian Semiárido, Tele-journalism.*

## I. INTRODUCTION

Bank robbery is “New Cangaço”, the water crisis is draught, verification gives way to misinformation. The textual construction is determined and feedbacked by the imagery marked by the climate when the territory described is the northeastern Brazilian hinterland.

It was not the media that has created the portrait of the Brazilian Semiárido (BSA) based on drought and scourge, but it certainly helped to consolidate it. With dramatic images, colors, testimonials and *background*<sup>1</sup>, the television continues to reinforce the distorted and stereotyped approach to these territories.

This inaccurate representation has harmed the emancipation and dignity of the existences of these territories in the most diverse forms, whether economic, social or political.

Contrary to this static and uninformed representation, the Contextualized Journalism concerning the Brazilian Semiárido (CJBAS) emerges as a proposal in the area of communication to guide these territories

without limiting the climatic determinism that use drought to substantiate all the social malpractices and injustices in those territories. According to Santos (2018, p. 25), the Contextualized Journalism in the Brazilian Semiárido

*is a proposition that invests in the various possibilities of representations about these territories that approach the reality, without omissions and distortions, with a diversity of production senses, themes, and approaches, in which the journalistic approach moves in a balanced way with the educational proposal.*

This concept is based on critical elements that guide the contextualized representation of these territories by the media, mainly from the knowledge about the specificities of the Semiárido.

The CJBAS was consolidated because of a Master's research conducted from 2014 to 2016 and that in 2018 was published in a book. However, the work of thinking the journalistic narrative about the Semiárido began long before that.

This kind of undistorted educative approach was developed over thirteen years from the practical exercise at two Universities located in the very heart of the semiárido area.

Firstly, by the students of the Multimedia Journalism Course at the State of Bahia University – UNEB in Juazeiro, through the Extension Project Experimental Television Programs – WEBTV Uneb Juazeiro (2007), in the production of TV reports and programs which presents a differentiated way of approaching these territories with accurate information and without using the scarcity of rain as an explanation and exclusive cause to explain all the historical neglect that marked the management on the population of BSA.

Secondly, by TV Caatinga, TV Universitaria of the Federal University of the Valley of Sao Francisco – UNIVASF, which expanded the contextualized production to other formats, aside from the journalistic one. With instructive programs of different proposals, the semiárido theme is deepened and discussed, encouraging other dissertations on these territories.

<sup>1</sup> Background music used in radio or television journalism while the text is read by a newspaperperson.



These digital platforms behave similarly to what Celia Del Palacio Montiel (2009, p. 9-11) witnessed at the Mexican press. The author perceived that some regional characteristics, which distinguish one place from the other, also interfere in their production, distribution and content process, for example.

Applying partnerships with other television channels, TV Caatinga succeeds in distributing its content to other regions of Brazil, especially to the Southeast and Midwest. By sharing a wide variety of products, with many approaches on the semi-arid and its population as dominant themes, the educational TV UNIVASF proposes other views and reflections on these territories, in regions that generally produce and reproduce speech on the backlands in which predominates the climatic determinism.

This labor of sending contextualized content is made since 2014, initially with the TV Futura and subsequently with TV Brasil, NBR, TV Cultura, TV UFMA, TV Unifor, Canal Saúde, TVE Bahia, TV Pernambuco and TVU, those last one from the state of Pernambuco. These broadcasters have educational characteristics, whether public, state or university owned, and are on open television channels, therefore, as television media reach a large share of the population.

Depending on the partner network, the content can be displayed in journalistic programs with reports and interviews, or the schedule, with educational programs, or still in both forms, journalist or programming.

With the systematic dissemination of this content contextualized with the Brazilian Semi-arid in these broadcasters for at least four years, we ask ourselves the following question: How is this media appropriating and re-signifying this content in its programming?

Therefore, the objective was to investigate as journalists of open television broadcasters, such as TV Cultura, appropriating and re-signifying the contents contextualized with the semi-arid in their schedules, to reinforce, or not the misinformation about these backland territories and the people who inhabit them.

Once "human ecology can be defined as a multidisciplinary social science for the privileged approach of mutual dependence between social and natural systems" (PIRES, 2011, p. 3) and still, it can emphasize "the cultural aspects and technological management of the environmental impacts posed by human civilization" (p. 3), this research was associated with the field of Human Ecology for its contribution to the understanding of the mutual action between man and nature.

To find the answers, this paper analyzed the case of a news show presented at TV Caatinga, and a version of it re-edited and enlarged, displayed in a national network at the Jornal of Cultura of TV Cultura, to verify the re-

signification of the original content. It was used as a methodology predominantly guided by Contrastive Ethnography, comparing and confronting "senses and meanings as a device of multi-experiential and trans-singular objectification". (MACEDO, 2018, p. 90). Research that seeks a generative inter-criticism based, as directed by the author, in an interpretation formed by the "encounter between opinions, points of view, and definition of situations".

## II. THEORETICAL DISCUSSION

The research is based on the Contextualized Journalism with relation to the Brazilian Semi-arid, a concept under construction in the field of Communication. The term contextualization relates to the specificity of the semi-arid areas since it is a very peculiar condition that affects its representation in the media.

Moreover, even though we are all socially, historically, politically, economically and culturally contextualized, we are not always inserted in our reality, but in emanating center of an "official" speech (SANTOS, 2018, p. 26). Concerning education, Josemar Martins states that discuss the contextualization is also argue about the decolonization.

(...) And now it is no longer about the relationship of colonization of one country over another, but especially of human groups about others, regions about others, of narratives about others. It is therefore about recognizing tiny colorizations that stick to more considerable oppositions that are embedded and consolidated in everyday language, the official language, in sexualities, identities, regionalities, etc. (MARTINS, 2004, p. 4).

Similarly, the journalism made about the Brazilian Semi-arid is decontextualized and colonized, since it insists on disregarding very particular issues related to those territories, such as the historical disregard that causes social inequity and contributes to the constant misinformation on this matter.

Once the methodology in Human Ecology is fundamentally multidisciplinary to enable the exploitation of many simultaneous interactions in both human and ecological systems, we have to appeal to study the field of communication and the production of senses to the TV journalism.

The research also based on Human Ecology theorists, namely Juracy Marques, Felix Gattari, and Iva Miranda Pires to reflect the way the semi-arid territories and their people are being designed to all of the countries from an original contextualized approach.

Whereas “society changes, or is maintained through a participation process, in which the decisions define the economic and social paths” (LIMA, 1984, p. 25), and wherefrom this question is posed, it is believed that the continuous exposition of these contents contextualized on these spaces located in other regions of the country and that are configured as emanating issues of an “official” statement that may contribute to the shifts of paradigms about the representation of the semi-arid and its people, since it provokes a look on those territories on a more diverse and closer way to the reality. Featuring this movement of production of content that looks for representing the semi-arid territories throughout its dimension, TV Caatinga would become the pioneer in this action that also contributes to the dissemination of knowledge about these territories.

Trying to understand how man relates to nature, Human Ecology also helps us in this study which seeks to understand how the newspaperman represents it in the media when the agenda refers to the semi-arid territories.

A “retraction” frozen in time going through the processes of homogenization and invisibility of the collective identities formed by these structures.

As Marques (2012, p. 15) alerts us: “whenever we try to explain something to someone about our truth it becomes a sign that it is denied”, as evidenced in the practice of Contextualized Journalism with the BSA. The author still questions us: “How to think about media, communicational flows amongst humans, homogenizing collectives, and behaviorist” (MARQUES, 2012, p. 27), and yet more, collectivities that are “being fed by the speeches of visible individualities resembling the invisible collectiveness” (p. 27).

Gattari strengthens by asserting that heterogenic processes should replace homogenizing practices, so that specific cultures and the singularity, the exception, and the rarity may flourish and “work together with a state order or at least the less heavy possible.” (2011, p. 35).

In this specific methodology, the authors consulted were Jorge Duarte in the definition of an in-depth interview, and Antonio Carlos Gil in the concept of research-action. Also in the field of research on Human Ecology, we used Maria José Araujo Lima, as well as Emilio Morán, who contributed with the definition of ethnoecology, while Roberto Sidney Macedo is going to be used in the Contrastive Ethno-research.

### III. MATERIALS AND METHODS

The research was carried out from the content displayed in the partner network of TV Caatinga, i.e., TV Cultura. The case mentioned above was chosen by the broadcaster to maintain a partnership and show content from UNIVASF's WebTV for some years. The TV

network exhibits news of the TV Caatinga in the Jornal da Cultura.

The information was collected and analyzed with Contrastive Ethnography because it is a “multi-case/multi-experiential research” in which the “contrast appears as a significant device, to the extent that you want to approach the creation of particular research construct heuristically” (p. 87).

This “Contrastive Perspective” of the research proposed by Roberto Sidney Macedo instills us to a generative inter-criticism by using an enlarged triangulation of experiences that can be incorporated by a “plurality/heterogeneity pertinent”, which also broadens the creative possibilities of the study of the researched phenomenon and the differentiations relevant to its comprehension (p. 88-89).

The perspectives of both the relational pluralization of the sources and the understandings and the triangularization enable the enrichment and robustness of a Contrastive Ethno-research to the extent that they produce, inter-critically, the significant multiple-voices scheme (MACEDO, 2018, p. 89).

Contrastively, it aimed to understand what was appropriate to generate contextualized knowledge about the semi-arid and its people in the programming of broadcasters to be evaluated and what was distorted, consolidating a historically misrepresented view of, at least, misinformed on these territories.

Two reports were analyzed in a contrastive way. The original version, produced by TV Caatinga on tour inspired by Lampião, in the city of Serra Talhada, and the version re-edited and enlarged by TV Cultura, which used the original story to address what was called “New Cangaço”. Both reports are available on the Internet.

The analysis was also performed from a “qualitative technique that explores a subject from the search for information, perceptions, and experiences of informants to analyze them and present them in a structured way” (DUARTE, 2011, p. 63).

To understand this process, which implied the representation of the semi-arid and the populations that inhabit it, it resorted to ethnoecology, since

it facilitates the field research because it is based on the collection of linguistic data and the criteria that differentiated a linguistic term from another. Thus, the researcher can gradually discover the logical structures that compose the perception of the physical and social Environment (MORÁN, 1990, p. 90).

Considering that “action research has situational characteristics, since it seeks to diagnose a specific

problem in a specific situation, with a view to achieving some practical result” (GIL, 2010, p. 42), in the next step, after taking knowledge of the reaction of the producers of the original content, a contact was made via e-mail with the essay on TV Cultura addressing the negative impact caused in the journalistic sector of the TV Caatinga, with the reissue of the matter. The e-mail was not answered until the conclusion of this work.

It was an attempt to understand the motivation to change the content researched from the guiding elements of Contextualized Journalism with the Brazilian Semiarid, viz. combat x coexistence + experience; water tank truck is the solution?; the haunted cow; fruitless seeds; emblematic floor; education without context; access to land, basic need and media and viability (SANTOS, 2018, p. 154-172). An action to contrast “the knowledge produced and the training experienced/conquered by the subjects” (MACEDO, 2018, p. 105) in the process both singular and relational of ethnic-research-formation.

The contrastive analysis of the collected information helped to seek the answer to the question that guides this work: as journalists of open television broadcasters, such as TV Cultura, appropriated and re-signifies the contents contextualized with the semiarid in their schedules, in order to reinforce the disinformation about these territories and the people who inhabit it?

Through the Contrastive Ethno-research, it was intended to deepen the studied phenomenon to understand it in a sense understood by Roberto Sidnei Macedo (2018), to learn together, create relationships, encompass, combine, and conjugate.

#### IV. RESULTS AND DISCUSSION

Much is spoken and criticized about the portrait made of the semiarid in journalism. Several types of research have already performed analysis of journalistic coverage during the drought periods in various news programs and more than one broadcaster, pointing out flaws in the account, marked by disinformation and climatic determinism.

However, the study that proposes the Contextualized Journalism with the BSA is the first one to bring along – in practice – an educative approach closer to the reality in those territories. The concept shows to the journalist in a direct way the manner to guide BAS.

The proposal already emerge from the experimentation at the University and reached national TV broadcasters through the display of contextualized products, although it is still necessary to investigate how journalist from these broadcasters receives those contents, once they are opinion leaders and multipliers of information, who so far consolidate the semiarid of hunger, scourge, misery, and many other afflictions.

To highlight the necessity of deepening the studies on this theme, let us appreciate some situations which at the same time provoke us, intrigue us and instigate us. On the first of February, 2018, the Journal da Cultura exhibited a story about the 80th anniversary of Lampião<sup>2</sup>'s death. Still at the presentation text narrated by the anchor of the news, the date of the death of Virgulino Ferreira da Silva has been connected with the “New Cangaço”, a term used to identify the inner violence in the northeastern Brazil which “resist time”.

The subsequent news coverage was constructed from the re-issue of a content previously produced by TV Caatinga, WebTV of the Federal University of Vale do Sao Francisco – Univasf, with the addition of text, sound (interviews) and images.

In the original coverage, the TV Caatinga showed the tourist itinerary “in the footsteps of Lampião” in the city of Serra Talhada, birthplace of said “cangaceiro”, which tells the life-story of Virgulino Ferreira from places like the house his grandmother raised him and the Museu of Cangaço, which preserves a collection of objects belonging to the “Serra Talhada” man. The original coverage lasts 5 minutes 12 seconds<sup>3</sup> and narrates the saga of Virgulino in a way to illustrate the tourist route, without producing a value judgment.

However, the text exhibited by TV Cultura begins with the question: “Hero or Villain?” and keeps on sustaining that “during 20 years Lampião and his team of gangsters terrorize the Brazilian backlands with sacks, robberies, and murders. More than 100 deaths are attributed to the known King of Cangaço”.

Following this TV Caatinga exhibits images of the news showing the house where Lampião has been raised, followed by an interview of TV Univasf informing that tourists are taken to historical sites where they come to know the trajectory of Lampião in the Cangaço, in the decade of 20 and 30.

Subsequently, the reporter of TV Cultura recites the text: “since a small boy the cangaceiro had contact with violence, as shown by the reporter Cora Macedo”, to refer to other excerpts of the report of TV Caatinga at the moment the reporter tells how was the first ambush suffered by Lampião, which would be the reason for Virgulino to become a cangaceiro. In the original report, a source explains that Lampião was never considered a victim of the ambush and that no lawyer wanted to defend him against a wealthy and influential family. This interview that shows TV Cultura did not exhibit the actual reason for the entry of Virgulino in the Cangaço.

<sup>2</sup> <https://www.youtube.com/watch?v=M0FJ3nRQRag>, around 36'46”

<sup>3</sup> Promenade offers to walk on Lampião's shoes: <http://rtvcaatinga.univasf.edu.br/video/pod8nd->

Instead, the text of the reporter of TV Caatinga was followed by the interview of another source that affirms the pride of the residents of the city of Serra Talhada proud to be Lampião's fellow compatriots.

This argumentation is contested afterward in part aggregated to the matter presented by TV Cultura in a text read by Moacir Assunção, who wrote a book about the enemies of Lampião. The newspaperman is categorical in stating that Lampião was a wrongdoer. At that moment the matter exhibited by TV Cultura takes an entirely different direction indicating the hat worn by the Cangaceiros "became one of the symbols of the Northeastern traditions".

The hat would be used again in the text to make another association, seemingly meaningless, when the newspaperman of TV Cultura narrates "even without the Cangaceiros' leather hat, cities in the Northeast part of the country, and other regions as well, face what is called a new Cangaço. "Armed gangs practice robberies and kidnappings, and use the population as a shield." The images illustrating the text are from security cameras that display the action of burglars. The journalist report lasts two minutes and forty-seven seconds.

When we watch TV Cultura, we ask ourselves what is the relationship these robberies would have with the term "new Cangaço"? Would it be only the territorial issue, although it is not revealed where the thefts take place? Which is the difference between the robberies and the action similarly made by the bandits exploding ATMs and robbing banks in other regions of the country?

Furthermore, comparing the original report of TV Caatinga with that of TV Cultura, we can detect the extent the original issue was distorted, since the initial content gives visibility to a tourist route in the semiarid zone, promoting another look on these territories commonly ruled in a negative procedure.

It is noteworthy that according to information from the reporter of the WebTV, when the professionals of TV Cultura contacted their colleagues of TV Caatinga, they requested some content to commemorate the 80th anniversary of the death of Lampião in 2018. There was not a moment when it is said that there would be a re-issue and association of content with what the broadcaster calls "new Cangaço".

After being aware of the reaction of the producers of the original issue, on the occasion of the national network display, contact was made via e-mail with the matter of TV Cultura addressing the negative impact caused by the information, and with TV Caatinga, on the re-issue of the case. Suffice to say that these e-mails have not been answered until the conclusion of this study. This behavior demonstrates the lack of interest in maintaining a dialogue with the partner university broadcaster who has

since that time has been trying to re-discuss the terms of partnership before submitting new contents to be displayed.

It is also observed intentionality of the changing of information to adapt them to the intended approach, although this has impaired the channeling of the matter, with incoherent, unreasonable, and imaginative connotations. It seems that the distorted re-signification was already defined when the program was required, perhaps, for this reason, the proposal was not adequately publicized.

Differently, broadcasters such as Futura Channel, TV NBR, TV Brasil, and TV Educativa da Bahia frequently display contents of TV Caatinga which unveil the semiarid zone in a contextualized way.

Amongst the most varied examples, we can see releases featuring stylized Quadrilha Juninas and discussing the traditional and current styles, which also motivated the production of a 25-minute thematic program with two interviewers at the television studio (Futura, 1.06.18)<sup>4</sup>; the exhibition by TV NBR of an environmental education program debating the agro-ecology practiced by the farmers in the semiarid zone (18.07.18 and 15.08.18); TV Brasil showing the whole country the initiative of a couple who built what they have called a "bio-pleasing house" with materials reused and that would have been discarded in the dumpsite (27.10.2018)<sup>5</sup>, and the report about women who were walking down the roads of Motorcycle Sertão, exhibited in the sports programs of TVE da Bahia (11.10.18).

Observing a distorted kind of approach in a broadcaster maintained by Padre Anchieta Foundation, which announces on their website that education, journalism, citizenship, and culture are some of the priorities in their vehicles of communication, which "have as a principle the support to independent production, to regionalized programs and the exhibition of Brazilian cinematographic works, bringing to the general audience the knowledge and the cultural diversity"<sup>6</sup>, and otherwise wholly different to see the display by other broadcaster of contents that discuss the semiarid zone and its people more contemporaneously and closer to their reality, which leads to some interrogations: at what extent contextualized materials provoke a reflection about the distorted approach practiced in the productions about the semiarid and its people? How do the opinion makers who receive the contextualized content in these broadcasters seize this proposal? How do the appropriate and re-signify these

<sup>4</sup> <http://www.futuraplay.org/quadrilhas-de-festas-juninas433057/>  
<sup>5</sup> <http://tvbrasil.abc.com.br/reporter-brasil/2018/10/casa-no-interior-da-bahia-e-chamada-de-bio-a-gradavel>

<sup>6</sup> Description obtained at the site of Fundação Padre Anchieta: <http://fpa.com.br/fundacao/>

contents and how is this echoed in the production of knowledge of the programming of these broadcasters? How far do they approach or withdraw from the initially contextualized proposal? Those are themes for new debates.

These are some of the concerns raised by this study, since the Contextualized Journalism related to the Brazilian Semiarid constitutes an educational proposal in the field of communication, which provoke on us to rethink the usual approach that has been made on these territories, and their people as well.

## V. CONCLUSION

Since man is a product of self-creation and consequently a result of human action, we sought to understand how those who produce and disseminate information in the media understand the proposal of Contextualized Journalism with the Brazilian Semiarid and whether it really is available to rethink what kind of representation would approach the reality of these territories and their people.

In the republished and enlarged issue, analyzed in this paper contrastively with the first content, it was observed that the new version was a complete adulteration of the original report, which not only compromised the proposal of the initial release, but as altered Dramatically its meaning to reinforce a negative and distorted image about the semiarid territories.

As there was no transparency when revealing the actual proposal of the matter requested to the university broadcaster producing the original content, as well as no response to the e-mail questioning the modification of the first report, it is understood that the change was carried out intentionally and that a re-signification was already defined to reinforce distortions and misinformation about the semiarid zones, consolidated by the media in a recurrent way.

But if on the one hand it is observed behaviors that reinforce and reveal the lack of information about these territories, as in the case studied in this paper, on the other hand the study also demonstrated examples in which the contextualized content fulfills its educational role, disseminating knowledge in the programming of broadcasters that publish the content without alterations and distortions that impair the proposal in its entirety.

Accordingly, this study may lead to other reflections such as: what kind of contextualized content it is being selected for display in the programming of broadcasters? How are these contents apprehended by the opinion makers of these channels? Which kind of knowledge does the content generate for these subjects? Are they somehow influenced by another way of guiding the semiarid territories? What kind of discourse is

elaborated by them, specifically at the head<sup>7</sup> of the subjects, from the contact with the contextualized content? Relevant and necessary questions for opinion makers and content producers in communication interested in producing quality information, with a closer assessment of the reality of the semiarid territories of Brazil and their people.

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<sup>7</sup> Head means the enunciate elaborated by the editor of the text which will be narrated by the presenter of the TV program, as in the news.

# Estuarine Fish Fauna Affected due to Industrialization near D. H

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**Abstract**— Rapid industrialization in the west bank of river Hooghly near Diamond Harbour( D. H ) causes health hazard for heavy metal contamination in fish muscle tissue. Human consumption of fish as protein source in daily diet of major Bengali people lives near coastal belt as well as in 3 cities in Maritime state West Bengal affects in many ways. Digestion problem is now-a-days common in people of Kolkata, Howrah and Haldia. Heavy metals like Zn.Cu and Pb affects fish health of estuarine belt near Bay-of-Bengal. Hilsa, a migratory fish is most tasteful to consume with highest market price. Other brackish water fishes like *L.calcarifer*, *N. chitala*, *P. pangasius* also popular to eat. AAS detect heavy metal accumulation (non bio degradable) in fish muscle tissue collected from the site i.e D.H near Bay-of Bengal.

**Keywords**— AAS, D.H, Brackish water, Heavy metals.

## I. INTRODUCTION

Hooghly river gets polluted by bottom painting of ships and trawlers due to continuous leaching of paint in adjacent water. Cu toxicity present in water, sediment and (higher trophic level resident of Hooghly) fish.

Fish muscle tissue gradually enters in human and bioaccumulated in their body (absorbed through intestine and circulate through blood to different organs like Liver, Pancreas, Brain, Muscle tissue, Adipose tissue, Gonads and Skeleton ).

Haldia petro chemical presents in the opposite bank of river Hooghly which add heavy metals near Diamond harbour.

## II. MATERIALS AND METHOD

If you see images you will understand how river Hooghly gets affected due to Ships and trawlers and fish landing stations near Mohona at Digha coast.



Fig.1: Ships carries petroleum from Haldia port



Fig.2: River Hooghly



Fig.3: River Bhagirothi meets Bay-of-Bengal



Fig.4: Trawlers visible for fishing and carries human

If you see the opposite bank of river Hooghly it is clear that trees are visible. Length almost 700 m .from east to west. Till Diamond harbour bouncy of river is there. So many ships and trawlers assembled there. Many estuarine fish available in that river belt. Bay –of-Bengal is hardly 50 kms. away. So many ships and trawlers enter from sea to river. Again ships are sailing in Bay-of –Bengal . Land and river holds mangrove in that area , largest delta known as Sundarban delta. 102 islands scattered in three districts like South 24 parganas, North 24 Parganas and Midnapur. Total coastline in Bay-of-Bengal from Bakkhali to Digha is in west Bengal. Largest island Shankarpur is near Digha coast. River Bhagirothi enters in Digha coast. Two tributaries of river Ganges.( Hooghly and Bhagirothi ) meets Bay-of-Bengal.

Estuarine fish like *Hilsa ilisha* who leads a migratory life (Half life in river and half life in sea) available in this zone. *Lates calcarifer*, *Pangasius pangasius* , *Notopterus chitala*, *Notopterus notopterus* , *Satipina phasa* all estuarine fish available in daily catch. Marine zone holds many species variety of marine fish like Pomfret, Ray fish, Sea horse, Ornamental fishes and edible fin fishes as well as shell fishes.

I have collected marine and estuarine fishes like *Hilsa* sp., *Notopterus chitala*, Pomfret (*Pama pama*) and *Lates calcarifer*.From river Hooghly and marine zone i/e Bakkhali and Digha.

20 mg. muscle tissue of equal size fresh fish collected from the stations and preserved in crushed ice and bring to the laboratory for AAS to see accumulation of heavy metals in above mentioned fishes in 2019 March 17<sup>th</sup>.

#### Trace Metals Analysis

Inductively coupled plasma – mass spectrometry (ICP-MS) is now - a - day accepted as a fast, reliable means of multi-elemental analysis for a wide variety of sample types (Date and Gray, 1988). A Perkin-Elmer Sciex ELAN 5000 ICP mass spectrometer was used for the present analysis. A standard torch for this instrument was used with an outer argon gas flow rate of 15 L/min and an intermediate gas flow of 0.9 L/min. The applied power was 1.0 kW. The ion settings were standard settings recommended, when a conventional nebulizer/spray is used with a liquid sample uptake rate of 1.0 mL/min. A Moulinex Super Crousty microwave oven of 2450 MHz frequency magnetron and 1100 W maximum power Polytetrafluoroethylene (PTFE) reactor of 115 ml volume, 1 cm wall thickness with hermetic screw caps, were used for the digestion of the muscle samples of the fish. All reagents used were of high

purity available and of analytical reagent grade. High purity water was obtained with a Barnstead Nanopure II water-purification system. All glasswares were soaked in 10% (v/v) nitric acid for 24 h and washed with deionised water prior to use.

The analyses were carried out on composite samples of 4 specimens of each species having uniform size. This is a measure to reduce possible variations in metal concentrations due to size and age. 20 mg composite muscle samples from 10 individuals of each species of fishes were weighed and successively treated with 4 ml aqua regia, 1.5 mL HF and 3 ml H<sub>2</sub>O<sub>2</sub> in a hermetically sealed PTFE reactor, inside a microwave oven, at power levels between 330-550 W, for 12 min to obtain a clear solution. After digestion, 4 ml H<sub>2</sub>BO<sub>3</sub> was added and kept in a hot water bath for 10 min, diluted with distilled water to make up the volume to 50 ml. Taking distilled water in place of muscle samples and following all the treatment steps described above the blank process was prepared. The final volume was made up to 50 ml. (Source : Abhijit Mitra, Prabal Barua, Sufia Zaman & Kakoli Banerjee , 2011)

### III. RESULT

L. calcarifer	<b>Zn</b> 53 ppm	<b>Cu</b> 45 ppm	<b>Pb</b> 0.133ppm
P. pama	<b>Zn</b> 97 ppm	<b>Cu</b> 94 ppm	<b>Pb</b> 0.155ppm
H. ilisha	<b>Zn</b> 92 ppm	<b>Cu</b> 45 ppm	<b>Pb</b> 0.111ppm
N. chitala	<b>Zn</b> 93 ppm	<b>Cu</b> 41 ppm	<b>Pb</b> 0.1777ppm

### IV. DISCUSSION

Heavy metal analysis shows Zn>Cu>Pb . Permissible limit by WHO AND FAO ( Pb is 0.10 ppm ) . So it is exceeding the permissible limit.

Lead , Copper and Zinc, these three heavy metals are persistent in river water and sediment. They flows from Himalaya (Gangotri glacier ) to Bay-of Bengal. Total 2525 kms stretch of this pure Ganges water carries these metals for weathering of rocks, addition of Zn, Cu and Pb from adjacent catchment area of agricultural field. Different pesticides and fertilizers add these metals during monsoon run off to river. Industrial effluents from Haldia petro chemical add major contribution of heavy metals in D,H . ( Station ). Fish health affected and bio accumulate in adipose tissue and muscle layer in fish. Which in turn as these metals are non-biodegradable after cooking too these are

gradually enters in human system to break BBB.(BLOOD BRAIN BARRIER )

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# Robot Chow: Automatic Animal Feeding with Intelligent Interface to Monitor Pets

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**Abstract**— According to the latest IBGE (Brazilian Institute of Geography and Statistics) survey, there are more than 74.3 million dogs and cats in Brazil. Moreover, the highest cost for raising these animals is pet feed, which should be served at appropriate times and quantities. In contrast, the daily lives of pet breeders have often unforeseen events such as meetings, last minute trips, traffic jams, among others. With the purpose of helping the difficulties faced by small domestic animal breeders, this work presents the implementation of a solution called RobotChow, capable of serving granulated feed and water exchange at pre-scheduled times and volumes for pets; in such a way that the user can monitor if the animal is feeding. For this, the customer can use instant messaging on the mobile, with a solution interface that controls the features only interacting ("chatting") with the application. In addition to providing commands, the solution also send photos or even notify the user if something is unusual to happen with the pet. The user can monitor his/her pet regardless of space-time, just accessing the internet. The entire solution was developed in Raspberry pi, using Python, and it is integrated with the Watson Assistant and Telegram cloud services.

**Keywords**— *Pet Feeder, Artificial Intelligence, Raspberry, Chatbot, Pet Breeders.*

## I. INTRODUCTION

According to a survey from the Brazilian Institute of Geography and Statistics (IBGE), around 63% of all households in Brazil have at least one dog or cat, totaling 52.2 million dogs and 22.1 million cats in Brazil country [1]. In another survey carried out by the National Confederation of Shopkeepers (CNDL), in conjunction with the Credit Protection Service (SPC Brazil), 52% of the respondents buy premium pet feed (higher digestibility), and these data show that the Brazilians are worried about the quality of life of their pets.

As discussed above, quality food is one of the major concerns of Brazilian animal breeders. Besides the quality, the control of the amount of feed per day is fundamental for the maintenance of the body weight of the animal and must be calculated based on the

metabolizable energy of the food due to the estimated energy requirement of the animal, according to the Brazilian Association of Animal Estimation Products [2]. In addition to controlling the amount of food, it is imperative that the breeder could monitor whether the animal has been eating. Otherwise, this fact may be a strong indicator of problems for the animal or in the food served to it.

Another important aspect is the feeding times of the animal, which may vary according to race, size and age. The fact is, every animal should be fed at least once a day. Ensuring this happens is a basic and fundamental function for any pet breeder.

Faced with these challenges, pet breeders often find it difficult to overcome, for a variety of reasons, such as an unexpected trip or simply being stuck in traffic jam. Or even, commitments arising from a frenetic daily life.

Currently on the market, we can basically find two product groups that serve food to animals. The first one counts on products that function as prescheduled food dispensers, such as the feeders of manufacturers Amicus [3], Eyenimal [4] and Hoison [5]. The second group is focused on giving snacks to the animal seeking an iteration with the same, as the products developed by Pawbo [6], Petcube [7] and Furbo [8]. We observed that none of them has the monitoring features, with notifications and automatic feeding in the same device.

The solution we present here aims to make life easier for dog and cat breeders; by automating the serving of pet foods and water exchange, with controlled quantity and prescheduled times. In addition, the application allows to visually monitoring the animal through photos taken throughout the day. It can happens by automatic detection of animals' presence in strategic locations.

All the management of the solution is through an intelligent interface, which makes use of a conversational agent that interacts with the user through natural language processing techniques and artificial intelligence, known as chatbot [9]. The application seeks to help the user by answering questions, giving the impression of talking to a person, not a machine.

The physical part of the solution consists of low cost or reused equipment such as PVC pipes, solenoid valves,

proximity sensor, DC motor, 5 megapixel camera and 4 channel relay module, all connected to a Raspberry pi 3 microprocessor.

The purpose of this work is to present the development of a solution capable to automatic monitoring the feeding of dogs and cats, making use of intelligent and mobile interface. This application can allow: i) to control the meal dosage; ii) schedule meals online; iii) automatically change the water; iv) photographically record the animal being fed; v) detect the presence of the animal; and vi) create a double track line between the solution and the user.

## II. DEVELOPMENT

The development of the solution was basically divided into mechanics, electronics and software.

### A. MECHANICS

The mechanical part consists on the system of dispersion of granulated solid foods. Where it uses a pipe of PVC with 100 millimeters of diameter and one meter of height, working like a warehouse of foods. At the lower end of the barrel, it was added a rotary valve, made with PVC shaft and six 4 mm thick EVA fins. It should be noted that this choice is due to the malleability of the material. Many granulated foods are somewhat resistant and may cause valve locking when the fin presses the grain against the wall of the barrel.

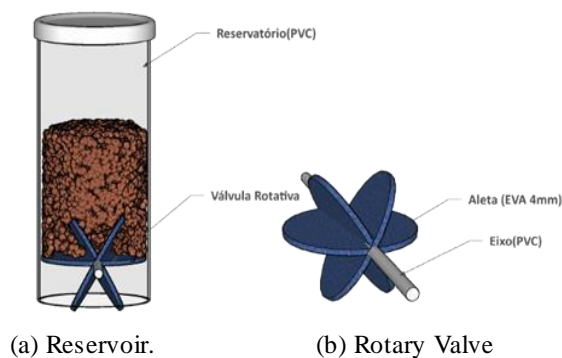


Fig. 1. Rotary valve and PVC food tank.

In order to prevent the animal from carrying shock, as well as gauging greater resistance to the components, the motor was coated with a wooden box. All wiring has been coupled and protected at the back of the equipment, as well as the solenoid valve.

### B. ELETRONICS

To turn the rotary valve, we use an AKYAMA motor, with a speed of 5 RPM. It has been chosen because of a torque of 70Kgf.cm with a low cost. When the motor is energized with a voltage of 220V [10], it starts to rotate its axis which is connected to the valve axis by means of a flexible coupling of 8 mm. When rotating its axis, the

food that is between the fins fall in the food container of the animal in a moderate form. Therefore, the amount of food is given by the control of time that the engine is energized.

An electromechanical valve, known as a solenoid valve, is triggered to control the flow of liquids. When resting, the plunger inside the valve closes the duct for passing the liquid. When energized, the piston changes position to unclog the orifice, allowing the liquid to flow [11].

In this project, we used a manual tap connected to the water box of the residence. When open, the tap dispenses water directly into the animal's container by the solenoid valve that controls the water flow through the application of 220v voltage at its poles.

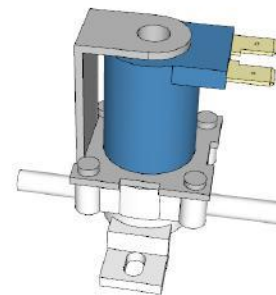


Fig.2: Solenoid Valve

Source: [12]

Relays are used to control the energization of the motor and solenoid valve. The relays are electromechanical devices that are able to close the circuit when energized [13]. A 4-channel relay module is used, where each channel, when energized with 5 volts, is capable of closing a circuit of 10 amperes and voltage of 250v.

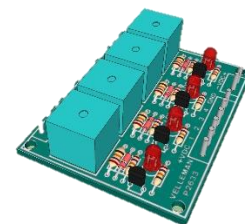


Fig. 3. 4-channel relay module.

Source: [12]

To find out if the animal is near the food container, we put an ultrasonic sensor, developed to measure the distance between where the sensor is and where the animal is. The sensor uses ultrasonic waves, which are inaudible by humans. The sensor used in this project is the HC-SR04, which measures the distance to a shield by calculating the timepiece between the emission of ultrasonic waves and the return of the waves after reaching the target [14].



Fig. 4. PVC box with proximity sensor and camera.

When the presence of the animal is detected, the system takes pictures to visually confirm if it is feeding. For this, we use a 5MP camera, which connects directly to the Raspberry microprocessor through the CSI (camera serial interface) port. This is a small and very accessible computer that can be used to learn programming [15]. It is a low cost microprocessor that is ideal for generic machines, control systems and units which need to generate less heat and spend less energy [16].

The version used in this project is the Raspberry pi 3 b +, which features a Broadcom BCM2837B0 64bits ARM Cortex-A53 Quad-Core processor, 1.4 Ghz speed, 1 GB of RAM and Bluetooth adapter. This component is responsible for controlling all the mentioned devices, as well as housing and running the software that make up this solution.

A powerful feature presented in the Raspberry pi 3 is the GPIO line, a general-purpose one, consisting of 40 pins for input and output. This line acts as interface for the control of the devices [17].

In the diagram below (Fig. 5) the connections between the raspberry and the other equipments are represented.

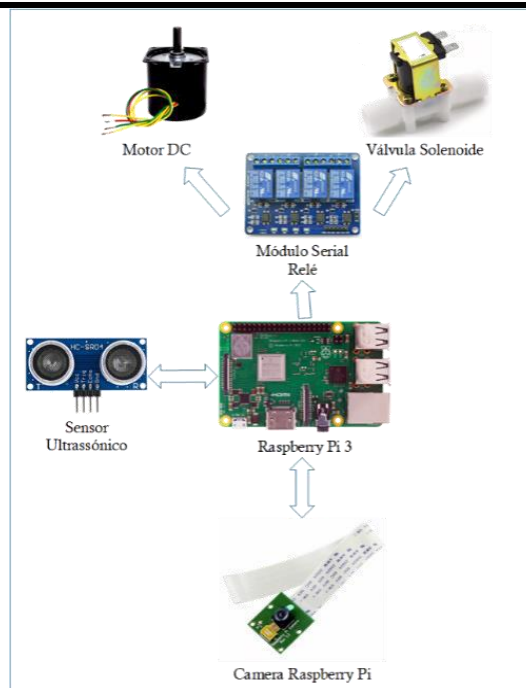


Fig. 5. PVC box with proximity sensor and camera.

Table I shows the connections between the Raspberry Pi GPIO ports and the device connections.

### C. SOFTWARE

The Operating System (OS) used is Raspbian 4.14 kernel version, based on Debian and optimized for Raspberry. The software is completely free, counting on more than 35 thousand packages of precompiled systems. The software is being maintained by a community of free software, with emphasis on stability and performance [18]. This system supports the entire software framework that makes up the solution, as we can see in figure 6.

Raspberry has memory and processing limitations. Therefore, all the technologies employed in this project were thought in the light of these restrictions. In this sense, we opted for a micro server, light and agile, called bottle in version 0.12 (stable), without dependencies; except the language module used, capable of being executed from a single file [19].

The language used in the development of the applications that make up the solution is Python, in version 3.7. Because it is a high-level, object-oriented language, Python can be used across platforms because it is interpreted [20]. This language has been shown to be a good choice for speed of development and maintenance; and has established itself as one of the most popular languages of scientific computing [21].

Table I: Conexions' Map

GPIO Port	Device Port	Device
2	VCC	Relay Module
4	VCC	Proximity Sensor
6	GND	Proximity Sensor
16	TRIG	Proximity Sensor
18	Echo	Proximity Sensor
38	IN2	Relay Module
39	GND	Relay Module
40	IN1	Relay Module

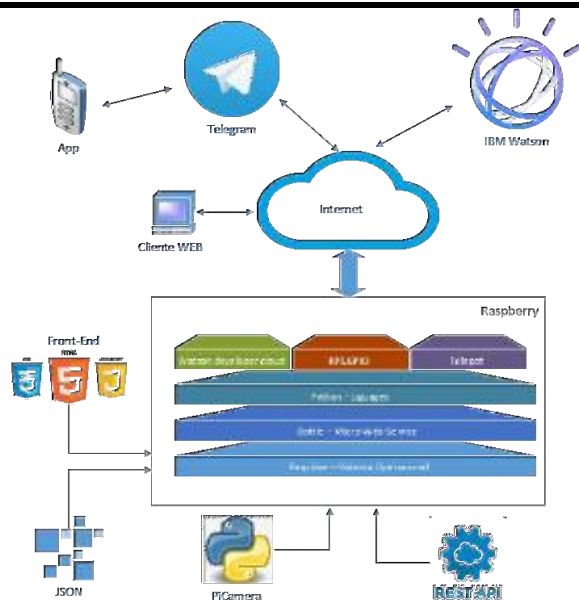


Fig. 6. Software Architecture.

All quoted scripts are initialized from `service.py`, which makes use of the threading module to be triggered independently. Modules are Python files, which can contain definitions, functions, and classes. Modules are initialized the first time they are imported (called) within the application [22]. Often, modules are used to abstract objects, being used in this project.

- RPi.GPIO provides a class to promote GPIO control of raspberry pi [23]; the version used in the project is 0.6.4.

- Telepot is used to help the communication of the application with the Telegram API [24]; the version used in the project is 12.6.

- Watson Develop Cloud: package used for interaction between the application and the IBM Watson API; used in this work version 2.4.0. Watson is a tool created by IBM, which makes use of artificial intelligence techniques such as machine learning and natural language processing. Watson is also used to support the construction of autonomous applications that simulate human speech, called bots or chatbots [25].

- Schedule: this module has the function of executing tasks in pre-scheduled periods by executing functions in python [26]. We opted for this module in version 0.4.3, due to its simple and friendly syntax, as well as its ability to run multiple scripts in parallel.

- PiCamera: A package that acts as interface between the Raspberry Pi Camera Module and the applications developed in Python [27]; version 1.13.

- Threading: Python module used to execute multiple processes in parallel [28]; you can activate and disable multiple scripts (applications) at the same time.

- JSON: As the name suggests, the module facilitates interaction with data in JSON format [29]. The format is

used to save system configuration information, thus avoiding the need to install a database.

#### D. Interface development

Seeking to promote a more comfortable experience for users, the system has two interfaces. One via web and another via the cloud-based instant messaging service, known as Telegram [30].

The Telegram provides the API Bot, fully open to developers, and customizable. It is an API that is able to connect bots to the telegram through special accounts; thus serving as a conversation interface between the application and the user [31].

To integrate Watson into the Telegram, the `chatbot.py` script was created, which connects to the Watson API and authenticates the previously registered user. The script also connects to the Telegram through the token specially created for the use of bots. Subsequently, the script enters a loop, forwarding messages from the telegram users to the Watson service. Watson interprets and responds to messages based on a question-and-answer database previously discussed. Such an answer is subsequently returned to the Telegram chat. During this message routing, the script analyzes them, checking if there are no commands to execute such as: taking a picture, serving a meal, exchanging water and others. For security reasons, only previously registered Telegram users can interact with the bot created on the platform.

The second interface, now in web format, is intended to make it easier to schedule daily tasks, such as serving food and changing water through forms. In addition, this interface can also pass commands to perform the tasks mentioned in real time. Another feature of the web interface is the visualization of the gallery of photos taken during the monitoring of the animal. The predefined structures of the bottle dynamize and promote the reuse of the HTML, JavaScript and CSS codes used in the development of these pages.

The scheduling data made by the web interface is saved in JSON format in the `config.json` file. Later, this data is read by the `schedule.py` script, which uses the schedule module to perform scheduling of the serving meal and / or serving water functions; depending on the configured parameters, according to the flow diagram of figure 7.

The `sensorprox.py` script has the function of taking a photographic record every time the animal eats. Thus, the user is certified that the animal has fed. A proximity sensor installed above the feeder detects the distance variation between it and the nearest bulkhead. When this distance reaches 10 cm, the script sends the command for photographic registration. The camera starts shooting every 3 seconds. After recording 5 photos, the system suspends monitoring operations for 60 minutes, saving memory space.

In determining a preset time, the system checks if there are records of the animal on that day. Otherwise, the breeder receives an alert in the Telegram informing that the animal did not go to the feeder. This can be interpreted by the creator as a hint of a problem.

The photos can be viewed either by request via Telegram or on the "gallery" page of the WEB interface.

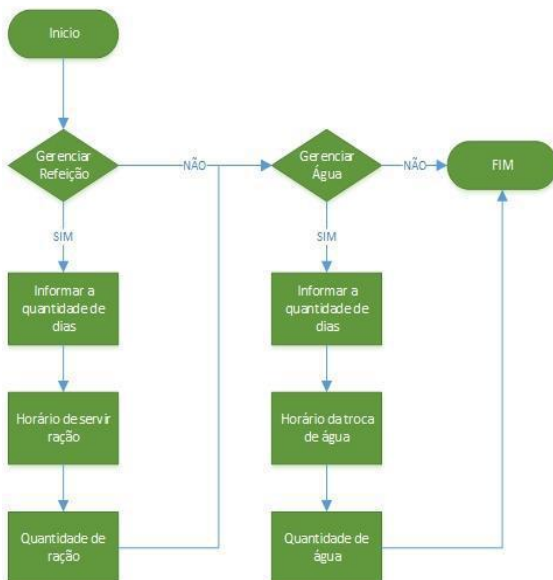


Fig. 7. Scheduling flowchart.

### III. CONCLUSIONS

During the development of this solution, we realize not only the importance of animal's health for breeders, but also their satisfaction and disposition to invest much of their income in the quality of animal's life.

The solution is economically viable, with a cost of production orbiting around \$150.00 dollars. The pet feeders cited in this research, which have access by mobile applications, can cost up to three times more. In addition, to making use of low-cost materials, we have chosen an open technology framework using free cloud services. And the technology used here can still be replaced. For example, instead of using Telegram, one can opt for any instant messaging tool like Facebook Messenger or WhatsApp. The Watson Assistant can be replaced by the services of Dialogflow, Wit.ai, Luis.ai and others.

The constant speed of 5 revolutions per minute of the chosen motor facilitated the control of the amount of pet food to be served. But, to know the exact ideal quantity, some tests should still be carried out with the ration chosen by the person in charge of the animal. Since each ration has its own density and granulation.

The use of an instant messaging interface has several advantages, such as, the need to install a new application and the creation of a single channel to receive notifications. The interface also receive photos of the

animal directly on the mobile device, making it easier to share the image on social networks.

At the end of the work, we can conclude that the solution has a reasonable and flexible cost, able to provide food and water for pets. The solution also allows to monitor the animals through photographic records and notification of possible problems. The application makes use of an interface with the ability to interact with the user through natural language processing techniques, sending and receiving instant messages. As a result, the application can provide greater comfort and convenience to the dog and cat breeders.

### ACKNOWLEDGEMENTS

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# Reduction of Emissions from Common-rail Diesel Engine using Mahua and Pongamia Methyl Esters

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**Abstract**— In this study, the performance, emission and combustion characteristics of two different biodiesel blends produced from Mahua and pongamia methyl esters were compared with conventional diesel fuel. Methyl esters for experiment were produced by using a catalytic transesterification process and, compared the properties with ASTM standard values of biodiesel fuel and diesel fuel. The experiments were performed in a four stroke, single cylinder, common rail direct injection (CRDI) system assisted diesel engine at a constant speed of 1500rpm with varying injection pressure. During the tests, the specific fuel consumption, brake thermal efficiency, combustion and exhaust emissions of the CRDI diesel engine were measured. From the results it is clear that the HC, CO and smoke levels are drastically reduced when using the methyl ester blends. Especially in the case of MME20, NO<sub>x</sub> emissions was minimum when compared with other blends and it also found less amount of other harmful emissions like HC, CO and smoke.

**Keywords**— Common rail direct injection (CRDI), Catalytic transesterification, Mahua methyl ester (MME), Pongamia methyl ester (PME), Emissions, Combustion.

## Nomenclature

ASTM	American Society for Testing and Materials
BSFC	Brake specific fuel consumption, kg/kWh
BP	Brake power, kW
BTE	Brake thermal efficiency, %
CO	Carbon monoxide, %
HC	Hydrocarbon, ppm
NO <sub>x</sub>	Oxides of Nitrogen, ppm
CRDI	Common rail direct injection
rpm	Revolution per minute
MME	Mahua methyl ester
PME	Pongamia methyl ester
MME20	Mahua methyl ester 20% + Diesel fuel 80%
MME40	Mahua methyl ester 40% + Diesel fuel 60%
PME20	Pongamia methyl ester 20% + Diesel fuel 80%
PME40	Pongamia methyl ester 40% + Diesel fuel 60%

## I. INTRODUCTION

Biodiesel is getting hold of increasingly important as a smart fuel due to the depleting fossil fuel sources. Chemically, the biodiesel is monoalkyl esters of long chain fatty acids derived from raw vegetable oils [1]. Biodiesel has several benefits such as it is non-toxic, biodegradable, low emissions and is a renewable source. Additionally, biodiesel does not contribute to the rise in carbon dioxide levels in the environment and thus reduces the amount of the greenhouse effect [2]. Two most important processes have been investigated to overcome these drawbacks and let the raw vegetable oils to be utilized as an alternative fuel: Pyrolysis and transesterification. Pyrolysis is a chemical decay of organic elements caused by the use of thermal energy in the absence of oxygen. Many researchers have studied the Pyrolysis of vegetable oils with the aim of obtaining biodiesel suitable for CI engines. Thermal decay of vegetable oil (triglycerides) produces compounds, including carboxylic acids, alkanes, alkenes and aromatics. Different types of vegetable oils depict big differences in composition when they are thermo-chemically decomposed. The pyrolyzed vegetable oils chemically similar to petroleum derived diesel fuel [3-7]. Transesterification is a chemical process between triglycerides of vegetable oil and alcohol (i.e. methanol or ethanol) in the presence of catalyst to obtain methyl or ethyl ester and glycerol as by product. The transesterification process generally depends upon the amount of alcohol, catalyst, time, water and FFA. Vegetable oils with huge amount of FFA are difficult to pass through the transesterification process because it will produce soap formation in the presence of the alkali catalyst [8,9]. The FFA additionally prevents the separation of methyl ester from glycerol layer. The diglycerides are the intermediates in this chemical process. The glycerol layer settles at the base of the vessel. The mechanism of transesterification process is shown in Figure 1.

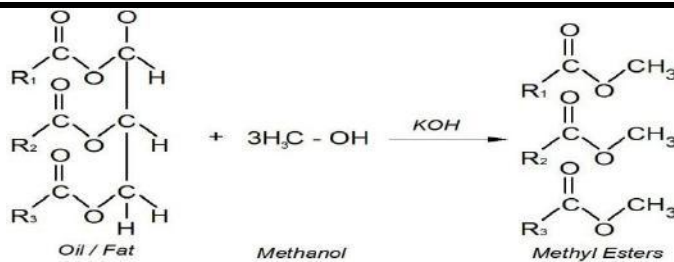


Fig.1: Mechanism of transesterification process

Biodiesel fuel generally includes a little amount of diglycerides having an advanced boiling point than the diesel fuel. These complex chemical bonds led to the configuration of gases of short molecular weight and thus volatile chemical compounds ignited in advance and reduced the delay period [10-12]. Many researchers have done experiments on the performance and emissions of a DI diesel engine operating with different biodiesel blends. They found biodiesel fuels produced lower harmful pollutant emissions such as CO, HC and PM emissions, and slightly higher NO<sub>2</sub> and NO<sub>x</sub> emissions [13-17]. The oxides of nitrogen are the most harmful parameter that affect the environment through acid rain, human diseases, etc.,. Also, CO and NO<sub>x</sub> are primary pollutants in the formation of troposphere ozone, which are the important greenhouse gases. Many researchers have found that the 20% and 40% biodiesel blends produced low emissions of HC, CO, NO<sub>x</sub> and PM, compared with other biodiesel blends [18-22]. For the present investigation biodiesel are prepared from Mahua oil and pongamia pinnata oil through catalytic transesterification method. The properties of both methyl esters thus obtained are compared to ASTM biodiesel standards. According to literature survey, MME20, MME40, PME20 and PME40 blends are used for experiment. The performance, emission and combustion characteristics of a four stroke, single cylinder, common rail direct injection (CRDI) diesel engine was analyzed using different methyl ester (MME, PME) blends to find out the suitable methyl ester blend.

## II. THE BIODIESEL PRODUCTION

There are many admitted technologies that have been employed for the production of biofuel. Vegetable oils are apposite to be customized in order to reduce their densities and viscosities, so that the product obtained has appropriate properties to be used as fuels for diesel engine [3]. Transesterification is the process of using an alcohol in the presence of a catalyst such as potassium hydroxide or sodium hydroxide, to break the molecule of the raw vegetable oil into ethyl or methyl esters, with glycerin as a by-product. The potassium hydroxide (7g/lit) is dissolved into methanol as catalyst in a biodiesel reactor. Then, the catalyst/methanol mixture is mixed with the raw vegetable oil (i.e., pongamia and Mahua). The final

mixture is stirred vigorously for one hour at 60°C in ambient pressure. A successful transesterification produces two different liquid phases, methyl ester and crude glycerin. Crude glycerin is the heavier liquid, will accumulate at the bottom later than some hours of settling. Phase separation completed within 2-3 hours of settling. Complete settling of methyl ester can take as long as 8-10 hours. Washing the methyl ester is a two step process. A water wash solution at the rate of 26% by volume of vegetable oil and 1 gram of tannic acid / liter of water is added to the methyl ester and stirred. This process is continued until the methyl ester becomes clear. After transesterification, the viscosity of both methyl esters was found to be reduced, which is nearer to the diesel fuel as given in the Table 1. Prepared methyl esters (MME & PME) were then blended with neat diesel in various concentrations for making biodiesel blends to be used in the CRDI diesel engine for conducting engine tests. The schematic diagram of biodiesel plant is shown in Figure 2.

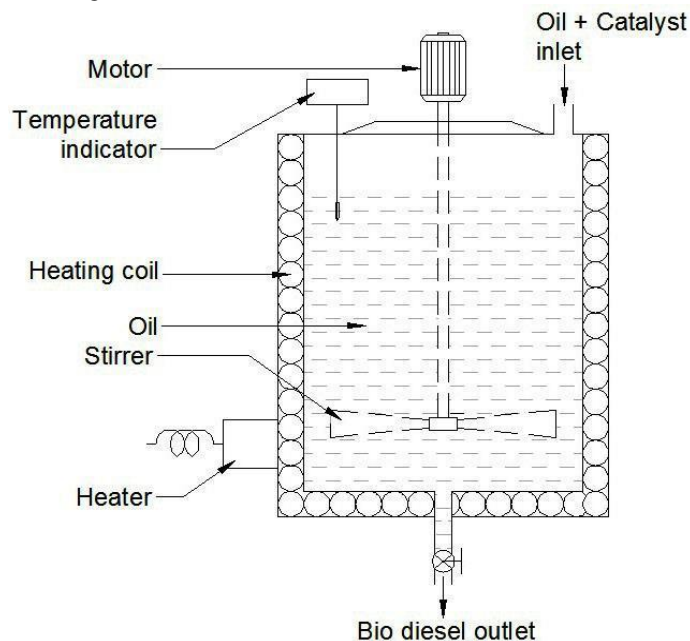


Fig.2: Schematic diagram of biodiesel plant

### 2.1 Properties of biodiesel

The properties of MME and PME in comparison with those of Biodiesel standards (ASTM) and the properties of biodiesel blends (MME20, MME40, PME20 and PME40) are compared with the neat diesel are shown in Table 2. The present results show that the transesterification process improved the fuel properties of the Mahua and pongamia oil with respect to viscosity (cSt), density (kg/m<sup>3</sup>), flash point (°C), cetane number and the calorific value (kJ/kg). Comparison of these properties with the diesel fuel shows that the Mahua methyl ester (MME) and Pungamia methyl ester (PME) have closer fuel properties to that of diesel.



Table.1: Properties of biodiesel samples

Properties of fuel	Unit	Biodiesel standards (ASTM)	Mahua methyl ester (MME)	Pongamia methyl ester (PME)
Viscosity at 40°C	cSt	1.9-6	4.9	5.4
Density at 15°C	kg/m <sup>3</sup>	850-900	869.8	875.2
Flash Point	°C	>130	136	148
Calorific value	KJ/Kg-K	≥36000	39950	37980
Cetane number	-	47 to 65	54.8	56.9

Table.2: Properties of diesel - biodiesel blend samples

Properties of fuel	Unit	Diesel	MME20	MME40	PME20	PME40
Viscosity at 40°C	cSt	3	3.17	3.36	3.25	3.53
Density at 15°C	kg/m <sup>3</sup>	815	819.4	824.7	822.9	829.1
Flash Point	°C	56	66	78	72	96
Calorific value	KJ/Kg-K	42000	41440	40920	41280	40360
Cetane number	-	42.8	45.1	47.4	45.7	48.5

### III. EXPERIMENTAL SETUP AND TEST PROCEDURE

Experiments were conducted on Kirloskar AVI, four stroke, single cylinder and air cooled diesel engine assisted by common rail direct injection system. The rated power of the engine was 3.7 kW. The engine was operated at a constant speed of 1500 rpm. By adjusting the injection pressure from 250 to 500 bar, the engine speed was maintained when the load increased. Injection duration of the fuel injected into combustion chamber should be maintained as constant 750µsec for all loads. The engine was initially fuelled with diesel fuel to provide the baseline data and then, it was fuelled with diesel and carbon multiwalled nanoparticles blended fuel in two different proportions. Details of the engine

specification are given in Table 3 and injector fuel specification in Table 4. The fuel flow rate is obtained on the gravimetric basis and the airflow rate is obtained on the volumetric basis. Eddy current dynamometer was used for loading the engine. AVL di-gas analyzer is used to measure HC, CO and NO<sub>x</sub> emissions. The specifications of the AVL di-gas analyzer is given in Table 5. The AVL smoke meter is used to measure the smoke density and the details of smoke meter is given in Table 6. The engine cylinder pressure and heat release rate were obtained by using data acquisition system interfacing with dual core processor. A burette is used to measure the fuel consumption for a specified time interval. The experimental setup is indicated in Fig.3.

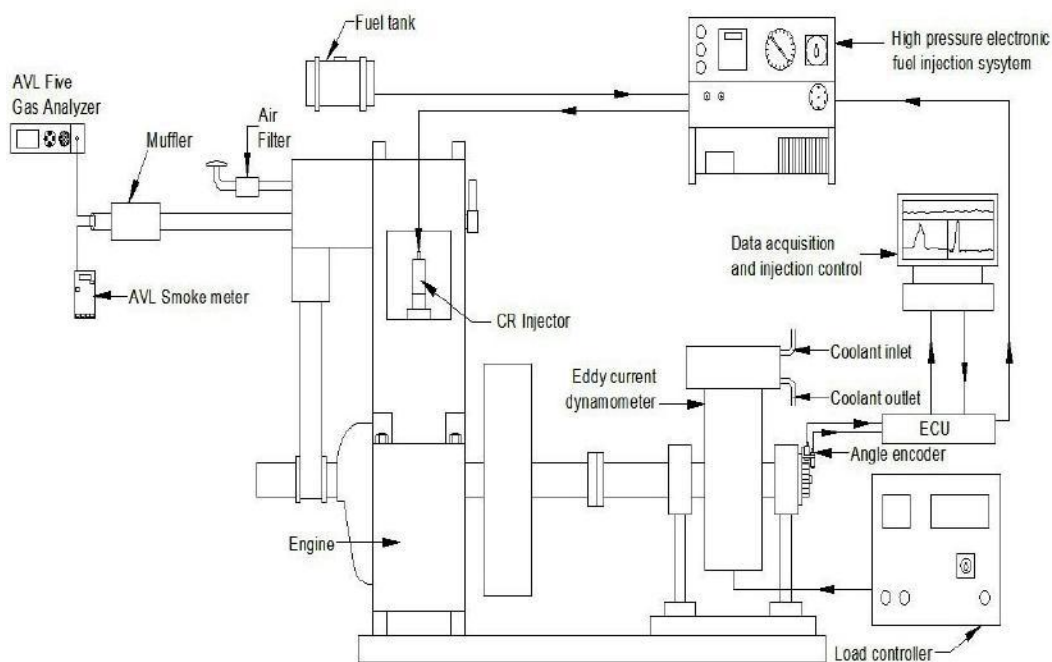


Fig.3: Experimental setup

Table.3: Engine specification

Type	:	Vertical, water cooled, four stroke
Number of cylinders	:	One
Bore	:	87.5 mm
Stroke	:	110 mm
Compression ratio	:	17.5:1
Maximum power	:	3.7 kW
Speed	:	1500 rev/min
Dynamometer	:	Eddy current
Injection timing	:	23° (before TDC)
Injection pressure	:	250-500 kgf/cm <sup>2</sup>

Table.4: Injector fuel system specifications

Fuel fed	Units	Common rail
Injection pressure	MPa	250-600 MPa
Number of nozzle holes	-	3
Nozzle hole diameter	mm	0.518
Start of injection	-	23° Before top dead center (BTDC)
Injection duration	µsec	750
Fuel injected	g/cycle	0.168 (at full load)

Table.5: Specifications of AVL Di gas analyzer

Make	AVL
Type	AVL Di Gas 444
Power Supply	11...22 volage ≈ 25 W
Warm up time	≈ 7 min
Connector gas in	≈ 180 l/h, max.overpressure 450 hPa
Response time	T <sub>95</sub> ≤ 15s
Operating temperature	5...45 °C
Storage temperature	0...50 °C
Relative humidity	≤ 95%, non-condensing
Inclination	0...90°∠
Dimension (w x d x h)	270 x 320 x 85 mm <sup>3</sup>
Weight	4.5 kg net weight without accessories
Interfaces	RS 232 C, Pick up, oil temperature probe

Table.6: Specifications of the Smoke Meter

Make	AVL 437 Smoke meter
Type	IP 52
Accuracy and reproducibility	± 1 % full scale reading
Measuring range	0 to 100 opacity in % 0 to 99.99 absorption m <sup>-1</sup>
Measurement chamber	Effective length 0.430 m ± 0.005m
Heating time	220 V approximately 20 min.
Light source	Halogen bulb 12 V/5W
Maximum smoke temperature	250 °C
Power supply	190 – 240 V AC, 50 Hz, 2.5 A
Dimensions	570mm × 500mm × 1250mm

**IV. RESULTS AND DISCUSSION**

The engine operation was found to be smooth throughout all the load conditions, without any operational problems for Mahua and Pongamia methyl esters blended diesel fuel. In the present section, the performance attributes such as brake thermal efficiency, specific fuel consumption and the emission characteristics such as NO<sub>x</sub>, CO, HC and smoke density are plotted against brake power. Based on the combustion data, heat release rate and in-cylinder pressure are plotted against crank angle.

**5.1 Engine performance**

**5.1.1 Brake specific fuel consumption**

Brake specific fuel consumption (BSFC) is the ratio between the mass of fuel consumption with the brake

power. The variation of specific fuel consumption with respect to brake power is shown in Fig. 4. As seen in the figure, when fuelling with the methyl ester blends, the BSFC are increased compared with the diesel fuel, which is in agreement with the many literature [11,14,17,22]. Increase in the BSFC is not caused by any loss in efficiency of biodiesel. It is seen that BSFC is highest for methyl ester blends and lowest for neat diesel because of higher viscosity and lower volatility. From the figure it is shown that the BSFC values of neat diesel fuel and MME20 blend fuel are nearly same, while the MME40 and PME40 blends shows a considerable increase of about 4.29% and 7.43% in comparison with the diesel.

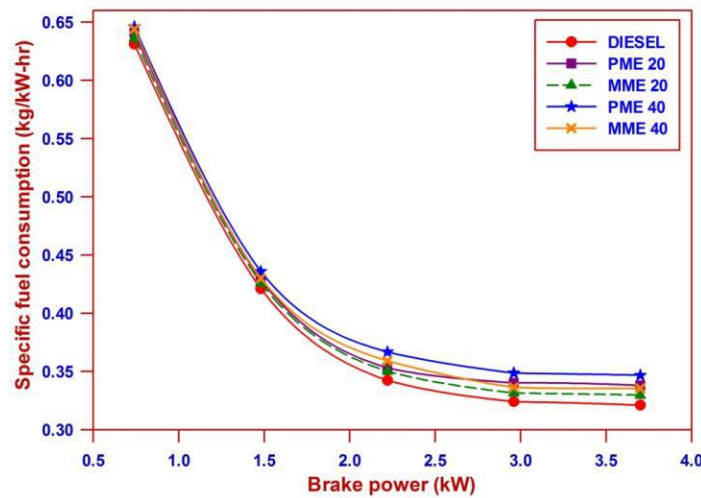


Fig.4: Specific fuel consumption against brake power

**5.1.2 Brake thermal efficiency**

Brake thermal efficiency (BTE) is more suitable than specific fuel consumption to evaluate the performance of different biodiesel fuels, in addition to their heating value. From the Fig. 5 it is clear that BTE increases with increase in, load up to part load and then decrease at full load due to the incomplete combustion of fuel. A number of research have been carried out and found to report that

the increase in brake thermal efficiency when using the biodiesel in diesel engine [16,23,24]. Brake thermal efficiency values of MME20 and PME20 blends are nearly same to the diesel fuel. From the figure, the BTE slightly increased with the increasing proportion of the biodiesel fuel. The maximum increase of BTE was found in MME40 by about 1.31%.

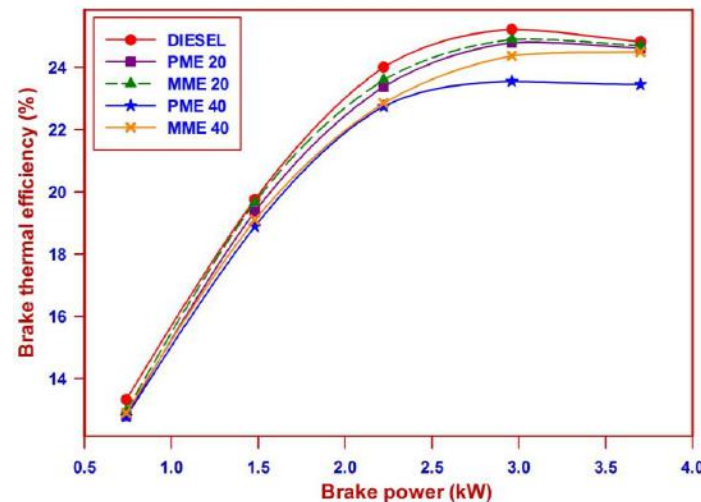


Fig. 5: Brake thermal efficiency against brake power

**5.2 Emission parameters**

**5.2.1 Oxides of nitrogen**

The oxides of nitrogen (NO<sub>x</sub>) emissions of the diesel engine is mainly depends on the flame temperature and oxygen content present in the fuel. The start of combustion was advanced with the methyl ester blends, which tends to an increase in mean temperature peak [22]. As seen in Fig. 6, the NO<sub>x</sub>emissions through the constant rpm band increased 4.60%, 9.31%, 10.99% and 11.33%

for the MME20, PME20, MME40 and PME40 blends, respectively, compared with the neat diesel fuel. From the figure it can be seen that NO<sub>x</sub> emissions for methyl ester blends are highest when compared to neat diesel fuel, which is in conformity with the report of K. Nantha Gopal et al. [25] and K. Sureshkumar et al. [26]. It also can be seen that the NO<sub>x</sub> emissions of MME40 and PME40 are nearly similar values.

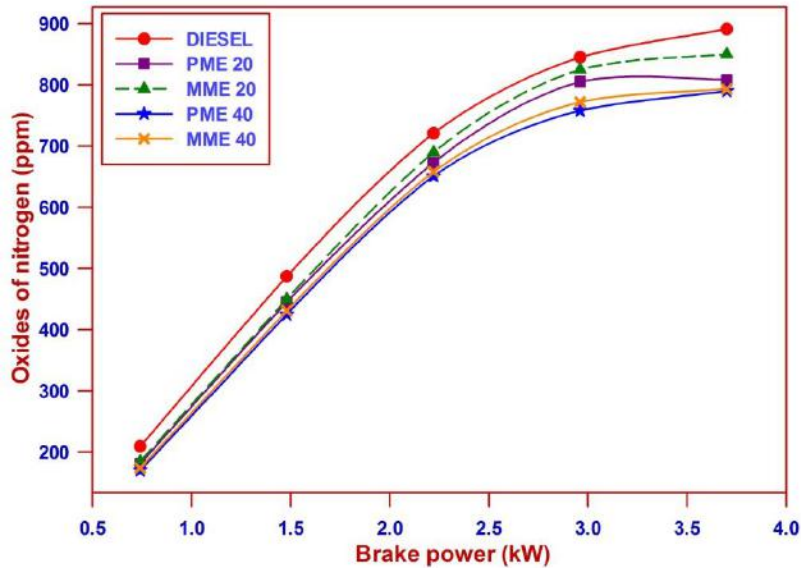


Fig.6: Oxides of nitrogen against brake power

**5.2.2 Carbon monoxide**

The variation of carbon monoxide (CO) emission by running CRDI diesel engine using Mahua methyl ester blends and pungamia methyl ester blends with neat diesel fuel is shown in Fig 7. It is observed that CO emission initially decreases at inferior loads up to 30% and then increases significantly for all the biodiesel-diesel blended fuels. Increased biodiesel blends cetane number, the least

chance of fuel-rich zones formation, generally related to CO emission [12]. From the perception of excess oxygen present in the biodiesel, it helps to lean combustion compared with the neat diesel fuel combustion. From the figure, it is shown that the usage of biodiesel instead of neat diesel resulted in a 3.84%, 5.66%, 8.08% and 12.28% average decrease when fuelling with the MME20, PME20, MME40 and PME40, respectively.

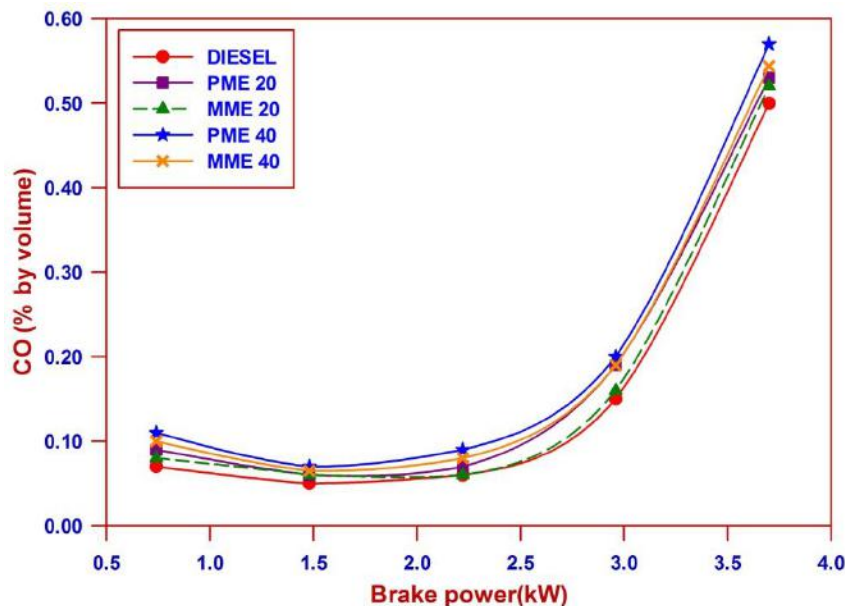


Fig.7: CO against brake power

**5.2.3 Hydrocarbon**

The variation of hydrocarbon (HC) emissions with brake power is shown in Fig. 8. The blends of methyl esters with diesel fuel considerably decrease the HC emissions when compared with neat diesel. Methyl esters naturally contain rich oxygen content that increases the HC oxidation. From the figure, it is seen that the HC emission

decreased with the increase of percentage of methyl esters with diesel fuel. Hydrocarbon emissions for MME20, MME40 were 105, 113 and 110, 118 ppm for PME20, PME40 blends, respectively. Compared with pongamia methyl ester, Mahua methyl ester reduces the HC emissions effectively.

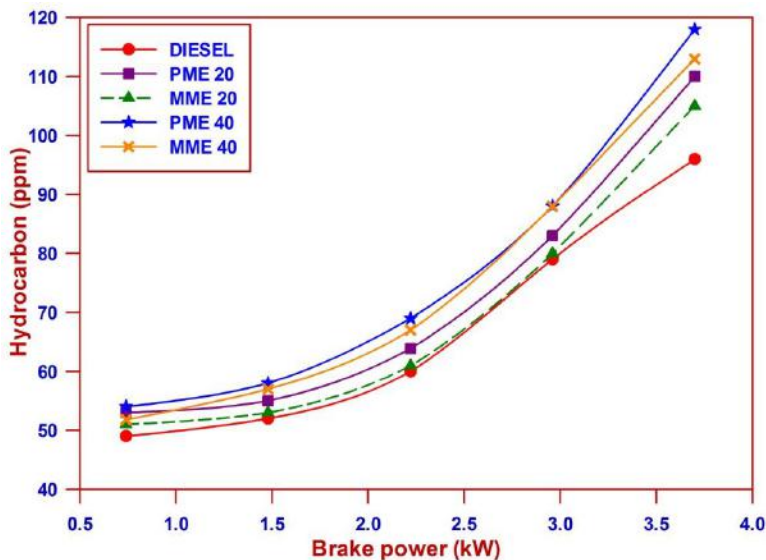


Fig. 8: HC against brake power

**5.2.4 Smoke opacity**

The formation of smoke is mainly depends on the partial burning of the liquid fuel and the incompletely reacted carbon present in the fuel [21]. Fig. 9 shows the variant of smoke opacity for Mahua, pongamia methyl ester blends and diesel fuel over the entire series of the brake power. As it was given in Fig. 9, the smoke emission reduced by

the rise in biodiesel percentage. The mixing of biodiesel blend with air, producing locally rich regions of oxygen to prevent the crucial smoke formation. The smoke emission over the constant rpm band decreased 1.82%, 3.44%, 5.02% and 7.03% for the MME20, PME20, MME40 and PME40 blends, respectively, compared with the neat diesel fuel.

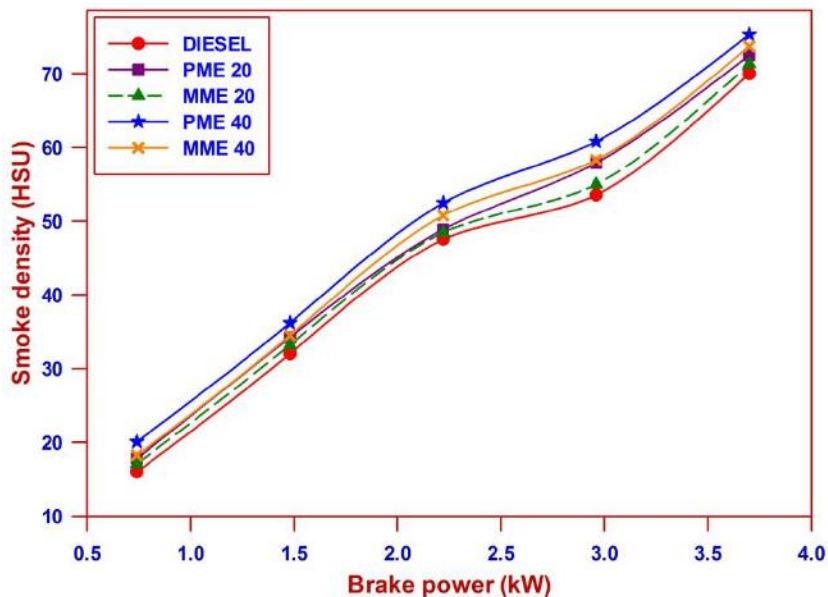


Fig.9: Smoke density against brake power

### 5.3 Combustion characteristics

#### 5.3.1 Cylinder pressure

The peak pressure of Mahua and pongamia methyl ester blends, and diesel fuel at full load condition is shown in Fig. 10. As a result of the shorter delay, maximum cylinder pressure occurs earlier for methyl ester blends in comparison with neat diesel. This is for the reason that the higher oxygen content in methyl esters are sufficient to

make complete combustion of the fuel during the pre combustion phase and maintain to burn in the main combustion phase. It can be seen from the figure that MME40 had an 7.17% higher peak pressure than that of diesel fuel followed by PME40 (7.97%), MME20 (2.79%) and PME20 (4.26%). The similar tendency is observed during the whole range of engine operation at no load and part load conditions for all the test fuels.

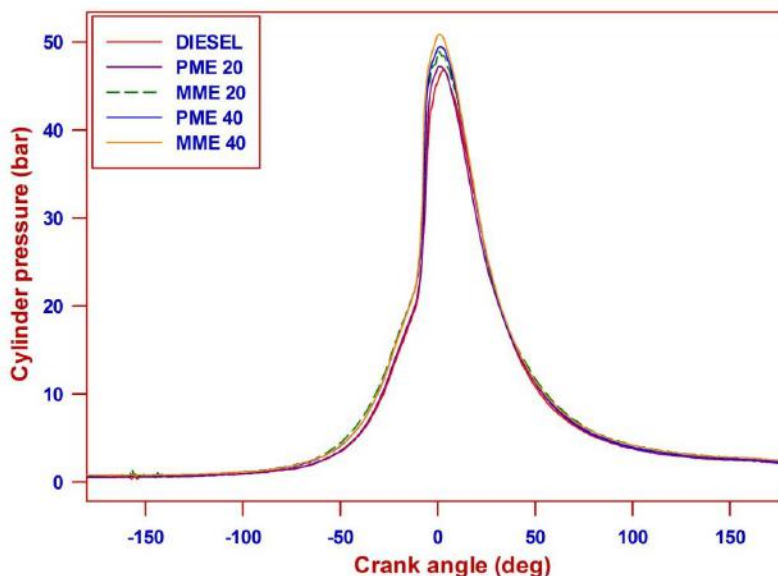


Fig.10: Cylinder pressure against crank angle

#### 5.3.2 Heat release rate

The heat release rate (HRR) at certain operating points of different biodiesel-diesel blended fuels and diesel fuel operation are shown in Fig. 11. The figure shows HRR representing that the ignition delay for biodiesel blends was shorter than that for neat diesel. Many researchers intend that the combustion process is advanced as a result of the advanced injection with the help of physical properties of methyl esters like density, compressibility and viscosity [14,17,20]. The calorific values of Mahua and pungamia methyl esters and their blends are lower

than that of neat diesel due to their oxygen content. The existence of oxygen in the methyl esters helps for complete combustion of fuel. The maximum HRR of methyl ester and their blends is higher than that of neat diesel, particularly, 105.69kJ/m<sup>3</sup>deg for PME20, 107.09kJ/m<sup>3</sup>deg for MME20, 79kJ/m<sup>3</sup>deg for PME40 and 86.47kJ/m<sup>3</sup>deg for MME40 compared with 108.01kJ/m<sup>3</sup>deg for neat diesel fuel. This is due to, as a result of the premix combustion phase and the shorter ignition delay for methyl ester blends.

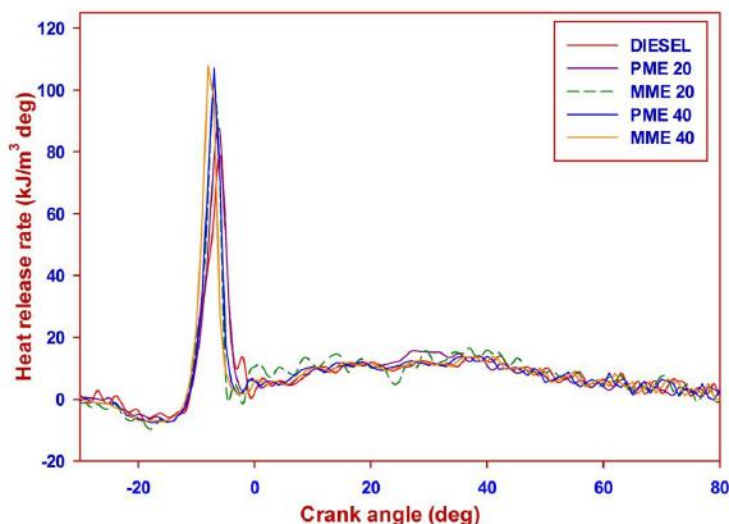


Fig.11: Heat release rate against crank angle

## V. CONCLUSION

From the experiments on the CRDI diesel engine fueled with Mahua and pongamia methyl esters blends, and neat diesel, the following conclusions can be drawn:

- ❖ Improvement in brake thermal efficiency was observed with Mahua methyl ester (MME40) by about 1.31% at optimized operating condition.
- ❖ With the use of methyl ester blends, the level of risky pollutants in the exhaust gas, such as HC, CO and smoke, was appreciably reduced when compared to that of diesel fuel.
- ❖ Mahua methyl ester blend (MME40) reduces CO emission up to 12.28% compared with neat diesel, because of methyl ester blends act as an oxygen buffer and exploit oxygen during the combustion of fuel.
- ❖ The smoke density of diesel engine was decreased on both MME and PME blends by about 3.44 – 5.02%, especially at full load.
- ❖ Methyl esters blended diesel fuel showed higher heat release rate and cylinder gas pressure at optimized operating conditions.

Hence, MME40 and PME40 reduces HC, CO and smoke emissions but in the case of NO<sub>x</sub>, they are not efficient, but MME20 is efficient in improving performance and produce less amount of NO<sub>x</sub> from the diesel engine, compared with other methyl ester blends.

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## CONFLICT OF INTEREST

This article is original and contains unpublished material. The corresponding author confirms that the other author has read and approved the manuscript and no ethical issues involved.

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# T-ISO: A Standard Proposal for Green IT Indicators Oriented to Higher Education Institutions

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**Abstract** — *This article shows the degree of maturity in relation to the implantation of Green Information Technologies (IT) in the higher level institutions of the São Francisco Valley, Brazil. From a standardization of indicators, it proposes policies of actions and good practices that allow these organizations to achieve excellence in IT sustainability. For this, we realized that it is necessary to adopt strategies of motivation and awareness for some managers who still have resistance in implementing Green IT and applaud others for the initiatives and sustainable thoughts already adopted. This research has an exploratory character through a bibliographical survey and interviews with the IT managers of the studied institutions. It is also qualitative-quantitative, for measuring and fostering the level of Green IT present in these institutions. Some results were collected immediately because some actions are already present and successfully adopted by some universities.*

**Keywords**— *Green IT, Sustainability, IT Standard.*

## I. INTRODUCTION

In this article, we highlight the importance and the need to implement Green Information Technology (IT) practices for the well-being and sustainability of the environment.

Initially, a bit is discussed about the history and concepts of sustainability and green IT. Next, we present the degree of Green Information Technology (Green IT) used by higher education institutions of the São Francisco Valley, Brazil. Finally, we present a proposal for standardization through sustainable indicators focused on Green IT.

Concerned about the current world scenario, the motivation for carrying out a research project was raised, seeking to bring to light the current situation in the higher education institutions located in the São Francisco Valley, a Brazilian agricultural center. A region that should always be in tune with the environment and that needs to have a green thermometer in place. The research was based on a bibliographical survey and the results obtained

from interviews conducted with the IT managers of the main institutions of higher education in the region. These institutions were chosen because we understand that they are protagonists of an active process with a great potential for cultural transformation related to Green IT.

With the thinking on this ability of managers to adapt and based on what Mr. Ban Ki-moon, senior UN chief, said, taking into account Gandhi's remark about the important message that "the land provides enough to meet the needs of all, but not the greed of all and that we must be the change that we want to see in the world " [01]. After reading this article, we hope to lead in some way a reflection on the current situation and question what we are doing to improve it, or even wake up the directors, managers and IT managers the feeling for education and green awareness.

## II. THEORETICAL FOUNDATION

With the accelerated development of digital information technologies in the mid-1980s, the term sustainability has gained prominence by promoting a greater awareness of the importance of environmental preservation, as well as the management of resource consumption and thinking on species continuity [02].

From this, the term Green IT emerged in the period between 2004 and 2005. TI Green has been gaining space and force in the world since a very accelerated growth of the digital information technologies was perceived: the equipment began to stay more frequently obsolete, causing, consequently, a substitution and uncontrolled disposal of equipment, called e-waste. With this, there was concern and questions about where and how these products would be discarded, since it is known that electronic waste has many substances harmful to the environment, and that, if not disposed of correctly, they harm the lives of all living beings [03].

Today, electronic waste, also known as e-waste, which is all material waste produced by the disposal of electronic

equipment, has been treated as a major challenge by organizations, government and especially society, as it has become a major environmental problem in relation to the disposal of unserviceable goods in suitable places, since their composition is rich in non-biodegradable substances.

According [04]: A non-bio-degradable, or recalcitrant substance, as some call it, is that which does not rot, does not decompose.

Given this scenario, TI Verde creates forces as an instrument for solving environmental problems caused either in the manufacture of products, in the acquisition, efficient and economical use of equipment and especially in the process of discarding materials.

Their customers are increasingly seeking after companies that invest in the sustainability of the planet. We know that much of this is also due to environmental programs, standards and regulations. The environmental impact caused by mankind has been shown to be of global concern. It is certain, that commercial industries and companies can create and use technologies that help achieve their goals, without harming the environment. In other words, Green Technology becomes an ally of the business, because the corporate world makes understood and mainly uses good practices to meet the needs of the business in a sustainable way [05].

2.1 Sustainability and Green IT: Two concepts, one goal.

We have all heard about sustainability through the various media, but are we practicing what we hear? Are we thinking of our children, grandchildren? Or rather, are we thinking about the continuity of species?

According to [06], "it is a systemic concept, that is, it correlates and integrates in an organized way the economic, social, cultural and environmental aspects of society. The key word is continuity - how these strands can keep in balance over time." That is, "that meets the needs of present generations without compromising the ability of future generations to meet their own needs" [07].

It can be seen that green IT has the same purposes as regards sustainability, but it is focused on the sphere of information technology, since it is an area that greatly harms the environment with enormous amount of resources extracted for clothing, in the use and consumption of energy, emission of gases and mainly in the discard (return to nature).

### III. RESEARCH METHODOLOGY

In this work, initially a bibliographic research was carried out, followed by individual interviews, semi-structured, and based on a pre-established script, but with flexibility [08]. Through the deepening of several bibliographies and the experience with the subject, we identified the most important points and the greatest impacts to the

environment, and, based on these, the items were chosen to compose the list of indicators of the research and proposal for use of standardization:

- 1- Program of education for sustainability;
- 2- Use the hibernate function;
- 3- Use of some kind of alternative energy (solar, etc);
- 4- Energy consumption management policy;
- 5- In the purchase, sale, production of IT products is controlled emission of CO<sub>2</sub>;
- 6- Execution of adequate donation and disposal of equipment;
- 7- Option for products with green seal in the acquisition of new equipment;
- 8- Work home office;
- 9- Reconsider redundancy;
- 10- Outsourcing of printing;
- 11- VDI or Thin client project (mouse, monitor, keyboard);
- 12- Virtualization of servers and storages;
- 13- Clustering;
- 14- Computing in the cloud;
- 15- GED (Electronic Document Management);

To highlight the degree or level of green IT, 05 (five) higher education institutions were selected in the São Francisco Valley, Brazil, being possible only the interviews with the managers of four of these. They were chosen because they understood that they have or should have a large technological park and great equipment turnover. Moreover, they could serve as a model and motivation for other institutions and, through the human capital present in them, the propagation of knowledge regarding education for sustainability and consequently for green technologies.

After the collection, based on the indicators that emerged from the theory that guided this research, from the implementation of the methodology and the field of research itself, the data were tabulated from each institution and then the analyzes and inferences were made. This moment demanded knowledge of the area and a greater capacity for reflection.

From there, a valuation table was built as a proposal for annual monitoring that can be used by the institutions. We established the use of scores according to the status of the indicator: (0) Absence of the indicator; (1) started, for when the indicator is in the implantation phase; (3) partially, when the indicator is present but not yet fully functioning; and (5) fully, when the indicator is being used in its entirety.

After adding the scores found in each indicator, a degree of Green IT found in the institution was calculated so that, from there, managers could consolidate sustainable IT in institutions or serve as a starting point for the implementation of new indicators.

It is clear that there are practices that are easier to implement than others. Even if implemented, we must take into account the degree of implementation difficulty, the impact that is caused and the environmental return. In this way, institutions will be ranked more fairly. Then, a table was drawn up with the appropriate weights for each indicator, which is then multiplied by the valuation achieved through the institution mapping.

#### IV. LEVEL OF GREEN TECHNOLOGY IN HIGHER EDUCATION INSTITUTIONS OF THE SÃO FRANCISCO VALLEY

From the interviews, it was possible to perceive individually the scenario found before each perspective, since we will be able to show which practice is being applied the most, the ones that are less present, either due to difficulty of implantation or culture, so that it is in some way to other practices and to improve those already in use.

According to results obtained, about the knowledge about Green IT, half of the interviewees declared to have knowledge and the remainder divided into not aware with already heard: one of the managers had already heard about the term TI Green, two stated to have knowledge in the practice and one of them stated that they did not even have knowledge of the term, even though it is practicing some sustainable practices. The manager who informed that he or she does not know has no course focused on information technology within the courses offered by the institution to which it belongs. This means that the term green IT is still unknown by some managers and there is a gap to be filled in the sustainable scope.

On implementing Green IT practices, half stated using paper reduction strategies (double-sided printing, for example) and the other half was divided between the use of A3P<sup>1</sup> program and educational strategy (energy consumption). The best-known practice used by managers is to reduce paper consumption through two-sided printing. It is perceived that there is a very great disparity between some universities - federal public institutions are better organized in relation to state and private institutions.

Most institutions recognize the advantages of deployment and the gain that this can bring, but they run into internal rules and regulations of their respective headquarters or other general regulatory frameworks, even if they are oblivious to public norms. We note that there is resistance coming from the convenience of the collaborators. For example, some users can not unlink from a printer on

their desk. On the other hand, it is noticed that the adherence of the green IT practices are isolated attitudes and it meets some rules, regulations, contradicting with the statement: Green consumption is one in which the consumer, in addition to seeking better quality and price, includes in its power of choice the environmental variable, giving preference to products and services that do not harm the environment, both in production and distribution, consumption and final disposal [09].

Looking at table 1, according to the interviewees, all institutions have some kind of educational program focused on sustainability, although not specifically green IT. Sometimes even by intuition, but not by institutional policy. It is possible to realize that there is a massive practice regarding the use of the hibernate function of desktop computers, but it is not active in 100% of the institutions. Regarding energy management, we can see that 50% of the institutions carry out this type of control, although they are implemented through sustainable committees and extension projects.

Table.1: Institutional indicators

Indicators	%
Program of education for sustainability	100%
Use the hibernate function	75%
Use of some kind of alternative energy (solar, etc)	0%
Energy consumption management policy	25%
In the purchase, sale, production of IT products is controlled emission of CO <sub>2</sub>	0%
Execution of adequate donation and disposal of equipment	75%
Option for products with green seal in the acquisition of new equipment	25%
Work home office	0%
Reconsider redundancy	0%
Outsourcing of printing	0%
VDI or Thin client project (mouse, monitor, keyboard)	0%
Virtualization of servers and storages	50%
Clustering	25%
Computing in the cloud	50%
GED (Electronic Document Management)	25%

All of them do not control CO<sub>2</sub> emissions in the acquisition, sale, production, and disposal of IT materials. "A computer connected one hour a day consumes 5kwh / month, and at the end of a year it emits 18 kg of CO<sub>2</sub> in the environment, which means that reducing one hour of the operating time of a home computer implies the reduction of emission of CO<sub>2</sub> equivalent to the emission of a gasoline car traveling 120 km / h." [10].

The disposal of waste equipment is carried out by 75% of the institutions, but none of them has its own waste

<sup>1</sup> The Environmental Agenda in Public Administration (A3P) is a program of the Ministry of Environment which aims to stimulate public agencies in the country to implement sustainability practices.

disposal project. The equipment is collected through specific projects of the respective parent institutions, located in the capitals, which in turn, in contract with third companies or the army battalion itself handles the disposal properly. The remaining 25% focus on reuse and donation. In this case, the institution that is contemplated with the donation of the equipment becomes responsible for the final disposal to the environment.

For the purchase of products with a green seal, that is, products with green technology and that have a lower incidence of environmental aggression, the universities stumble across regulations and bidding processes that prevent them from choosing them.

In college environments, it is common to find some teachers who use their personal computer to work from home. However, in all the universities interviewed, the employees must attend the workplace, not characterizing, as a rule, the home office.

Today, 100% of the institutions do not reconsider the physical redundancy of IT equipment, that is, they prefer to consume more resources than to consider the possibility of a possible loss of data or interruption of some critical service, since information is much more important than sustainable gain in this regard, according to IT managers. On the other hand, 50% of universities use the virtualization process (machines that work virtually using the resources of a physical machine), regarding the contingency of servers and storages, thus reducing the use of physical machines and consequently energy consumption, CO2 emission, and future discard reduction.

In the current scenario, only 25% of universities have a clustering system. This system allows computers with reasonable processing power, work synchronously, together, thus forming a machine with high processing power. This would increase the time of use of these machines, since they would stop becoming obsolete quickly, not to mention the gain in processing.

When it comes to paper consumption, control of impressions and consumption of toners and printer cartridges, a good practice is the implementation of Outsourcing of printing (robust printers, placed in strategic points of the organization, that meet the need of collaborators).

By using this practice, the IT manager has control over what is printed, inhibiting undue impressions, eliminating the diversity of printer models and brands in the organization, and considerably reducing the acquisition and consumption of large quantities and models of cartridges and tonners. One hundred percent of the universities do not have Print Outsourcing, but one of them is starting a deployment project.

According to IT managers, there is usually a lot of resistance from most employees regarding convenience

and culture, especially the high-level staff. Employees do not agree, for example, to have to get up from their armchair, get out of the front of their computer, to get their printout that was sent to a printer located in a hall ten meters from your living room. (Strategic point).

Another very important practice is the use of the Thin Client or VDI system, in which the company has only one large server (usually clustered) and in the stations only the monitor, the mouse and the keyboard are included, thus eliminating a large amount of CPU's on workstations. For managers, it would be very good to be able to use this system, but this technology has a very high deployment value, especially in relation to infrastructure.

Of these companies, fifty percent have some kind of cloud storage that makes a notable gain in information security and reduces the use of physical equipment in the organization and consequently reduces the amount of disposal in the environment.

On the last of the indicators, the Electronic Document Manager (GED), which is a computer system in which it has a set of five basic functionalities, which are: capture, manage, store, distribute and preserve information [11]. In this sense, only 25% of universities said they managed documents by image and use documents with controlled copies.

**4.1 Suggested Model**

For each indicator analyzed with the IT manager of each institution is verified the scenario in which it is found and added the appropriate score according to the legend:

Evaluation: Absent (0); Initiated (1); Partially (3); Total (5)

Table 6 shows the green IT level calculation model, according to the valuation ratio found in each existing or non-institution indicator.

Table.2: Fictional Institution

Weight	Indicator	Utilização					w/weight
		Absent	Initiated	Partial	Total	Accum.	
1	Program of education for sustainability	X				0	0
1	Use the hibernate function				X	5	5
3	Use of some kind of alternative energy (solar, etc)		X			1	3
3	Energy consumption management policy	X					0
1	In the	X					0

	purchase, sale, production of IT products is controlled emission of CO2						
3	Execution of adequate donation and disposal of equipment				X	5	15
1	Option for products with green seal in the acquisition of new equipment			X		3	3
3	Work home office			X		3	9
3	Reconsider redundancy	X					0
3	Outsourcing of printing	X					0
5	VDI or Thin client project (mouse, monitor, keyboard)	X					0
5	Virtualization of servers and storages			X		3	15
5	Clustering	X					0
5	Computing in the cloud		X			1	5
5	GED (Electronic Document Management)		X			1	5
	TOTAL	7 x 0 = 0	3 x 1= 3	3x 3= 9	2x 5= 10	32 /7 5= 42,7 %	60/28 0=21, 42%
	ATTRIBUTE D CONCEPT					C	D

If we did not include a weight (degree of difficulty), the fictitious company would reach the green level category "C", since the maximum score would be 75 points. Already with the weight, the calculation is done upon the multiplication of the valuation with the weight and at the end would be divided no more by 75, but by 280, which is the maximum attainable value. Then, 280 points are equal to 100% and the concepts would be subdivided into the following scale:

**Concept (A):** 80% above; **Concept (B):** between 60 and 79%; **Concept (C):** 40% and 59%; **Concept (D):** between 20 and 39%; **Concept (E):** up to 19%.

According to the concepts adopted above, we mapped institutions using the relationship between the indicators method and the valuations obtained in the current scenario.

Table 3 shows that none of the institutions studied have an ideal level of green IT deployment. We have a big gap that can be seen as opportunities for improvement that can be healed with awareness and motivation.

Table.3: Institutions Mapping

Weight/difficulty	Indicator	Institution			
		Inst. U	Inst. F	Inst. N	Inst. P
1	Program of education for sustainability	5	1	1	1
1	Use the hibernate function	3	3	5	0
3	Use of some kind of alternative energy (solar, etc)	1	0	0	1
3	Energy consumption management policy	3	0	0	3
1	In the purchase, sale, production of IT products is controlled emission of CO2	3	0	0	0
3	Execution of adequate donation and disposal of equipment	5	3	3	1
1	Option for products with green seal in the acquisition of new equipment	5	0	0	0
3	Work home office	0	3	3	3
3	Reconsider redundancy	0	3	3	0
3	Outsourcing of printing	1	0	0	0
5	VDI or Thin client project (mouse, monitor, keyboard)	0	0	0	0

5	Virtualization of servers and storages	5	3	3	0
5	Clustering	5	0	0	0
5	Computing in the cloud	5	3	0	0
5	GED (Electronic Document Management)	5	0	3	0
	TOTAL	52,1 4%	21,4 2%	22,5 %	8,92 %
	ATTRIBUTED CONCEPT	C	D	D	E

## V. FINAL CONSIDERATIONS

In the perception of most of the interviewees, the organizations in which they work do not know or do not care about Green IT practices, although some use an environmental management system, usually led by the respective ISO 14001-related Headquarters, standardization, and environmental regulation. Some simple practices, such as the use of control of energy expenses, paper consumption and equipment discards, show that organizations, even without knowing the practices, already apply some initiatives, yet it is still irrelevant to what is proposed in green IT.

We also noticed that even with the lack of knowledge in Green IT practices, the majority of interviewees do not think about implementing practices in their organizations, even though they are concerned about sustainability.

In view of the above, it is necessary to pass on the knowledge of Green IT practices in order to articulate them effectively to a strategic policy of implementing a culture of sustainability in companies. It is understood that these policies and practices should be part of not only the strategy, but the culture and business of organizations in all their environments, so that not only IT professionals know, but everyone who is part of the organization.

Green IT still shares opinions. Some practices, which have a considerable environmental impact and return, are not easy to implement but should be part of a new IT culture. With that, IT professionals, organizations, and the environment as a whole win.

It is hoped that this work will sharpen the sense of greenness and social, educational, cultural and environmental responsibility of managers in the general scope and that green IT will be a part of a massive form in the institutions, not only those of higher education, of this study, but in general. That the synchronism of the processes of the companies and the environment are treated like differential and attractive model for new clients.

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# The Interdisciplinary Practice of High School Teachers of Nature Sciences: Focusing on the Environment in full-time School

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**Abstract**—This research project had the objective of analyzing the interdisciplinary pedagogical practice of the professors of Higher Education Nature Sciences. The interdisciplinary practice in the school environment has been considered primordial in the process of teaching and learning, for enabling it to occur in an innovative, integrative, participative and dynamic way. Considering that Environmental Education is related to the preservation of the environment and sustainable development, the locus of the research was the School of Integral Engineer and Professor Sérgio Alfredo Pes-soa Figueiredo in the city of Manaus, for being located in the vicinity of the Ducke Reserve, one of the most important research centers of the National Research Institute of Amazonia (INPA), given the existence of a great diversity of species of fauna and flora of the Amazon. The study was developed from the descriptive, exploratory bibliographical research with a qualitative and quantitative approach through the case study, a visit to the MUSA (Museum of the Amazon) with students and teachers, where it was possible to observe curricular activities developed by the professors of Sciences of the Nature of the High School. Questionnaires were applied to 181 students, 13 teachers and the school manager, where it was possible to identify pedagogical practices aimed at the preservation of the environment.

**Keywords**—Sciences; Environmental education; Preservation; Environment.

## I. INTRODUCTION

The Ducke Reserve was created through State Law No. 41 of February 16, 1963. "At that time, the Government of the State of Amazonas made a donation of 100,000 square meters of the Forest Reserve named" Ducke "to the National Institute of Amazonian Research (INPA), which has become an important space for study and research of the same" (AMAZONAS, 1963 apud MARQUES et al., 2014, p. 32).

It is a Forest Reserve located in the Cidade de Deus neighborhood, Zona Lesta de Manaus, known for its great

variety of fauna and flora and springs in streams, one of the most visited sites by national and international researchers in the studies and scientific research focused on the environment.

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At present, the Ducke Reserve has in its surroundings a School of Integral Time that according to the Secretary of State of Education (SEDUC, 2018), should be a reference in education in Brazil, since the classes are daily and continuous (morning and afternoon), where programs and pedagogical resources are offered that can foster quality education. In this way, pedagogical and interdisciplinary practices that diminish the environmental impact, present themselves as important alternatives in the indicated context, being essential the muddance of habits and attitudes of the society, having in the school a suitable space for such, possibility of effective integration of the student into the environment.

Pedagogical practices, in this new social context, require the collective construction of knowledge with other teachers, as mediators and guiding the process of teaching learning. The preservation of the environment demands a new educational posture, regarding pedagogical practice which is not limited to expositions only dialogued in the classroom, on the contrary, presupposes a new model of teaching and learning in an interdisciplinary way.

It is in this context that Critical Environmental Education assumes the important function of contributing to the recovery of essential values for a new citizenship, taking an integrated view of the relationships between human beings and nature and between human beings and their peers (GUIMARÃES, 2014). That is, environmental education must consider all the social and political aspects of man and nature, at all educational levels.

Thus, during the process of teaching and learning, the teacher must develop pedagogical practices that awaken the students' environmental perception, making them perceive their daily life and the social environment in which they are inserted, so that they can reflect, and feel subject to the educational process and the preservation of the environment. Morin (2011, p. 37) comments that "education should favor the natural ability of the mind to formulate and solve essential problems and, in a corresponding way, to stimulate the total use of general intelligence." This total use requires the free exercise of curiosity, the most lively and most expansive faculty during childhood and adolescence, which education often extinguishes, and which, on the contrary, is to stimulate, or if it is adoring to awaken.

The relevance of this study is to contribute to the interdisciplinary practice of Science Teachers of the High School in relation to the strengthening of the perception that education constitutes a social space that encompasses many indispensable practices for the formation of critical subjects and environmentally responsible. Based on this assumption, it becomes clear that interdisciplinary doing allows significant learning through the association of theory with environmental practice, engendering new knowledge, concepts and meanings capable of articulating the school space to the environment in which they are inserted.

## II. LAWS, AND RESOLUTIONS AND POLICIES IN ENVIRONMENTAL EDUCATION

The legal bases and backs of the Public Policies for Environmental Management and Education in the three federal, state of Amazonas and municipal districts of Manaus provide conceptual and historical information on the Ducke Forest Reserve in the eastern part of Manaus, in addition to having the function of tourist visits and students of private and public school networks, is the research base of the National Research Institute of the Amazon.

### 2.1 Federal legislation on environmental education and policy

The CF / 88 establishes the National Environmental System (SISNAMA), which is the highest national body to manage the national environmental policy, and has one of its functions to advise the president of the Republic on matters of the area environmental.

According to Law No. 6.938, dated August 31, 1981, the advisory body of the National Environmental System is the National Council for the Environment (CONAMA) and the executive body is the National Institute for the Environment (IBAMA) (BRASIL, 1981).

Brazil is considered to be one of the countries with the most advanced environmental legislation for contemporary ecological needs, but effective data indicate that

this legislation has been idle or obsolete since more than 90% of the fines applied by IBAMA are not actually collected, since the fined individuals tend to resort to justice and slowness tends to cancel the tone of punishment to the owner and the damage caused to nature.

Another fact that deserves attention in a negative critical tone is the paradox between Brazil as a holder of a consistent and plausible legislation to ecology while at the same time being reproved for the devastation of natural forests in the Amazon, of burnings, in the Amazonian rivers and bragging about the pre-salt as a source of exorbitant wealth going against the demands and needs of dies and sources of clean renewable energies unlike fossil fuel oil.

The National Environmental Policy, besides being recommended in the Federal Constitution of 1988, is dealt with in Law n° 6.938/1981:

Art. 2°. The aim of the National Environmental Policy is the preservation, improvement and recovery of the environmental quality conducive to life, aiming to ensure, in the country, conditions for socioeconomic development, interests of national security and protection of the dignity of human life.

In fact, what is observed in the legislation in force for both politics and environmental education, there is no doubt that the Brazilian legislator has approved an ideal system for both actions in the environmental area, but it remains to be verified whether this legislation is fulfilled as it should.

The ABNT (ABNT, 2014) is a legally constituted body to establish standards and enforce them through official inspections carried out by public agencies. In the private area the Environmental Management System / EMS is executed according to the principles: Principle 1 - Environmental commitment and policy; Principle 2 - Planning of compliance with environmental policy; Principle 3 - Implementation; Principle 4 - Measurement and evaluation; and Principle 5 - Critical analysis and improvement of global environmental performance.

Brazil has laws to regulate the exploitation of resources, but does not invest in infrastructure to oversee compliance with these laws in an area that, evidently, needs supervision. The resources applied to satellite monitoring, for example, do not correspond to the on-site monitoring of deforestation authorizations. In order to be effective, the inspection must arrive before, to prevent deforestation from happening, to inhibit the criminal action in its origin. And the Public Prosecution action must be intensified, as provided by the Forest Code, Environmental Policy and the Environmental Crimes Law (SOARES; HIGUCHI, 2006, p. 576).

Moreover, in contemporary Brazil and in other countries there is a neoliberal state that acts in concomitance



with interested companies, granting them licenses and tax incentives, as has been the case with Brazil in relation to foreign oil companies and attempt to liberate the Copper and Similar National Reserve in the state of Amapá.

Regarding Environmental Education, especially for children, it is how these paradoxes can be discussed with them in the face of such contradictions that, even, can be configured complacency, prevarication, among other acts against nature.

### 2.2 Legislation of environmental policy and education of Amazonas

What differentiates Amazonas is the Manaus Free Zone that has diverted the common economic matrix in the legal Amazon from vegetable and mineral extractivism to manufactures of electrical and electronic products thus benefiting the region with a clean and untied economy - predatory acts. In addition to the State Department of the Environment, the State has a specific body for the state environmental issue that is the Environmental Protection Institute of Amazonas (IPAAM, 2017).

These units represent 55.47% of the State area distributed as follows as protected areas (Table 1):

Table.1: Protected Areas of the State. (D1).

Áreas Protegidas do Estado		
CATEGORY	% AM	UC
RSD	6,53	16
PAREST	2,20	07
FLORESTA	1,67	08
APA	1,08	06
RESEX	0,56	04
REBIO	0,02	01
<b>TOTAL</b>	<b>12,05</b>	<b>42</b>

Source:SEMA (2015)<sup>1</sup>.

In addition to the data specified in Table 1, the aforementioned source provides the following data specifically cited in Table 2, according to the Amazon Environmental Matrix.

Table.2: Distribution in% and category of Protected Areas in Amazonas.

Protected Areas in Amazonas		
CATEGORY	% AM	Há
Indigenous Areas	27,07	42.205.013,83
Federal UC	15,16	23.630.678,83
State UC	12,05	18.787.397,29
Municipal UC	1,19	1.853.012,10

Source: SEMA (2015).

<sup>1</sup> Dados da Secretaria de Estado do Meio Ambiente (SEMA). Disponível em: <<http://meioambiente.am.gov.br>>. Acesso em: 8 jan. 2018.

Regulatory Framework for Environmental Policy for Sustainable Development in Amazonas is thus distributed and organized:

Table.3: Distribution in% and category of Protected Areas in Amazonas.

Regulatory Framework for Environmental Policy / AM	
Climate changes	Law nº 3135/2007
Environmental services	Law nº 4.266/2015
Environmental Licensing	Law nº 3785/2012
Water resources	Law nº 3167/2007
State System of Conservation Units	Law nº 53/2007

Source: SEMA (2015).

In practice, the environmental policy for sustainable development in the State of Amazonas is carried out in the following thematic areas: Conservation Units - UC; Deforestation and burning; Environmental Regulation - CAR; Climate changes; Ecological Economic Zoning - ZEE; Solid Waste; Water resources; Environmental services; Environmental education; Strengthening Municipal Environmental Management; Peoples and Traditional Communities; and Forestry Policy.

### 2.3 Legislation of the environmental education policy of Manaus -AM

The Environmental Policy of the municipality of Manaus is based and legally based on Law no. 605, dated July 24, 2001, through the establishment of the Environmental Code of the Municipality of Manaus, which recommends in its Chapter I, the Principles of said document:

Art 1 - This Code, based on local interest, regulates the action of the Municipal Public Power and its relation with citizens and public and private institutions, in the preservation, conservation, defense, improvement, recovery and control of the ecologically balanced environment, a very diffuse and essential nature to the healthy quality of life.

Art. 2 - The Municipal Environmental Policy is guided by the following general principles:

I - Everyone's right to the ecologically balanced environment and the obligation to defend and preserve it for present and future generations;

II - The optimization and guarantee of the continuity of the utilization of the natural resources, qualitatively and quantitatively, as a presupposition for the sustainable development;

III - The promotion of the integral development of the human being.

The city of Manaus has an Environmental Policy that advocates environmental licensing and inspection, which due to the greater degree of entronement of the State Ama-zones and greater human settlement presents the most urgent need for action focused on environmental preservation.

### III. MATERIALS AND METHODS

#### 3.1 Typology

The research was qualitative, and based on the classification criteria proposed by Vergara (2011), which distinguishes it in two respects: as regards ends and means. Regarding the ends, the research was characterized as applied and exploratory because it is a case study, which according to Yin (2015, p. 23): Exploratory research is an investigation or survey through case studies, and field and can be treated as important methodological strategies for research where a phenomenon occurs or has elements to explain it, may include interviews application of question-and observations.

So this research was of a basic nature of the non-experimental type where the researcher studied the phenomena without intervening in a systematic way. In this perspective, (MARTINS, 2000, APUD, VERGARA, 2011, p. 1), points out that in this type of study the "... researcher observes, records, analyzes and correlates facts and variables without manipulating them".

#### 3.2 Focus

In its focus the research had as theoretical and methodological contribution also the deductive method, which according to the classic meaning, consists of the method that leaves the general for the particular. Thus, "through a chain of reasoning in descending order of analysis from the general to the particular, where he came to a conclusion. To Gil (2010), "This method uses the syllogism that consists of the logical construction, from two premises, which will base a third one, called of conclusion". In view of the above, the object of this study is the pedagogical interdisciplinary pedagogical practice of the professors of Higher Full-time School of Engineering and Professor Sérgio Alfredo Pessoa Figueiredo in the city of Manaus.

#### 3.3 Study area

The area of study is part of the urban area of Manaus state of Amazonas, located in the District of Cidade de Deus that emerged as another invasion of land occupied by migrants from the interior and other states. At the time, according to residents' reports, nothing was done to stop the landless families from invading the place. It was not until 1993 that the region became a bair-ro. Far from the center of Manaus, the neighborhood is close to Cidade Nova, in the North Zone, and Jorge Teixeira, in the East Zone of the Amazonian capital. Therefore the neighbor-

hood is considered border of the zones east and north. The questionnaires were composed of a set of questions whose purpose was to know the important information. Gil (2010), comments that "this type of approach aims to identify knowledge, values, expectations, aspirations, among others." According Goldenberg (2014), "Closed-type questions are standardized, readily applicable, can be analyzed quickly and dispassionately."

#### 3.4 Sample and Study Population

The composition of the sample was based on the dialectical method that Furasté (2015, p. 42), "Dialectics is a way of analyzing reality from the confrontation of theses, hypotheses or theories."

The population that compose the study are the science teachers and students of the High School of this curricular component enrolled in the School of Integral Time. Thus composed of 438 students in high school in the three series 1<sup>a</sup>, 2<sup>a</sup> and 3<sup>a</sup> series, 22 teachers of high school and one manager.

In this context, the subjects participating in the research were considered only randomly selected. Thus, the sample consisted of 13 (thirteen) teachers; One (1) manager and 181 (one hundred and eighty-one) high school students.

##### 3.4.1 Inclusion criteria

Acceptance was made by teachers and high school students to participate in the research and the proposed study with the permission of the school board.

##### 3.4.2 Exclusion Criteria

Students and teachers who did not agree to participate in the study were excluded or were not included in the inclusion criteria.

#### 3.5 Data collect

Data collection was carried out from the observation and application of questionnaires with closed-ended questions with the teachers and students of the High School of the Engenheiro Tempo Integral School and Professor Sérgio Alfredo Pessoa Figueiredo since it is an instrument planned for the purpose of responding to established objectives.

#### 3.6 Procedures

The researches were exploratory and descriptive defined for the proposed study, since both are usually carried out by researchers who are concerned with the practical action. Thus, "exploratory research is developed with the aim of providing an approximate overview of a given fact" (GIL, 2010, p. 27).

As for the descriptive research, it is emphasized that its main purpose is to "describe [...] the characteristics of a given population or phenomenon or the establishment of

relations between variables. [...] one of its most significant characteristics is the use of standardized techniques of data collection" (Gil, 2010, p. 28).

For the proposed study, the mis-ta approach was used to integrate quantitative and qualitative research, making it possible to cross-reference information more reliably, "since data collection is not from a single procedure" (GOLDENBERG, 2014). Thus, it is quantitative because it represents the space of the scientist that can be translated objectively, and in mathematical and qualitative ones, by aiming to work with the universe of meanings, motives, aspirations, beliefs, values and attitudes, "which corresponds to a deeper space of relationships, processes and phenomena that can not be reduced to the operationalization of variable" (MINAYO, 2011). The procedures used were the bibliographic research, field research and case study carried out as a procedure to analyze the results.

The bibliographical research, according to Lakatos e Marconi (2017, p. 17), consists of the "[...] survey of all the bibliography already published, in the form of books, magazines, separate publications and the written press. Its purpose is to enable the researcher to come into direct contact with all material written on a particular subject [...]" . In this way, the bibliographic research will subsidize the analysis, interpretation and attribution of meanings to the data collected in the field research and case study.

To Yin (2015), "[...] a case study is an empirical investigation that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly defined." Therefore, the case study is applicable when there are many interested in a complex and changeable circumstance, whose answers have not yet been fully found, as is the case of the researched topic.

#### IV. RESULTS

##### 4.1 School profile

The school works with Elementary School Years and High School levels. It is part of the Metropolitan Region of the City of Manaus, located in the "Cidade de Deus" Neighborhood, approximately 20 km north of the city, in a straight line, access by BR-174, at the geographical coordinates in 3° 0' 27" S, 59° 56' 22.92" W -3.0075, -59.9397° S W. It is limited with the districts: New City, Golden Field, Sweet Creek, Alfredo Nascimento, Jorge Teixeira, Francisca Mendes 2, according to figure 1.



Fig.1: Neighborhoods around (EETI).

Source: Google Maps (2019).

The research was carried out at the State School of Integral Prof. Eng. Sérgio Alfredo Pessoa Figueiredo next to the botanic botanist of Manaus - Adolpho Ducke, as shown in Figure 2.



Fig.2: Forest Reserve Adolpho Ducke.

Source: Google Maps (2019).

The State School Full Time Prof. Eng. Sérgio Alfredo Pessoa Figueiredo, executes the activities in partnership with 54 employees, according to Census data, 2017 the physical structure has 24 classrooms; Board room; Teacher's room; Computer lab; Science lab; Indoor sports ground; Kitchen; Library; Bathroom inside the building; Conference room; Refectory; Warehouse; Auditorium and Green Area.

To understand what prevails in the school environment, that is, the interdisciplinary practice of nature science teachers in a School of Integral Time in the Municipality of Manaus - AM. The institution chosen as a field of research was the State School of Integral Prof. Eng. Sérgio Alfredo Pessoa Figueiredo. The school has an administrative staff composed of: one (1) Manager; one (1) Secretary; one (1) Pedagogist; two (2) middlemen; three (3) administrative; six (6) general services and 40 Teachers, of which 18 are teachers from the 6th to 9th year of elementary school, and 22 teachers from the 1st to 3rd grade of High School. The school has a Library, a Computer Room, Laboratory, sports court, and cafeteria. The school has a number of classes: a) three (3) 1st grade classes, with a

total of 155 students; b) three (3) 2nd grade classes, with a total of 140 students; c) four (4) third grade classes, with a total of 143 students. The teachers are distributed in the disciplines according to table 4.

Table.4: Number of teachers for each discipline (EETI).

Number of teachers for each discipline	
Portuguese language	05
Mathematics	05
Methodology	02
Religious education	01
Geography	03
Sciences	04
Story	03
Physics	02
Chemistry	02
Biology	02
Ed. Física	04
English	02
Spanish	02
Arts	02
Computer lab	01
Total	40

Source: Authors (2018).

Founded on January 31, 2013 through Government Decree 32,081 / 2012. The name of the school pays homage to the Engineer and Professor Sérgio Alfredo Pessoa Figueiredo. The School Belongs to the Distrital V Coordination and is located in the Cidade de Deus neighborhood, at Ave-nida Uirapuru, no. 1532. Serving the students of the adjacent communities offering them the Middle and High School. Having as its first manager and current Amílís Barroso dos Santos. The patron of the School Engineer and Professor Sérgio Alfredo Pessoa Figueiredo, born on December 14, 1948 in Manaus. He graduated in Civil Engineering from the Federal University of Amazonas and worked as a professor at the same University in the Department of Hydraulics and Sanitation. He joined the state public service as a technical assistant. He passed away at age 57 in 2005, leaving a legacy of professionalism and responsibility for the public cause and development of the northern region.

The data were collected through applied and dialectical research, the data collected were tabulated and analyzed in three parts with: teachers, students and managers. For the research, research questions were elaborated. Through documentary analysis it was possible to collect data such as: the interdisciplinary practice of exact and natural science teachers, and how this interferes or not in the process of teaching and learning of students, in order to identify the level of environmental perception of stu-

dents, with relation to the content delivered in class, related to the conservation and protection of the environment. For the questionnaire, a script was prepared with twelve questions, for students, manager and teachers, in the direct observation was used photos where the researcher filled in according to his personal analysis.

The study sought to emphasize the interdisciplinary practice of the Faculty of Natural Sciences and the environmental perception so that it is possible to measure the effectiveness of the knowledge and application of content delivered in the classroom related to the preservation of the environment in the school.

In this aspect the data were empirically collected with students, and the questionnaires were applied inside the school, in the classroom itself of the class in which the students are enrolled and with the presence of the teacher (a) and the researcher, and the result was kept in a safe place, in order to guarantee the confidentiality of the information, preserving the individual's right to freedom of expression and privacy, environmental education and educational actions that contribute to the training of conscientious citizens in relation to the preservation of the environment capable of taking decisions on environmental issues necessary for sustainable development.

We surveyed 40 teachers, and only 22 (teachers) worked in high school, but the survey respondents were exactly 13. Among them, 31% were male and 69% female. Among the participants of the research, 15% are between 20 and 30 years old; 61% between 31 and 40 years; 23% from 41 to 50 years and only 1% with age above 51 years. Regarding marital status, of the 13 teachers, 54% are married and 46% are single. 69% of the teachers in the school have an effective link with the State Department of Education and 31% in the PSS (Simplified Selective Process) regime.

The training of the 13 participants was based on the interviews with the teachers, where they can affirm their respective ones where (2), science teachers, and (2), Portuguese speakers the other 9), distributed in the formations according to figure 3.

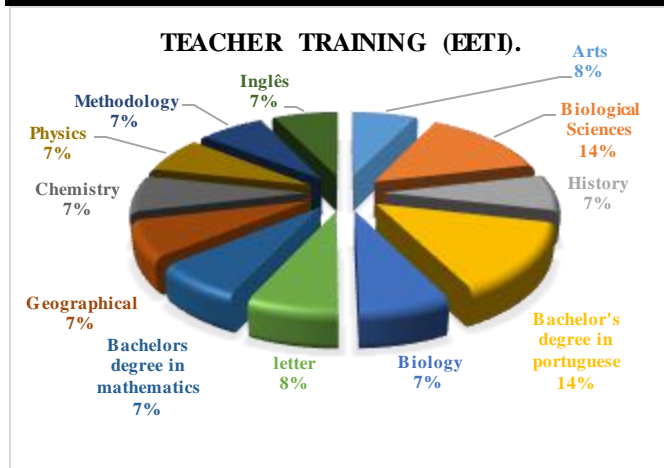


Fig.3: Teacher Training.  
Source: Authors (2018).

The profile of the science classes are the same in the classroom in its highest level of teaching and the lectures, figure 6 shows this disposition well.

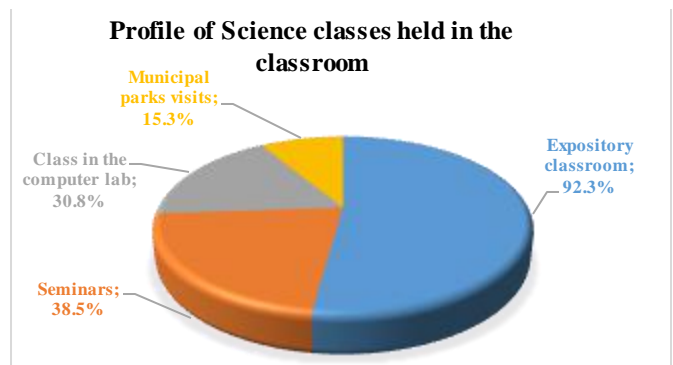


Fig.6: Profile of the Science Classes in Sala.  
Source: Authors (2018).

As for the discipline that teachers teach, it is possible to identify that the majority of science and the language of Portuguese is the ones, but as shown in Figure 4.

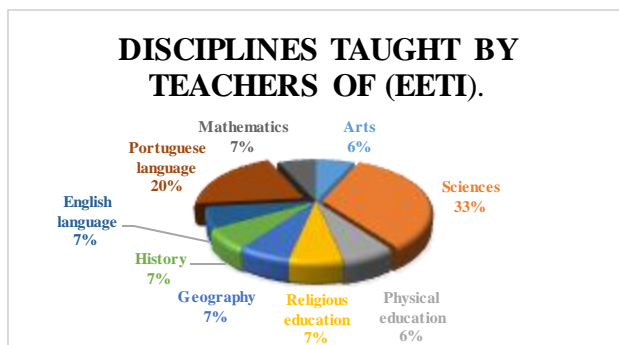


Fig.4: Disciplines Taught by Teachers of (EETI).  
Source: Authors (2018).

Environmental issues are addressed as often as in the classroom, according to teachers the main issues are about global warming; water bodies / rivers and seas; selective collection and the environment in general, as shown in figure 7.

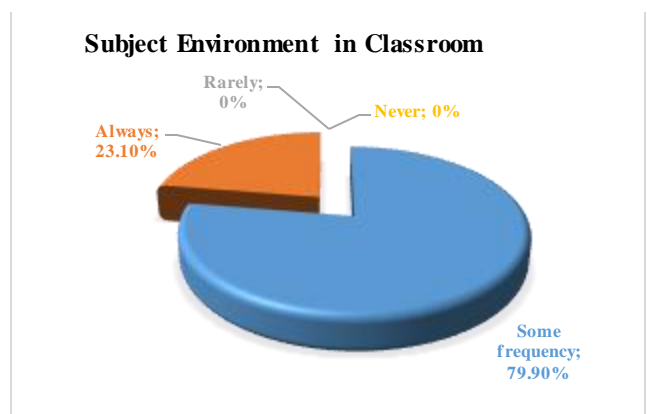


Fig.7: Subject Frequency Environment in the Classroom.  
Source: Authors (2018).

As for the time worked in school, it was possible to identify that, of the (13), teachers only (2), have 6 years of work time and (4), teachers are in school for 3 years; (1), (1), teacher at 5 years; (1), teacher at 4 years; (1), teacher at 2 years; (1) teacher at 1 year and the others at months, as shown in figure 5.

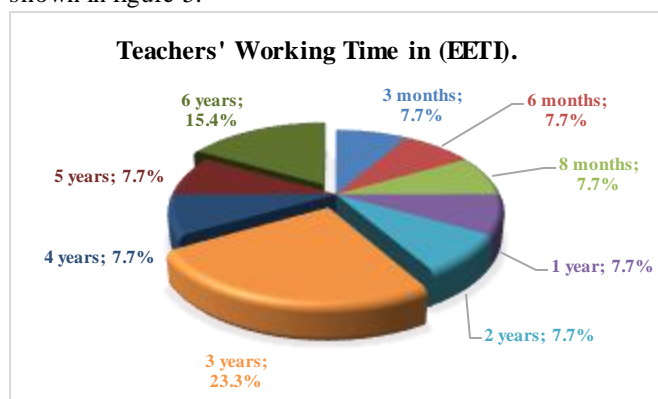


Fig.5: Teachers' Working Time in (EETI).  
Source: Authors (2018).

The students of Escola de Integral Engenheiro and Professor Sérgio Alfredo Pessoa Figueiredo are very interested in the Environment Theme, although most of them live near the school that is next to a forest reserve, figure 8 shows this disposition well.

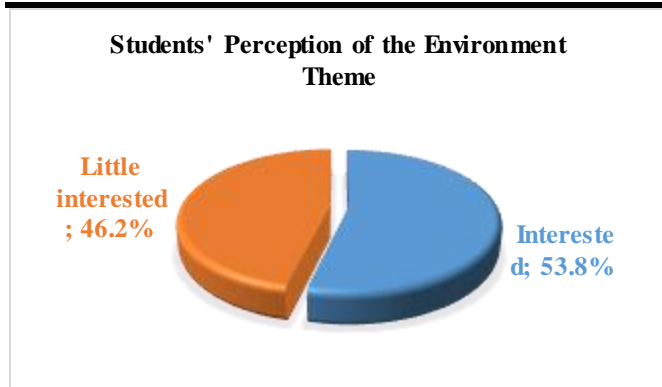


Fig.8: Environment theme.  
 Source: Authors (2018).

At school there is a Selective Collection Project, in some environments, according to teachers' reports, so figure 9 shows the classification of the collection.

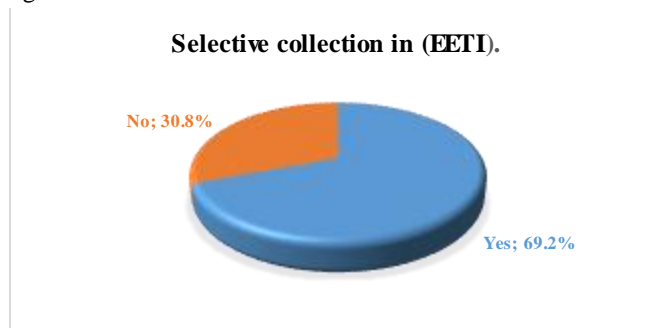


Fig.9: Selective collect.  
 Source: Authors (2018).

The Environmental Themes are inserted in the middle classes, mostly through specific projects; Class planning, figure 10 shows the percentage of this provision.

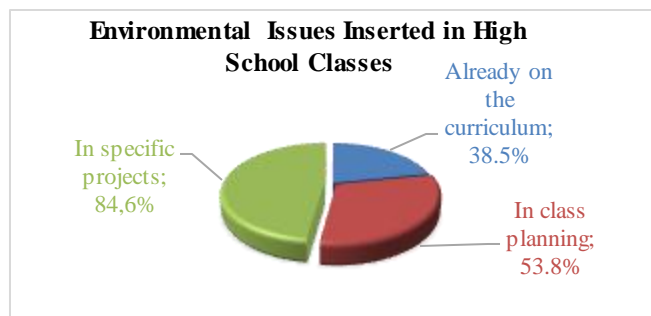


Fig.10: Subjects inserted in high school classes.  
 Source: Authors (2018).

The activities carried out in the AdolphoDucke Reserve with the students are frequent according to the teachers' reports, figure 11 shows in percentages these activities.

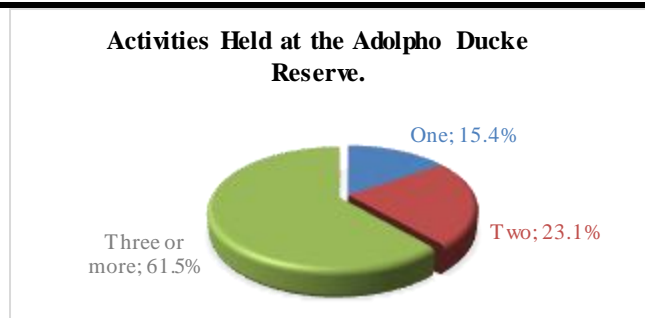


Fig.11: Activities in AdolphoDucke Reserve.  
 Source: Authors (2018).

In this way, the interviews with the in-wanted teachers were carried out in the research process entitled: The interdisciplinary practice of high school teachers of natural sciences (Physics Biology and Chemistry): focusing on the environment in the full-time school prof. eng.Sérgio Alfredo Pessoa Figueiredo in the municipality of Manaus-AM.

### 5.1 RESULTS OF THE RESEARCH WITH THE MANAGER

The manager is over 51 years of age and his or her position in the School is statutory has a degree in Literature. The time of service in the School is 6 years, reported that the school attends the Secondary School and Final Years as shown in figure 12.

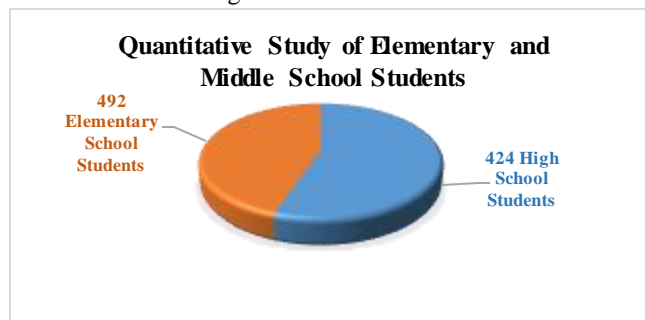


Fig.12: Student Quantitative.  
 Source: Authors (2018).

The teachers who work in the school are 18 of the High School and 22 of the high school, figure 13 shows this percentage.

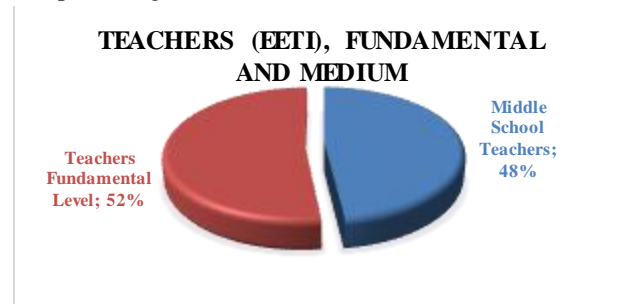


Fig.13: Elementary School Teachers and High School Teachers.  
 Source: Authors (2018).

According to the manager the school has specific projects to work Environmental Education with the students, these projects are already developed in the school, such as: Selective Collection; management of fruit plants; Study of water bodies; global warming. There are specific didactic materials in the school to work with Environmental Education, since it is located next to a reserve. In this aspect, two (2) teachers develop Environmental Education Projects in the Integral School of Engenheiro and Professor Sérgio Alfredo Pessoa Figueiredo thus making the interest sharpened by the issue of the environment, it says that it is not possible to measure the quantitative assessment of interested students, but states that most of the students are very interested in the environmental issue, which shows that the manager's statement is true, where in an interview with the 181 students, it was possible to identify how interested the students are with the question of the environment, as shown in figure 14.

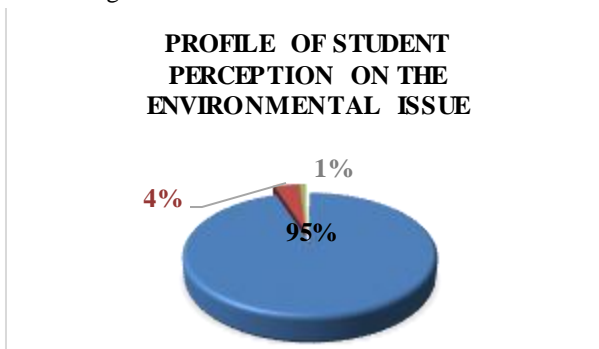


Fig.14: Profile of Students' Perception on the Environment.

Source: Authors (2018).

The manager affirms that there are Environmental Education projects per Area of Specific Knowledge, and that the science teachers are focused on the plans of lectures aiming at the AdolphoDucke reserve as the main lesson instrument.

**5.2 RESULT OF RESEARCH WITH STUDENTS**

In the field of research the data of the 181 students questioned in the study were asked the questions of the questions made with them and placed in a graph form where the data were presented on the school perception in the scope of Environmental Education and identified in their respective contexts, starting with the series as shown in figure 15.

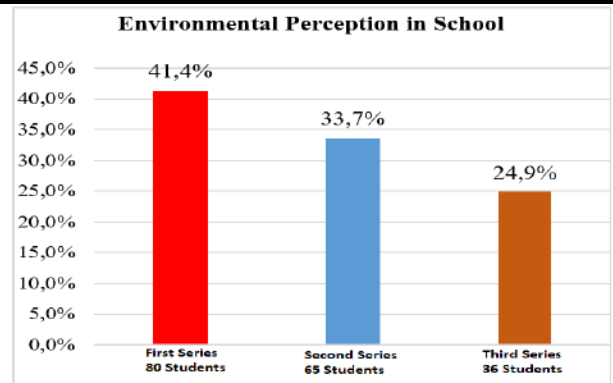


Fig.15: Environmental perception.

Source: Authors (2018).

It was possible to identify that the majority of the students of the State School Time Integral Prof. Eng. Sérgio Alfredo Pessoa Figueiredo are female, as shown in Figure 16.

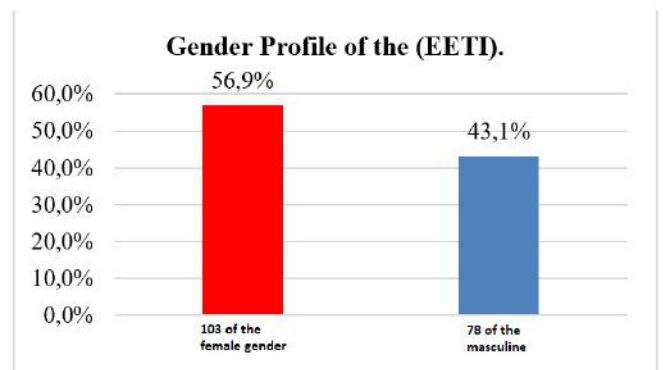


Fig.16: Gender Profile of Students.

Source: Authors (2018).

As for the question of interests, for the Environment of the students, in this sense it was easy to identify that in the majority the interest is very significant, although, there are still a significant number of students dispersed in relation to the environment in which they lived. Figure 17 shows this arrangement.

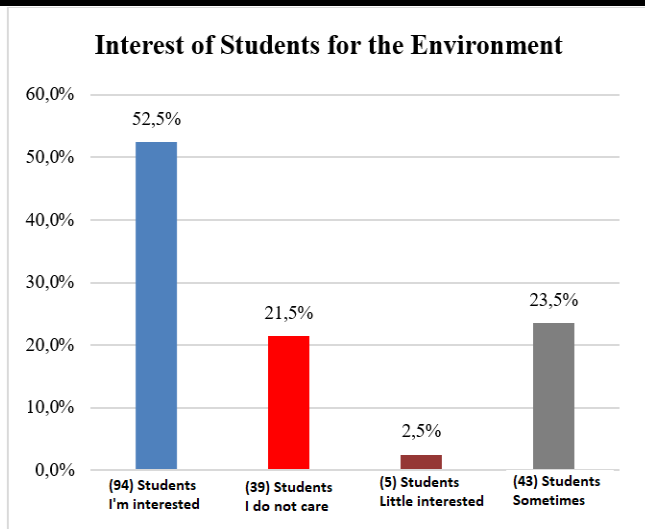


Fig.17: Interest in the environment.  
 Source: Authors (2018).

About where the students of Escola de Tempo Integral En-genheiro and Professor Sérgio Alfredo Pessoa Figueiredo acquired knowledge about the Environment of the (7), alter-nativas the pioneer is still the T.V. Figure 18 shows this provision.

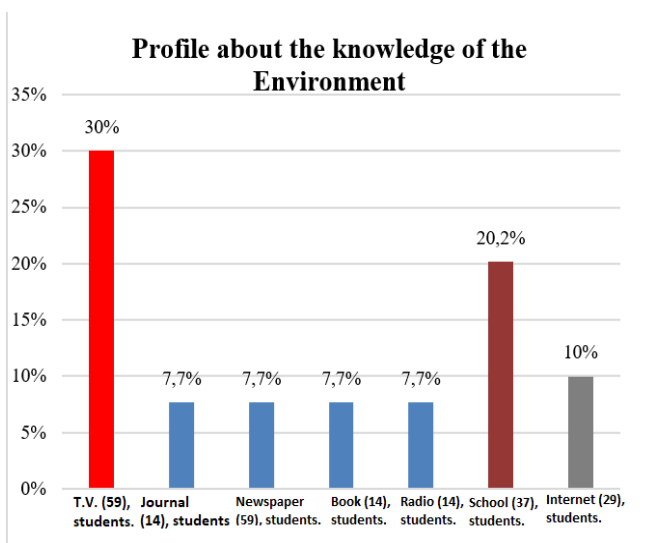


Fig.18: Where you learned about the Environment.  
 Source: Authors (2018)

Concerning the concern with environmental problems, the majority of students, as shown in figure 19, are concerned with the environment in which they live.

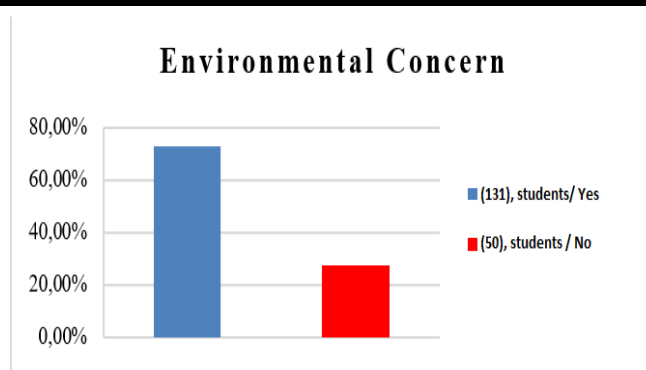


Fig.19: Concern about the Environment.  
 Source: Authors (2018).

On the students' knowledge about Environmental Preservation, it was possible to identify that most of them have knowledge about this subject as shown in figure 20.

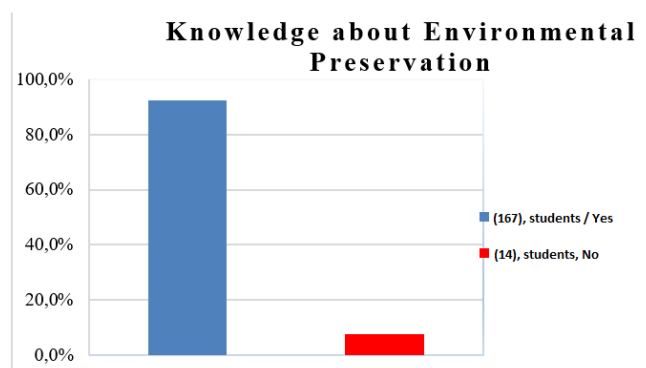


Fig.20: Knowledge about Environmental Preservation in (EETI).  
 Source: Authors (2018).

In the Integral Time School Engineer and Professor Sérgio Alfredo Pessoa Figueiredo in the classroom the teacher addresses environmental issues, as shown in chart 21.

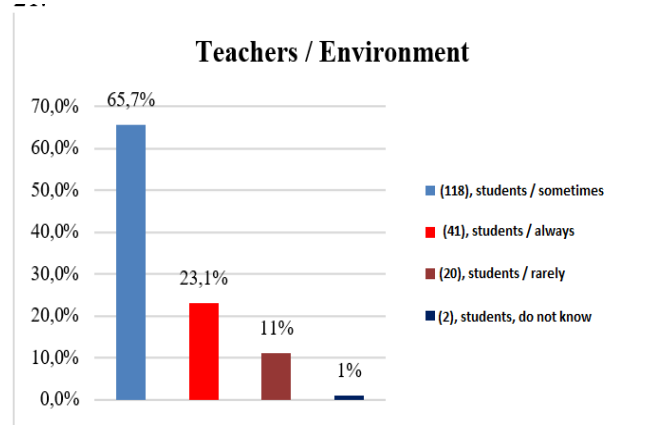


Fig.21: Teachers / Environment.  
 Source: Authors (2018).



On what occasion the theme "Environment" according to the students is approached Figure 22 shows this perspective.

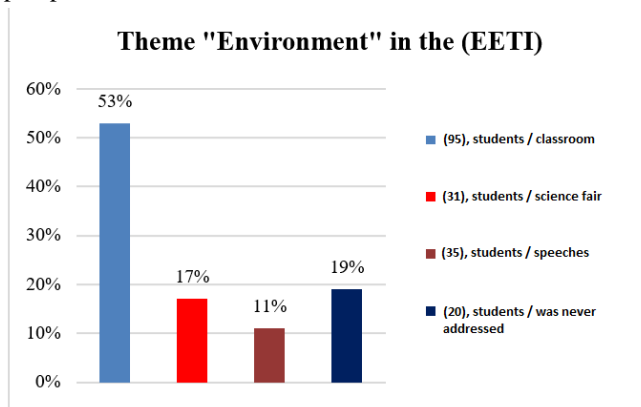


Fig.22: Theme "Environment".  
Source: Authors (2018).

The visit to the MUSA, is frequent most of the students, know the reserve AdolphoDucke those who do not know are mostly newcomers at school and others have not had the opportunity to meet, figure 23, discusses this provision.

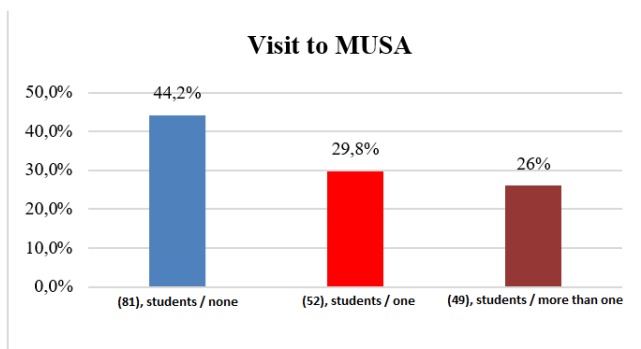


Fig.23: Visit to MUSA.  
Source: Authors (2018).

The school has a Selective Collection project according to the students, figure 24, illustrates this provision well.

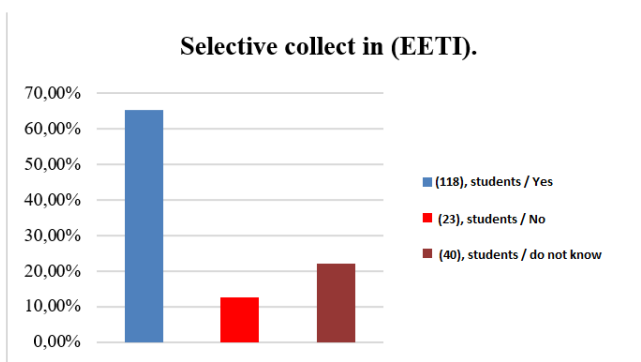


Fig.24: Selective collect  
Source: Authors (2018).

The main discipline that the teacher addresses the environment issue most often is Science, as shown in figure 25.

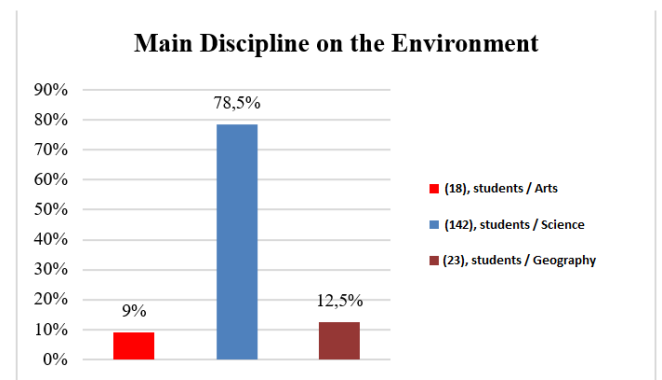


Fig.25: Main Discipline on the Environment.  
Source: Authors (2018).

In this way, the importance of the interdisciplinary practices of the Science Teachers as a pedagogical intervention in the Environmental Education of the high school students in the School of Integral Time in the Municipality of Manaus - AM was worked out in the form of a conversation wheel.

With the focus on analyzing the interdisciplinary pedagogical practice of professors of Sciences of the High School of Prof. Eng. Sérgio Alfredo Pessoa Figueiredo, located in the city of Manaus, it was possible to identify through the analysis of the results that the Teachers have Interdisciplinary Practices, besides the classes through seminars, lectures and visits to the (MUSA).

The Museum of the Amazon - Musa completes 11 years of creation. Located in the AdolphoDucke Forest Reserve, in the eastern part of Manaus, it has developed events and activities for 11 years in order to popularize and deepen the historical, cultural and scientific significance of the communities and biomes of the great Amazon Basin. means of research and exhibition for educational and tourist purposes. The Muse for the School of Integral Engenehiro and Professor Sérgio Alfredo Pessoa Figueiredo has the purpose of presenting the students to nature, plants and animals, where they grow and reproduce. For this to be possible, students should be well informed before entering the world of the forest, Figure 26 illustrates the students of the School of Integral Engineer and Professor Sérgio Alfredo Pessoa Figueiredo visiting the MUSA, leading the pedagogical practices of teachers



Fig.26: Interdisciplinary Practices of Teachers and Students of the (EETI).

Source: Authors (2018).

Thus, teachers in their classes in the forest correlate the didactic content to the students' school space, so that they understand and value the objectives and teachings of the science discipline, developing in each one an interest in preserving the environment.

Therefore, it is necessary to ensure that these students, who live in a city with countless natural beauties, can become aware of the implementation of environmental actions, aiming in particular for the sustainable development of the same, since according to the understanding of Wagner et al. (2011), environmental education may be the only way to minimize the negative environmental effects of tourism in natural and protected areas by giving real examples of appropriate behavior for visitors. An example of this is the AdolphoDucke Reserve as shown in figure 27.



Fig.27: Environmental Education Reserve AdolphoDucke.

Source: Authors (2018).

According to Torres, Almeida and Vasconcelos (2015), the teaching of sciences can reflect in students the abstract knowledge built on the environment, in addition to developing their autonomy and competence in relation to

communication, critical thinking and decision-making, which form the basis for lifelong learning.

According to the first specific objective whose idea was to raise theoretical-practical-methodological data used in the process of teaching science learning in this aspect of the science classes, they are carried out in the classroom mostly as reported by teachers in classes expository

According to Zaballa (2010, p. 119), "it is necessary to provide opportunities for students to participate more and more intensively in the resolution of activities and in the process of personal development, rather than simply copying and reproducing instructions or explanations of teachers ". Therefore, the student of the Escola Estadual Tempo Integral Prof. Eng. Sérgio Alfredo Pessoa Figueiredo is invited to search, discover, construct, critique, compare, dialogue, analyze, experience the process of knowledge construction itself in the exposition classes as shown in figure 28.



Fig.28: Exhibition classes.

Source: Authors (2018)

Environmental issues are addressed as often as in the classroom, according to teachers the main issues are about global warming; water bodies / rivers and seas; selective collection and the environment in general.

The second specific objective It sought to know the interdisciplinary practice of the professors focused on the use of the natural space of the AdolphoDucke Reserve in Science classes, where they questioned about their interest the students of the School of Integral Engineer and Professor Sérgio Alfredo Pessoa Figueiredo they are very interested in the environmental theme, although most of them live next to a forest reserve, and 53% of these students, as shown in graph 10 of the results analysis, are Trobat (2015, p. 34), states that "in order to achieve the goals of environmental education it is necessary to know how people think and act, with a view to planning educative, formative, informative and motivational actions that promote responsible behaviors.

In this context, the third specific objective contextualized that it is noticeable that the AdolphoDucke Reserve,

provides students with useful information, through pedagogical practices that favor daily interaction, which is fundamental for the individual's learning and their relationship with the environment that lives, starting to interact with the pedagogical process.

According to Dantas (2014, 247), writes that "the student is not only the subject of learning; it is also the one who learns from the other what the social group produces: values, language and knowledge itself." Thus it becomes clear the necessity of an education conception based on principles that involve participatory action and practice of knowledge in a context of continuous construction.

Therefore, the students of the School of Integral Engenheiro and Professor Sérgio Alfredo Pessoa Figueiredo, visit the (MUSA), Museum of the Amazon frequently, and also know the AdolphoDucke reserve the ones they do not know for the most part are newcomers to school and others have not yet had the opportunity to know each other. In this respect, Dias (2014, p. 32) argues that "environmental education should act as a set of environmental contents and practices, aimed at solving day-to-day problems with an interdisciplinary and active and responsible participation of each student".

The fourth specific objective identified the level of environmental perception of the students, in relation to the contents taught in the classroom, related to the conservation and protection of the environment, so the students, for the most part, seek to be perceptive, Schultz (2010) explains that, "Unquestionably, environmental problems are social issues caused by human behavior and their solution will require changing individual and social behavior." Therefore, it was important to know that the students of the School of Integral Engineer and Professor Sérgio Alfredo Pessoa Figueiredo, have the perception of the problems that exist around them.

Although the obligation to think about means that benefit groups of students to know the problems of their environment, Freitas (2017) clarifies that "student must develop their activities, encouraging their perceptions in order to reflect on the medium in which they are inserted. Visualizing the possible spaces of action; realization and understanding of the role for the conservation of the environment.

According to Davi (2011), conceptualizes that perception "is the procedure of reservation of the interpretation of methodological data (practice), teacher to develop a teaching with awareness of the environment, clearly showing the perception." Morin (2013) considers that "environmental perceptions are not static and the reflective look towards the environment allows a holistic vision capable of inducing behavioral changes".

The environmental perception of the students of the Escola Estadual Tempo Integral Prof. In this natural habi-

tat the students practically live and make a point of preserving, figure 29 illustrates how important is the perception.



Fig.29: Perception of the students.

Source: Authors (2018).

It is in this context that the students of the School of Integral Engineer and Professor Sérgio Alfredo Pessoa Figueiredo are environmentally educated, it is important to affirm that this environment is not an alternative but a privilege for the conscientization, in relation to the need to preserve the natural patrimony.

The fifth objective of the study was to elaborate a proposal for preservation and conservation of the environment at the Integral School of Engineering and Professor Sérgio Alfredo Pessoa Figueiredo Educational School of Integral Time in the city of Manaus with a view to consolidating the basic environmental principles in this thinking Dantas (2014), who teaches that "it is of utmost importance to preserve nature, to preserve the environment is fundamental to maintaining the health of the planet and all living beings living in it." "To celebrate the effort to protect natural resources, ecology is the science that studies the relationships between living beings and the environments in which they live" (WAGNER et al., 2011).

The proposal is to make the student participatory in some way so that this happens, it is enough to elaborate a lesson plan that follows the following steps during the school year where the students can have knowledge of the schedule proposed to them as shown in table 5.

Table.5: Proposal Schedule.

Program for the Preservation and Conservation of the Environment in the (EETD).				
Preservation / Conservation	1° Semester	2° Semester	Month/Year	Expository classroom
Watersaving	X		18/02/2019	Adolpho Forest Reserve
Energy saving		X	05/08/2019	Musa / Museum

Shopping Savings	X		18/03/2019	Classroom
Selective collection practice		X	05/09/2019	Adolpho Forest Reserve
Recycling practice	X		18/04/2019	Adolpho Forest Reserve
Management of fruits		X	05/10/2019	Musa / Museum
Seed management	X		18/05/2019	Adolpho Forest Reserve
Identification of sheets		X	05/11/2019	Adolpho Forest Reserve
Management of wild animals	X		15/06/2019	Musa / Museum
Disposable products		X	05/12/2019	Adolpho Forest Reserve

Source: Authors (2018).

The School Prof. Eng. Sérgio Alfredo Pessoa Figueiredo, through the circular informs a week before how, when and who will minister the class extraclass.

The objective of the proposal was to promote an adequate methodology to generate changes in the environmental realities, having as real motivation the liberating consciousness and the struggle for transformations, that is, the desire for change. Zaballa (2010), states that "this approach is qualitative and characterized as an action study in which teachers must adopt the method of participant observation, which entailed the construction of workshops in which students were proposed to reflect and develop an understanding of the importance of the environment and the search for improvements in the environment and life. "O sexto objetivo foi propor o desenvolvimento de práticas pedagógicas interdisciplinares em (EA), como ferramenta, para compreensão dos problemas ambientais local.

According to Carvalho (2016: 71), (EA), "it is initially analyzed as a prevention of ecological movements with the practice of awareness, being able to draw attention to the poor distribution of access to natural resources," as well as to their exhaustion, and thereby involve citizens in environmentally-minded social actions.

In the conception of Dias (2014), the (EA) "in school should not be a conservationist, that is, one whose teachings lead to the rational use of natural resources and the maintenance of an optimal level of productivity of Natural or managed ecosystems by Man, but that education focused on the environment that implies a profound change

of values, in a new vision of the world, which far surpasses the conservation state. " Environmental Education is a topic that is much discussed today because of the perceived need to improve the world we live in, because it is easily seen that we are increasingly regressing in our quality of life, letting ourselves be carried away by our obligations daily. (GUESTS, 2016).

Environmental education plays a transformative role in the lives of educators, although it is a great challenge to overcome the aim of changing habits and attitudes of the human being with the environment.

## V. CONCLUSION

The study sought to analyze the interdisciplinary pedagogical practice of teachers of High School Sciences in the School of Integral Prof. Eng. Sérgio Alfredo Pessoa Figueiredo, located in the municipality of Manaus. In view of the fact that every school has norms and rules, it is difficult to suggest interdisciplinary pedagogical practices that will be an integrative action of the disciplines, in a enriching Perspective in Environmental Education, overcoming the fragmentation of knowledge and promoting the interaction of humans with nature.

The conservation of the environment demands a new educational posture, with pedagogical practices, where the classes are not limited to the dialogical expositions in the classroom, on the contrary, it requires a new model of teaching and learning in an interdisciplinary way as well as the collective construction of knowledge by teachers and students in the course of the educational process.

Thus, the Integral Time School Engineer and Professor Sérgio Alfredo Pessoa Figueiredo uses practical methodological data with the interest of trying to make environmental themes a constant presence in classrooms, Environmental Education is inserted in the school curriculum, as theme. According to the National Curricular Parameters (NCPs)

Therefore, the interdisciplinary practice of teachers turns to the use of the Ducke Reserve's natural space in science classes and thus bring Environmental Education into classrooms and show young people that preserving the environment is not a luxury, but a need urge you to preserve the planet.

## VI. ACKNOWLEDGMENT

The Postgraduate Program in Science and Environment of the Institute of Exact and Natural Sciences of the Federal University of Pará (PPGCMA/ICEN/UFGPA) and the ITEGAM for the support of Research.

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# Origin and branching of the phrenic nerve (*Sus scrofa domestica* Linnaeus, 1758) of the Pen Ar Lan Line

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**Abstract**— Swine farming has increasingly developing worldwide due to advances in genetic improvement, thus, researchers are investigating possible anatomical variations in new lineages. The objective of this study was to assess the origin and branching of the phrenic nerve in 27 swine (*Sus scrofa domestica* – Linnaeus, 1758) fetuses of the Pen Ar Lan line—19 males and 8 females. They were dissected after fixing in a 10% formaldehyde solution. The phrenic nerve originated from 51 (94.4%) antimeres of the fifth cervical spinal nerve (C5), 54 (100%) antimeres of the sixth cervical spinal nerve (C6), and six (11.11%) antimeres of the seventh cervical spinal nerve (C7). Considering this distribution, the phrenic nerve emitted fibers to the pericardium and branched into the diaphragm muscle in all specimens evaluated. Six different branching were found, most frequently in the dorsal, lateral, and ventral branches in 22 (40.74%) antimeres, followed by branching to dorsal branches and ventrolateral trunk in 18 antimeres (33.33%). In addition, two of the branching found are not cited in scientific literature, denoting their variability. The dorsal branches were distributed to the pillar muscles in the lumbar part, the ventral branches to the sternal part, and the lateral branches to the dorsal part.

**Keywords**— Peripheral nervous system, Cervical plexus, Diaphragm muscle.

## I. INTRODUCTION

Swine farming has increasingly developing worldwide due to advances in genetic improvement focused on producing precocious animals, and improving their growth speed, production, and reproduction. Thus, researchers are investigating anatomical variations in current swine lines [1].

The Pen Ar Lan line is from Denmark; it is obtained by crossing animals from the Landrace and Large White lines, which is frequently used by Brazilian pig farmers for breeding, and is developed by Brazilian companies in partnership with foreign laboratories [2].

The phrenic nerve in pigs is formed by ventral branches of the fifth (C5), sixth (C6), and seventh (C7) cervical spinal nerves; the roots of the C5 and C7 are thin. These roots converge in a single trunk at the level of the seventh cervical vertebra and, then, are distributed into the diaphragm muscle [3].

Studies on the origin, branching, and distribution of the phrenic nerve have been conducted on *Callithrix jacchus* [4], *Dasysprocta agouti* [5], *Capra hircus* [6], and domestic cats [7]. Several studies on pigs describe the origin and distribution of various nerves, such as the femoral, sciatic, and rectal caudal nerves [1, 8-9]. However, none of them give information on the origin and distribution of the phrenic nerve in swine fetuses of the Pen Ar Lan line.

In this context, the objective of this study was to analyze the origin and branching of the phrenic nerve in swine (*Sus scrofa domestica* – Linnaeus, 1758) fetuses of the Pen Ar Lan line.

## II. MATERIALS AND METHODS

Twenty-seven swine (*Sus scrofa domestica* – Linnaeus, 1758) fetuses of the Pen Ar Lan line—eight females and 19 males—were used in the present study. The animals belonged to the Animal Anatomy Laboratory of the Faculty of Veterinary Medicine of the Federal University of Uberlândia, Minas Gerais, Brazil.

The specimens were fixed through an incision in the dorsal-ventral direction at the level of the ninth

intercostal space; the thoracic aorta was then individualized and two cannulas were introduced—one in the cranial and other in the caudal direction—to inject a 10% formaldehyde solution; then, the animals were submerged in opaque vats containing a solution at the same concentration.

The dissections began with the removal of the cutaneous and adipose tissues from the cervical and thoracic regions. Then, a median incision was made in the cranioventral direction ventrally to the jaw bone, passing medially through the sternum bone to its xyloid process, to access the mediastinum region.

The trachea, esophagus, and muscles of the cervical region were folded to visualize the cervical and thoracic vertebrae, mainly the costal process of the sixth cervical vertebra, and the first rib, which are important reference points; thus, it was possible to identify the actual origin of the phrenic nerve.

Dissections were performed in the mediastinum regions to verify the distribution of the phrenic nerve; this distribution was observed in the diaphragm muscle.

When necessary, an 8x-magnifying glass was used to visualize the structures. The documentation was made from schematic drawings and photographs of the origins and distributions of the phrenic nerves, and the nomenclature used was based on the *Nomina Anatomica Veterinaria* [10].

The statistical analysis for the origins and branching of the phrenic nerve was based on descriptive analysis with simple percentage.

### III. RESULTS

The evaluation of the 27 swine fetuses of the Pen Ar Lan line showed that the phrenic nerve originated from the union of the ventral branches of the cervical nerves, and the contribution to its formation is variable. The nerve originated from 51 antimeres (94.4%) of the ventral branches of the fifth cervical spinal nerve (C5), 54 antimeres (100%) of the ventral branches of the sixth cervical spinal nerve (C6), and six antimeres (11.11%) of the ventral branches of the seventh cervical spinal nerve (C7) (Table 1).

Table 1. Individual contribution of the ventral branches of the cervical spinal nerves to the formation of the phrenic nerve in swine (*Sus scrofa domestica* Linnaeus, 1758) fetuses of the Pen Ar Lan line, in the right and left antimeres. Uberlândia, MG, Brazil, 2018.

Individual contribution			
Cervical spinal nerve	Right antimeres	Left antimeres	Overall
C5	26 (96.29%)	25 (92.59%)	51 (94.4%)
C6	27 (100%)	27 (100%)	54 (100%)
C7	2 (7.4%)	4 (14.81%)	6 (11.1%)

The phrenic nerve originated from 48 antimeres (88.88%) of the ventral branches of the C5 and C6; three antimeres (5.55%) of the C5, C6, and C7; and three antimeres (5.55%) of the C6 and C7. The phrenic nerve presented symmetry in relation to its origin in 23 animals (85.18%), i.e., the nerve roots that originated it in both

antimeres coincided in number; in the case of asymmetry, this coincidence was not observed. This symmetry occurred by the union of the ventral branches of C5 and C6 in 22 specimens (81.48%) and by the union of the ventral branches of C6 and C7 in one animal (3.7%).

Table 2. Combined contribution of the ventral branches of the cervical spinal nerves to the formation of the phrenic nerve in swine (*Sus scrofa domestica* Linnaeus, 1758) fetuses of the Pen Ar Lan line, in the right and left antimeres. Uberlândia, MG, Brazil, 2018.

Joint contribution			
Cervical spinal nerves	Right antimeres	Left antimeres	Overall
C5 and C6	25 (92.59%)	23 (85.18%)	48 (88.88%)
C5, C6, and C7	1 (3.70%)	2 (7.40%)	3 (5.55%)
C6 and C7	1 (3.70%)	2 (7.40%)	3 (5.55%)

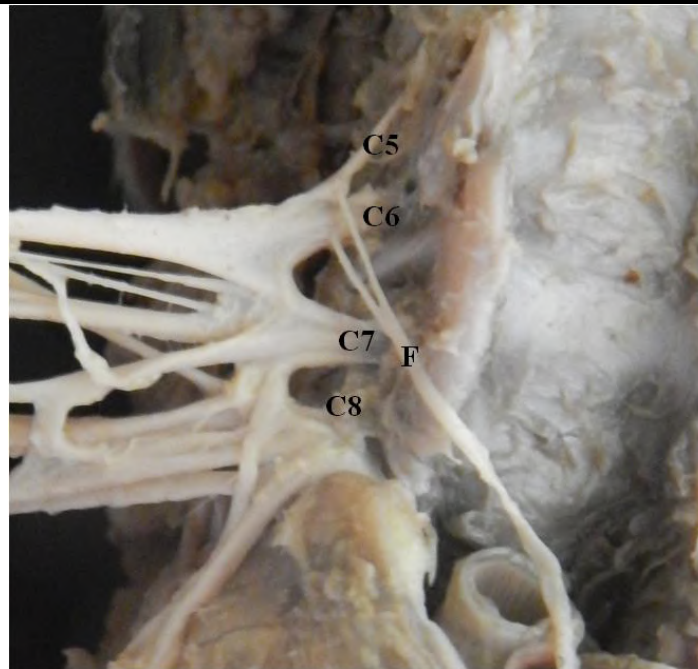


Fig. 1 Ventral branches of the cervical spinal nerves (C5 to C8) of swine (*Sus scrofa domestica*) fetuses showing the most common origin of the phrenic nerve (F) in C5 and C6.

The phrenic nerves of all fetuses evaluated (100%) crossed the lateral regions of the mediastinum region and emitted fibers to the pericardium and to the diaphragm muscle. Six types of branching were observed, most frequently the dorsal, lateral, and ventral branches in 22 antimeres (40.74%), followed by branching to dorsal branches and ventrolateral trunk in 18 antimeres (33.33%).

Terminal branching in ventral branches and dorsolateral trunk were also observed in three antimeres (5.55%); lateral branches, dorsal branches, and ventrolateral trunk in four antimeres (7.40%); dorsal and ventral branches in six antimeres (11.11%); and dorsolateral and ventrolateral trunks in one antimere (1.85%).

Terminal branches of the phrenic nerve presented symmetry in 11 specimens, which were identified in the branching of the dorsal branch and ventrolateral trunk of five specimens (45.45%); in the dorsal, lateral, and ventral branches of five specimens (45.45%); and in the lateral and dorsal branches, and ventrolateral trunk of one specimen (9.09%).

The branches were directed to specific regions of the diaphragm muscle, in which the dorsal branches were distributed to the pillar muscles in the lumbar part, the ventral branches to the sternal part, and the lateral branches to the costal part. After the divisions in branches and trunks, the branching to the peripheral portion of the diaphragm muscle differed according to the animal, possibly to all this diaphragm muscle had the necessary innervation for its functioning (Figure 2).

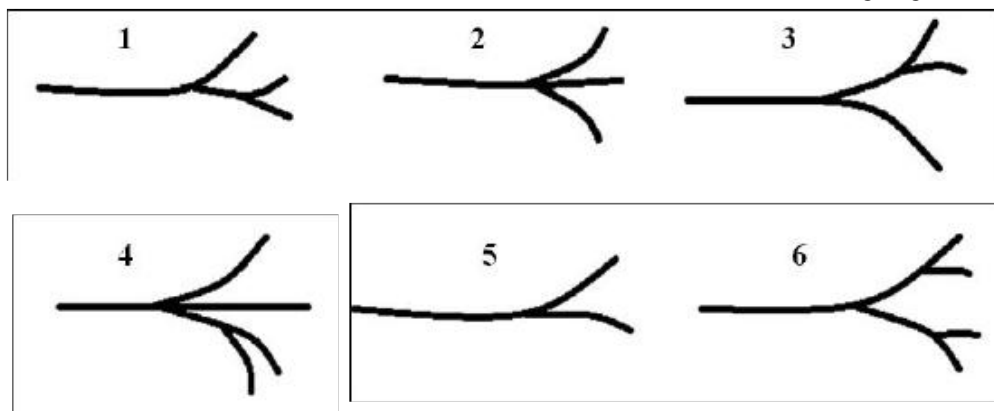


Fig. 2 Schematic drawing of the branching of the phrenic nerves in the diaphragm muscle in swine (*Sus scrofa domestica* Linnaeus, 1758) fetuses of the Pen Ar Lan line. Dorsal and ventrolateral (1); dorsal, lateral, and ventral (2); ventral and dorsolateral (3); lateral, dorsal, and ventrolateral (4); dorsal and ventral (5); and dorsolateral and ventrolateral (6).



Table 3. Branching types of the phrenic nerve to the diaphragm muscle in the right and left antimeres of swine (*Sus scrofa domestica* Linnaeus, 1758) fetuses of the Pen Ar Lan line. Uberlândia-MG, Brazil, 2018.

Branching	Antimere		Overall
	Right	Left	
Dorsal and ventrolateral	7 (25.92%)	11 (40.74%)	18 (33.33%)
Dorsal, lateral, and ventral	14 (51.85%)	8 (29.62%)	22 (40.74%)
Ventral and dorsolateral	2 (7.40%)	1 (3.70%)	3 (5.55%)
Lateral, dorsal, and ventrolateral	3 (11.11%)	1 (3.70%)	4 (7.40%)
Dorsal e ventral	0	6 (22.22%)	6 (11.11%)
Dorsolateral e ventrolateral	1 (3.70%)	0	1 (1.85%)



Fig. 3 Ventral perspective of the thoracic cavity of swine (*Sus scrofa domestica* Linnaeus, 1758) fetuses of the Pen Ar Lan line. Phrenic nerve in the mediastinum region and its distribution in the dorsal branch and ventrolateral trunk. Phrenic nerve (1); ventrolateral trunk (2); dorsal branch (3); pericardium (4); and diaphragm muscle (5).

#### IV. DISCUSSION

The origin and branching of the phrenic nerve in swine fetuses of the Pen Ar Lan line occur mainly through the contribution of ventral branches of the fifth cervical spinal nerve (C5) and sixth cervical spinal nerve (C6); ventral branches of C6 were found in all animals analyzed, confirming the results found by Almeida et al. (2008) [11] for Santa Inês sheep.

Combined contribution of the ventral branches of C5 and C6 was found in 48 specimens (88.88%), differing from the results found by Getty (1981) [3] for swine and ruminants, and by Dyce, Sack, and Wensing (2010) [11] for domestic ruminants, who reported that this nerve originates from the ventral branches of C5, C6, and C7; this configuration was found in three (5.55%) animals in the present study.

According to Miller (1979) [13] and Getty (1981) [3], phrenic nerve in dogs originates from ventral branches of C5, C6, and C7, with possible contribution of ventral branches of C4. No contribution of branches of C4 was found in the present study. The phrenic nerve of humans originates from ventral branches of C3 to C5 [14]. In the swine animals evaluated in the present study, this nerve originates from ventral branches of C5 in 94.4% of the antimeres, however, no contribution of the ventral branches of C3 and C4 was found.

The phrenic nerve was symmetric in relation to its origin in 23 animals (85.18%), i.e., the nerve roots that originated it coincided in number in both antimeres. Similar result was found by Almeida et al. (2008) for sheep; they found phrenic nerve symmetry in 63.33% of the animals.

According to Almeida et al. (2008) [11], the left phrenic nerve of Santa Inês sheep originates exclusively from ventral branches of C6 in 6.67% of the animals. However, the phrenic nerve of all animals analyzed in the present study was constituted by two or more ventral branches of spinal nerves, confirming its plurisegmental characteristic [15].

The primary source of the sensory fibers of the pericardium in humans is derived from the phrenic nerve [14]. Small filaments of fibers from the phrenic nerve to the pericardium were found in all swine fetuses, denoting the importance of this nerve in the nervous supply of the pericardium.

Six types of phrenic nerve branching were observed in the animals evaluated; the most frequent was the trifurcation in dorsal, lateral, and ventral branches, which was present in 22 antimeres (40.74%). Trifurcation in dorsal, lateral, and ventral branches was observed in 25% of domestic cats [7]; 11.8% (right antimeres) and 23.5% (left antimeres) of *Dasyprocta agouti*; 32.5% (right antimeres) and 12.5% (left antimeres) of goats [6]; with no predominance of trifurcation.

Moreover, the trifurcation in dorsal, lateral, and ventral branches presented symmetry in both antimeres in five specimens (45.45%). Similarly, Carvalho et al. (1996) [5] and Miglino et al. (1985) [6] found symmetry in one (*Dasyprocta agouti*) and three (goats) animals, respectively.

Branching to dorsal branch and ventrolateral trunk was the second more frequent, found in 18 antimeres (33.33%) of the swine fetuses evaluated. This type of branching was found in 6.66% of cats [7]; 17.6% (right antimeres) and 41.2% (left antimeres) of *Dasyprocta agouti* [5]; and in 40% (right antimeres) and 75% (left antimeres) of goats [6]. Symmetry in this branching was found in five antimeres (45.45%), similar results to those found by Moreira et al. (2007) in two domestic cats; and by Miglino et al. (1985) [6] in 13 goats.

Branching to dorsolateral trunk and ventral branch was the most common for domestic cats (63.33%) [7], and was found in 64.77% (right antimeres) and 23.5% (left antimeres) in *Dasyprocta agouti* [5]. Contrastingly, this branching was found only in 5.55% of the antimeres of the animals analyzed in the present study.

Two branching of the phrenic nerve found in the Pen Ar Lan swine fetuses were not found in the scientific literature, denoting the variability of the branching of this nerve. This branching in lateral and dorsal branches and ventrolateral trunk was verified in four antimeres (7.40%), and the division in dorsal and ventral branches was found in six antimeres (11.11%).

Most studies found on the phrenic nerve refer to adult animals. The use of fetuses in the present study, and

by Rosa (2012) [8], Lizardo et al. (2013) [16] and Santos et al. (2013) [1] is to make easier the obtaining and handling of the material when compared to the use of adult animals.

Ferraz et al. (2006) [17] studied the intra-pelvic part of the ischiatic nerve of fetuses of Zebu cattle and reported that it is probable that the sciatic nerve of adult animals presents similar origin and position to that found in the fetuses, considering the proportions between nervous system structures and adjacent tissues. Thus, it is assumed that it is also true for the origin and distribution of the phrenic nerve in the swine fetuses of the Pen Ar Lan line.

All the anatomical variations of the phrenic nerve origin and branching found and reported in the present study are important in cases of affections, and for clinical or surgical approaches that involve or compromise these structures.

## V. CONCLUSIONS

The phrenic nerve of swine (*Sus scrofa domesticus* – Linnaeus, 1758) fetuses of the Pen Ar Lan line originates from the fifth cervical spinal nerve (C5) to the seventh cervical spinal nerve (C7), with higher contribution of C5 and C6. It emitted fibers to the pericardium and to the diaphragm muscle.

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# Detecting anti-patterns in SQL Queries using Text Classification Techniques

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**Abstract**— A major problem with using relational databases, is writing efficient SQL queries. Some common errors known as anti-patterns are frequent in SQL queries and can seriously impact the query execution time and sometimes, the database general performance. This paper shows how machine learning techniques can be leveraged to detect anti-patterns in SQL queries by approaching the problem as a text classification problem. Our result is a model based on a convolutional neural network that can be used to classify a SQL query into zero, one or many anti-patterns classes.

**Keywords**— SQL, relational database, text classification techniques.<sup>1</sup>

## I. INTRODUCTION

With the increasing amount of information stored in relational databases, it is necessary to write SQL queries that execute faster. Anti-patterns in SQL are common mistakes that if avoided, can make a query executes faster. For example, when query-ing an indexed column, replacing the OR operator with the IN operator, will result in better performance, because the IN operator leverages the index. Thus, using the OR operator in this case, is an anti-pattern.

```
SELECT url FROM pictures WHERE
    id = 10 OR id = 20
    can be rewritten as
SELECT url FROM pictures WHERE
    id IN (10,20)
```

By detecting the anti-patterns in a query, we can rewrite it into a better version. In this paper, we approach the

problem as a multi-class multi-label classification problem. Our solution is schema-independent, meaning that the decision made by the neural network doesn't depend on the database logical or physical structure. The dataset used has been built from SQL queries provided by Sky-Server from Sloan Digital Sky Survey (SDSS).

SkyServer, the portal from the SDSS catalog, provides data access tools for astronomers and scientific education. Through SkyServer, users can use the SQL language to query the Sloan Digital Server database. Since 2001, the portal has seen more than 280 million SQL queries submitted by users and those queries have been opened to the public through the different data releases. We fetch 1 million queries from SkyServer, that we filter, process and transform. The final dataset of usage contains 363616 unique SELECT queries.

Following a supervised learning approach, the SQL queries from SkyServer are used as input data; we manually label the data by associating each SQL query with a list of anti-patterns it contains.

Our model is based on a convolutional neural network trained to classify a query into multiple categories. We use the one-hot encoding technique to encode the queries as word vectors. For encoding the anti-patterns classes we use a one dimensional tensor with each class represented as an integer.

We explore some of the important work in the field of SQL anti-patterns detection in section 2. In section 3, we explain in details the process followed to build the dataset. Then, we discuss our model architecture in section 4. In section 5, we analyze the results from our experiments. Finally in the conclusion, we compare our work to the existing solutions and explore the possible future work.

## II. RELATED WORK

Common mistakes in SQL has been already in the interest of researchers before the appearance of the ISO SQL-92 standard. In 1985, Welty studied how human factors can affect users in using SQL and found that user performance could be significantly improved. Later, Brass et al. started working on the automatic detection of logical errors in SQL queries and extended their work with the recognition of common semantic mistakes. They implemented the

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SQLLint tool which was able to automatically identify these errors in (syntactically correct) SQL statements. The tool seems to be unsupported today. There is another online tool named SQLLint, but it is a SQL beautifier.

There are also books in this area. The Art of SQL and Refactoring SQL Applications provide guidelines to write efficient queries, while the book of Bill Karwin collects antipatterns that should be avoided.

In a paper, Ahadi et al., presented a large-scale analysis of students semantic mistakes in writing SQL SELECT statements. They collected data from over 2,300 students across nine years and summarized typical mistakes of the students. They found that most of the mistakes were made in queries which require a JOIN, a subquery or a GROUP BY operator. We argue that queries typically use more complex syntax in practice compared to student projects. Hence, the situation can be even worse.

In the realm of embedded SQL, Christensen et al. proposed a technique and a tool (JSA, Java String Analyzer) to extract string expressions from Java code statically. As a potential application of their approach, they check the syntax of dynamically generated SQL strings. They limit their approach to the syntactic validation of the queries.

Wassermann et al. propose a static string analysis technique to identify possible errors in dynamically generated SQL code. With the implementation of a CFL-reachability algorithm they detect type errors (e.g., concatenating a character to an integer value). Their approach works with extracted query strings of valid SQL syntax. In a tool demo paper, they present their prototype tool called JDBC Checker.

Recently, Anderson and Hills studied query construction patterns in PHP. They analyzed query strings embedded in PHP code with the help of the PHP AiR framework.

Quality assessment of embedded SQL was proposed by Brink et al. in 2007. They analyzed embedded query strings in PL/SQL, Cobol, and Visual Basic programs while they propose a generic approach which could be applied to Java too. They investigate relationships which could be detected through embedded queries (e.g., access, duplication, control dependencies) and they propose quantitative query measures for quality assessment.

Many static techniques which try to deal with embedded query strings do it with the purpose of SQL injection detection. Yeole and Meshram published a survey of these techniques. SQL injection detection is different as the goal is specifically to determine whether a query could be affected by user input.

Some papers also tackle SQL fault localization techniques. A dynamic approach was proposed by Clark et al. to localize SQL faults in database applications. They

provide command-SQL tuples to show the SQL statements executed at database-interaction points.

A recent work of Delplanque et al. targets the database to assess the quality of the schema and to detect design smells in it. They implement a tool called DBCritics which can analyze PostgreSQL schema dumps and identify design smells such as missing primary keys or foreign key references.

A tool which also has to be mentioned here is the Eclipse plugin called Alvor and JSA [17], this plug-in analyzes the string expressions in Java code. What is more, Alvor checks syntax correctness, semantics correctness, and object availability by comparing the extracted queries against its internal SQL grammar and by checking SQL statements against an actual database.

### III. DATASET

#### 3.1 Collecting the queries

We start building our dataset, by fetching 1 million successful SQL queries from the SkyServer catalog.

```
SELECT TOP 1000000 statement
FROM SqlLog
WHERE error = 0
```

Some of these queries need to be filtered out, in order to build a more focused dataset.

#### 3.2 Filtering

From the fetched queries, we remove the duplicates, so the dataset contains unique queries only.

```
allQueries = list(set(values))
```

As we focus on query anti-patterns, we remove all of the non SELECT queries.

```
import re
allQueries = list(
    filter(
        lambda item: re.search(
            "^select",
            item.lower()
        ),
        allQueries
    )
)
```

In the end, the dataset is reduced from 1000000 to 318188 queries.

#### 3.3 Transforming

In order to eliminate irrelevant information and reduce the size of our dataset vocabulary, we replace all of the schema-related terms contained in the queries with standard words. Thus the queries contain almost only standard SQL keywords.

SELECT name from students;  
 will be transformed to  
 SELECT column from table;

### 3.4 Annotating

Following a supervised learning approach, having SQL queries as input, we need to map each query to a set of anti-patterns as labels.

Our work is based on 16 common anti-patterns. To each of the query, we match a single anti-pattern. In fact, a single query can contain several anti-patterns, but for simplicity purpose, we only consider the most dominant anti-pattern. We explain in detail each anti-pattern in the Appendix section.

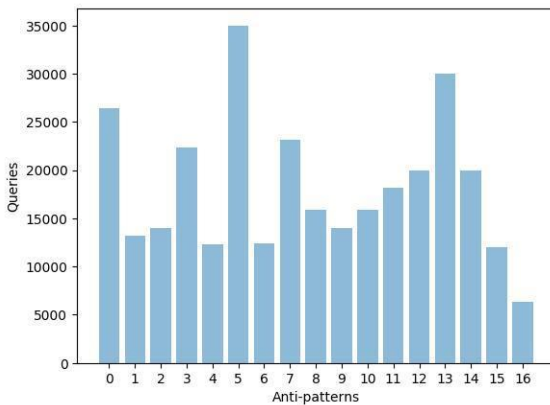


Fig.1: Dataset visualization

## IV. MODEL

### 4.1 Data Encoding

#### 4.1.1 Queries

Each SQL query in our current dataset is a list of words. Word representation methods generally fall into two categories. The first consists of methods such as one-hot vectors. This method is problematic due to homonymy and polysemy words. The other category consists of using unsupervised learning method to obtain continuous word vector representations. Recent research results have demonstrated that continuous word representations are more powerful.

In this paper, we use word embedding based on word2vec (Mikolov et al., 2013). To encode the SQL queries of our dataset, we choose to use the pre-trained google word2vec embedding. The model is trained on 100 billion words from Google News by using the Skip-gram method and maximizing the average log probability of all the words using a softmax function. Our result model contains 123.852 tokens.

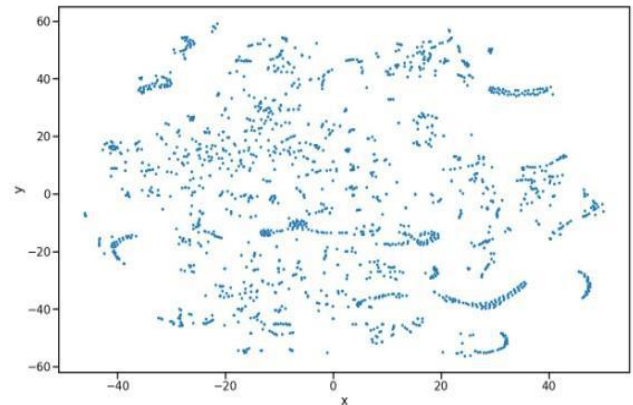


Fig.2: Queries Embedding

0	SELECT *
1	NULL Usage
2	NOT NULL Usage
3	String Concatenation
4	GROUP BY Usage
5	ORDER BY RAND Usage
6	Pattern Matching Usage
7	Spaghetti Query Alert
8	Reduce Number of JOINS
9	Eliminate Unnecessary DISTINCT
10	Implicit Column Usage
11	HAVING Clause Usage
12	Nested sub queries
13	OR Usage
14	UNION Usage
15	DISTINCT & JOIN Usage
16	No anti-pattern

Fig.3: Anti-patterns list

#### 4.1.2 Anti-patterns

As our work is based on 16 Fixed anti-patterns, we encode the label data as 1D Vector of integers.

### 4.2 Convolutional Neural Network

The convolution neural network is a state-of-the-art method to model semantic representations of sentences. The convolution action has been commonly used to synthesize lexical n-gram information. In our model, we use three different convolutional filters with varying convolution window size to form parallel CNNs so that they can learn multiple type of embedding of local regions so as to complement each other to improve model accuracy. The final output is the concatenation of the output of each.

**V. EXPERIMENTS**

5.1 Settings

For all our experiments, we use the Stochastic Gradient Descent optimization algorithm with a learning rate of 0.1 and a weight decay of 0.95. We conduct the experiments with 50 epochs and we use mini-batches of size 64. We evaluate the model every 100 steps. We use google pre-trained word2vec thus the dimension of each word vector is 300.

We study the sensivity of the proposed model to the convolutional region size, the number of con-volutional feature and the dropout rate. We found that we achieve the best performance when we use the settings values listed in the Table I.

Our model is developed in Python with Tensor-flow and Numpy libraries. The experiments are conducted on a MAC OS PC with 2.9 GHz Intel Core i7 processor and 8 GB RAM.

Region size	Feature Maps	Dropout rate
(4, 5, 6)	150	0.4

Fig.4: Experimental Settings

5.2 Validation method

For validating our model we use the iterated K-Fold validation model.

The dataset is split into 10 mini-datasets, which are used to validate each subset repeatedly.

5.3 Results

We compare our results with Sqlcheck . Sqlcheck is a lint tool that relies on syntax checking logic, to detect anti-patterns in SQL queries. We run SQL check on each of our dataset query, and store the results, which we then compare to our CNN re-sults.

SqlCheck	Our model
80	83.2

Fig.5: Experimental Settings

After running the experiments, our model can detect anti-pattern in a query with an accuracy of 83.2.

**VI. CONCLUSION AND FUTURE WORK**

In this work, we experimented using text classi-fication techniques to detect anti-patterns in SQL queries. The model uses a neural network with a custom dataset built from SkyServer catalog SQL queries. Experimental results demonstrate that, our model is quite accurate and can outperform lint syntax checking software.

For the future, we could focus on rewriting queries based on the anti-patterns detected.

**ACKNOWLEDGEMENTS**

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I would also like to thank my friend Miguel Kakanakou, for his very helpful advice and ex-perience sharing during the whole process of this work.

**APPENDIX**

Anti-patterns explanation select \*

When you SELECT \*, you're often retrieving more columns from the database than your appli-cation really needs to function. This causes more data to move from the database server to the client, slowing access and increasing load on your ma-chines, as well as taking more time to travel across the network.

Consider a scenario where you want to tune a query to a high level of performance. If you were to use \*, and it returned more columns than you actually needed, the server would often have to perform more expensive methods to retrieve your data than it otherwise might.

When you SELECT \*, it's possible to retrieve two columns of the same name from two different tables. This can often crash your data consumer null usage

NULL is not the same as zero. A number ten greater than an unknown is still an unknown. NULL is not the same as a string of zero length. Combining any string with NULL in standard SQL returns NULL. NULL is not the same as false. Boolean expressions with AND, OR, and NOT also produce results that some people find confusing not null usage

When we declare a column as NOT NULL, it should be because it would make no sense for the row to exist without a value in that column.

string concatenation

You may need to force a column or expression to be non-null for the sake of simplifying the query logic, but you don't want that value to be stored. Use COALESCE function to construct the con-catenated expression so that a null-valued column doesn't make the whole expression become null.

group by usage

Every column in the select-list of a query must have a single value row per row group.

order by rand usage

Sorting by a nondeterministic expression (RAND()) means the sorting cannot benefit from an index

pattern matching usage

The most important disadvantage of pattern-matching operators is that they have poor performance. A second problem of simple pattern-matching using LIKE or regular expressions is that it can find unintended matches.

spaghetti query alert

Split up a complex spaghetti query into several simpler queries

reduce number of joins

Too many JOINS is a symptom of complex spaghetti queries

eliminate unnecessary distinct

Too many DISTINCT conditions is a symptom of complex spaghetti queries.

implicit column usage

Although using wildcards and unnamed columns satisfies the goal of less typing, this habit creates several hazards. This can break application refactoring and can harm performance

having clause usage

Rewriting the query's HAVING clause into a predicate will enable the use of indexes during query processing.

nested sub queries

Rewriting nested queries as joins often leads to more efficient execution and more effective optimization

or usage

Consider using an IN predicate when querying an indexed column

union usage

Unlike UNION which removes duplicates, UNION ALL allows duplicate tuples.

distinct & join usage

The DISTINCT keyword removes duplicates after sorting the tuples. Instead, consider using a sub query with the EXISTS keyword, you can avoid having to return an entire table.

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# Use of Shear Wall Belt at Optimum Height to Increase Lateral Load Handling Capacity in Multistory Building: A Review

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**Abstract**—Due to the increase in the demand of high rise and fascinating structure with vertical & horizontal irregularity, different themes, and increasing height day by day leads to new challenges and requirement of new safety measures. To resist from earthquake and expressly wind effect due to increasing stature as the stiffness of the building is increases with increasing height we need to adopt some preventing structural system. Some of them are bracings, shear wall, outrigger system etc. In this study outrigger system is taken for analysis due the fact that is found the most optimal system for high rise buildings and skyscrapers. In this system the external columns are connected to main inner or outer core by means of outrigger beams at different floors to resist against story drift and rotating action of core due seismic and wind forces. In this study various papers allied to this topic are reviewed in which an enormous work is done in this field earlier. With the help of review of research paper we came to know about the conclusive outcome which forms the research objectives of our further study.

**Keywords**— *Belt supported system, Lateral load capacity, Optimum height, Shear strip cases Shear wall belt, Staad pro.*

## I. INTRODUCTION

In the present situation of overcrowding and increasing trend of luxurious and fascinating lifestyle in the fast growing nation, the building sector faces new challenges day by day specially the structural engineers to fulfill the dreams. To fulfill such type of need various researchers have done a lot of work and a lot new techniques are developed for every new generated problem comprises of bracings, outriggers, RC shear wall and shear core, steel plate shear walls, box systems, base isolation, dampers, seismic invisibility cloak, rocking frame, etc. One of the solution adopted for our analysis for such kind of problems is outrigger system or we can say the application of this system i.e. use of shear wall belt at

optimum height to make the structure capable of handling lateral loads developed due to earthquake forces or may be due to wind effects in case of high rise building or twin tower or skyscrapers as per the need of hour.

Here to face a lot of research work is done in the field of lateral load resisting system where various such kinds of systems are analyzed against various constraints separately for specific conditions and limitations. Shear wall and shear core both are optimized within the building against various parameters but the use of shear wall as shear wall belt like outrigger beam system is not analyzed till now.

In the present study various research papers are studied and reviewed to know the current challenges and so the further research is carried on the suggested objectives and problem statement generated from the review of research work. In the further study a 25 storied residential building having a standard plan and plinth area of 825 m<sup>2</sup> is analyzed. Various cases with shear strip belt at different locations are planned and analyzed against various parameters by Staad Pro software. Response spectrum method will be used along with SRSS combinations as per IS 1893 to determine various seismic parameters along transverse as well as longitudinal direction.

So a detailed review and study is required in the field of connected or linked structure for their stability analysis which helps in suggesting the recent situation the further need of research to optimize the suggested case contrary to various parameters. So a G+24 storied residential model is created with 16 different cases against several seismic parameters. They are as follows:-

CASE A = General structure without shear wall

CASE B = General structure with shear wall at corners

CASE B1 = Structure with shear belt at 0 m

CASE B2 = Structure with shear strip at 1<sup>st</sup> floor

CASE B3 = Structure with shear strip at 3<sup>rd</sup> floor

CASE B4 = Structure with shear strip at 5<sup>th</sup> floor

CASE B5 = Structure with shear strip at 7<sup>th</sup> floor

CASE B6 = Structure with shear strip at 9<sup>th</sup> floor  
 CASE B7 = Structure with shear strip at 11<sup>th</sup> floor  
 CASE B8 = Structure with shear strip at 12<sup>th</sup> floor  
 CASE B9 = Structure with shear strip at 13<sup>th</sup> floor  
 CASE B10 = Structure with shear strip at 15<sup>th</sup> floor  
 CASE B11 = Structure with shear strip at 17<sup>th</sup> floor  
 CASE B12 = Structure with shear strip at 19<sup>th</sup> floor  
 CASE B13 = Structure with shear strip at 21<sup>st</sup> floor  
 CASE B14 = Structure with shear strip at 23<sup>rd</sup> floor

Response spectrum analysis is performed and the building is analyzed for Zone 5, having Zone factor, 0.36.

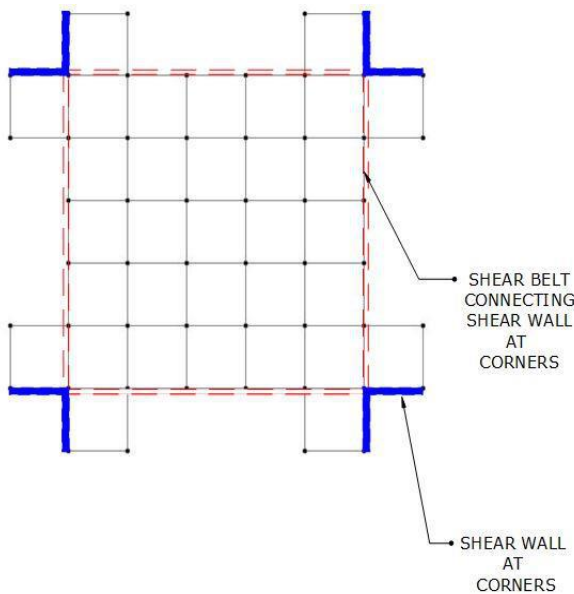


Fig. 1: Structure with shear strip connected with Shear Wall at Corners

## II. REVIEW OF LITERATURE

**Abbas Haghollahi, Mohsen Besharat Ferdous, Mehdi Kasiri**, in this paper studies are carried out in 2 steel framed high rise building 20 & 25 storied high braced by outrigger and belt truss system. This investigation is done by response spectrum and non-linear time history analysis by SAP software. The aim of this study is to find the optimum location of outrigger beams against lateral load within the building. The result of the study shows that stories drift ratio is kept away from the outcomes of response spectrum analysis. On the contrary the procedures trend is reversed for time history analysis. Outrigger beam location critically influences the structure's lateral behavior under seismic load. Outrigger and belt truss optimum location is at 10<sup>th</sup> and 14<sup>th</sup> story for 20 and 25 storied model respectively by response spectrum method on the other hand optimum location is 14<sup>th</sup> and 16<sup>th</sup> storey for 20 and 25 storied model respectively by time history analysis. Still the study

claims that the optimum location is preferably upper levels for each specific case as per site condition.

**Shivacharan K, Chandrakala S, Karthik N M**, in this paper an effort is made to explore the effect of belt truss and outrigger location in a building when subjected to both the cases of seismic and wind load one by one. Assumption made for wind load calculations is based on IS 875 (Part III) and similarly earthquake load by IS 1893 (Part I):2002. To analyze the response of above study a 30 storied vertically irregular multistory building model is proposed providing belt truss and outriggers at different levels are analyzed against various parameters. Drift and displacement of the structure under compression is studied. Linear static analysis is conducted for evaluation of outrigger and belt truss performance by E tabs software. The result of the study shows that our assumption of using outrigger and belt truss is proved efficient against lateral load and stiffness is increases in high rise structure. More precisely it can be stated that outrigger optimum location is 0.5 times of its height.

**Mohd Abdus Sattar et. al.**, this paper involve the comparative study limited to RC high rise building of 15, 20 and 25 stories with shear core, outrigger and belt truss. The plan area of the building is bay frame in the spread area of 40mX40m having columns placed at 5m apart from center to center. But the study is carried out for L shaped plan for floor rigidity with several models built without and outrigger and belt truss and 4 more cases with shear wall core and stringer beam with variable location of both one at a time each so as to understand the effect of each system effectively. The study is conducted by E tabs software for both wind loads and earthquake loads against various factors. The conclusions of the research shows presence of combination of double core shear wall, stringer beam and floor rigidity increases the stiffness of the structure. Floor rigidity is not necessarily increased for dead load and live load on floors. Combination of double core and stringer beams show a minimum of column forces and moments and also the drift and displacement is relatively less. Also corner columns have lesser moment as compared to outer one.

**J.C.D. Hoenderkamp**, in this paper optimum location of outriggers on shear wall with basement fin extensions was found by graphical means for preliminary design of multistory high rise building against horizontal loading. In this method we need seven parameters comprises of shear wall bending stiffness, fin-walls and outrigger, outrigger racking shear stiffness, bending stiffness by exterior column, shear wall's rotational stiffness and

foundation of column. Clubbing all the parameters provide a base for optimization for optimum level of outrigger and displayed in graphical form. All the study is carried out in form of characteristics equations to find the optimum location of outriggers. The assumption of basement fin wall reduce the translational stiffness of the piles to zero value and so providing an infinite value for characteristics non dimensional parameter. The mishmash of shear wall braced with outrigger and additionally providing basement fin wall facilitates optimum location of outrigger and maximum horizontal displacement.

**P.M.B. Raj Kiran Nanduri et. al.**, focuses their study on analyzing the behavior of outrigger system, optimization of its location and its efficiency while using three outriggers in a structure. Various models are framed for a 30storied high rise building with belt truss and outrigger placed in structure against both wing and seismic loadings for lateral displacement reduction. The analysis is done for Reinforced concrete high rise building of 90m height with a plan area of 38.5mX38.5m with column to column spacing of 5.5m by E tabs software. A total of seven different models are framed with or without outriggers placed at various locations. The result of the study shows that stiffness is increased by the use of aforesaid system also structural efficiency is improved. It is also found that placing of outrigger at the top is not so effectual but the use of second outrigger with cap truss at middle height of the structure is more efficacious.

**A. Rutenberg, D. Tal**, presents a numerical study and results of the study to investigate the drift reduction with rigid outriggers against various lateral load distributions in uniform and non -uniform belted structure. The assumption of the analysis are axial rigidity of periphery column and flexural rigidity of core, belts arm are infinitely rigid, neglecting shear deformations and frame action is precluded by pinning floor girders. On the basis of above analysis author makes an effort to study to investigate the influence caused by location of outrigger perimeter column to core stiffness ratio and variation of stiffness. The result of the study shows that outrigger efficiency is fully achieved by use of two outriggers for full mobilization of perimeter columns. Also the outriggers are not placed very proximate to the base of the structure.

**J.C.D. Hoenderkamp**, has made an attempt to analyze horizontally loaded tall building performances laterally supported by vertical trusses and horizontal offset riggers that are placed in the front face of the structure along the direction of lateral loading. The analyses is performed

against various structural parameters viz. trussed frames, façade rigger and perimeter frame. Several structural properties are discussed like location of façade rigger, horizontal deflection reduction, bending moment of trusses and belt truss. The outcomes of the study are increasing thickness of floor slab affects movement of faced rigger, increment in the deflection reduction and also it is significant too. By increasing the restraining moment there is an increment in the reduction of the bending moment. This method shows positive signs for allowing façade riggers perpendicular to the direction of horizontal loading.

**Abeena mol N M, Rose mol K George**, this research work is carried out on a 30 storied high rise core wall building. For this study a building with plinth area 38.5m X 38.5m is taken for consideration. This study is carried out by time history analysis and push over analysis. Maximum storey displacement is taken as key parameter to evaluate the performance of various outrigger systems with respect to conventional structure by E tabs software. Also we need to make this model economic along with structurally feasible. The aim of the study also includes excessive drift control due to lateral load and to evaluate the outrigger efficiency at various levels in multistory building. The results of the study shows with the increment of storey height lateral displacement are also increases. Also the major concluding outcome is stiffness and stability substantially increases against lateral loads while using outrigger structural system for high rise building.

**Akshay A. Khanorkar, Mr. S. V. Denge, Dr. S. P. Raut**, in this review paper the work is done on study of various research work done previously in the field of outrigger system. In some cases belt truss is used to resist lateral load and alter deflection. In some studies outrigger is proved better than belt truss system. In some research paper belt truss used in steel building to connect the entire periphery column, in this paper shear core is not directly connected to belt truss. Similarly a lot of research paper shows various techniques and methodologies adopted to resist lateral load i.e. both wind load and seismic forces against various constraints and also various valuable results and solution is also obtained which shows the use of outrigger and belt truss system along with shear wall and shear core is much beneficial and efficient. The conclusive outcomes of this study is the author find needs to further research on stiffness irregularity along with structural height.

**Goman W. M. Ho**, in this paper the special review is presented on the outrigger system that how the system works in tall buildings, its development history and its application. This paper initially tells about the early phase of high rise building, the first high rise building “Equitable Life assurance Building”, a 40m tall building in New York (1870). Further the concept of evolution of structural resisting elements and development of structural systems which helps in fulfilling the dream of today’s skyscrapers. Later the concept of outrigger is discussed in the paper which explains that perimeter and internal core is needed to be coupled and work as a system to resist the lateral load. After that location and topology is discussed in which the location identified in some paper is discussed. Also design issues are discussed. After that various types of adjustable outrigger system is suggested, some of them are cross jack system, Shim-plate correction method and retro casting techniques in outrigger construction. Various other methods are discussed like damped outrigger system and concrete outrigger system with structural fuse.

### III. CONCLUSIONS AND OUTLINE OF PROPOSED WORK

So far by reviewing and studying numerous research papers it has been analyzed that in the field of stability of multistoried twin tower against seismic and wind loads it is required to analyze the connected structure with various possibilities of structural stability by various means and its optimum location in the building. Here we come at conclusion drawn from studying the above review the position location of connector in the building is optimized so as to resist seismic loading.

The conclusive outcomes drawn from the study are enlisted below:

1. A multistoried building is taken for analysis with 13 floors in which floor twins is modeled up to 12<sup>th</sup> floor. Total of 13 cases are proposed with floor twins are varies floor height and the optimum condition is identified to resist seismic action. The tower is analyzed for zone 4 against medium soil type.
2. The study is conducted for both the directions viz. lateral and longitudinal direction.
3. Study is completed against various seismic parameters consists maximum displacement and storey drift in bot X & Z direction.
4. Conclusively the optimum case out of various cases is suggested with the help of above numerical data and Staad analysis.
5. The main focus is the shear strip which is a modified part of shear wall, its width and thickness

are fixed but height at which it behaves as a optimum case can be a major study.

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# Organizational Learning: Informal Learning as a Strategy of Knowledge and Support for the Decision-making of Managers of the Federal Institute of Rondônia

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**Abstract**—The objective of the research is to analyze how the managers of an Institution of the Federal Network of Education learn, that is, what strategies of learning use in the work and if the informal learning is seen like strategy to obtain knowledge and is influenced in the decision making of the managers. For this, a research was developed with Likert scale, mixed, descriptive, type of case study. The universe of this research was 125 managers. The participation of 57 managers was obtained. The research instruments developed were adapted from Brandão [6]. It was verified that informal learning is seen as a tool for obtaining knowledge and it was inquired whether informal learning influences the decision-making of managers. The data treatment was performed using paraconsistent logic. The results showed that the managers of the research institution learn mainly through the active reflection strategy and the search for interpersonal help. It was identified that Informal Learning is seen as a strategy to obtain knowledge and is taken into account in the decision process, consequently, influencing managers in their decision-making.

**Keywords**—Organizational and informal learning, Knowledge and Decision Making, Logic Paraconsistent.

## I. INTRODUCTION

In a totally dynamic, competitive and interconnected world, there is the moment when the organizational environment is increasingly changing, so that managers are led to rethink the way they act within organizations. In recent years there has been a growing interest in the learning process in the organizational context, fueled by the belief that learning is essential for survival in dynamic

environments, and that organizational learning is addressed as an important factor that positively impacts innovation [25].

For Nespolo and Dias [22] the result of learning is knowledge, since knowledge is linked to beliefs and commitments, aiming to reach a certain end. In fact, organizational decision-making is achieved through people, who carry out actions based on their learning, information processing and knowledge skills [33].

According to Miller, Hickson and Willson [21], the decisions of a more strategic nature, that is, decisions that happen in a more managerial degree and escape to the routine and the normality, end up determining that the administrator looks for new ways, new alternatives and information. This shows that the more uncertainty a decision has, the more likely it is for individuals to seek new knowledge and new sources of information, for learning strategies, and for structured formal learning.

Maluli [19] brings that schools, colleges and universities are organizations that develop formal learning processes within which individuals are expected to learn new knowledge, develop skills, and be able to make decisions. However, in addition to classrooms, teachers and students, there are a variety of managed and strategic procedures to be established and fulfilled, which, in a way, brings an educational institution closer to a company. Thereby, in the face of the valuation of the public manager, it is necessary to investigate the perception of these in relation to learning [10].

The research environment is an Institution of the Federal Network of Education located in Rondônia. The Federal

Institute of Rondônia (IFRO) has 9 Campuses implanted and 01 Rectory.

In this scenario it is necessary to think about learning beyond the formal strategies of teaching and its various modalities (face-to-face, virtual); the informal environment must be taken into account. Given the above, it is relevant to research on organizational learning and to identify the importance of informal learning for these public managers.

Given the context presented, the present study aims to analyze how managers learn by verifying whether informal learning is valued as a knowledge strategy and used for decision making in the management of the public organization studied. More specifically, to identify the learning strategies used by the managers in the work, to verify if the informal learning is seen as a strategy of knowledge and to analyze if the informal learning influences in the managerial decision making in the researched organization.

The research was carried out with 57 managers. For the application of the quantitative approach, we opted for the survey method. The research has consistent data and a good reliability of the data, proven by means of Cronbach's Alpha coefficient and Paraconsistent Analysis.

The results showed that managers use the "active reflection" and "search for interpersonal" strategies, using the Brandão [6] scale, which obtained a concordance of the factor considered substantial, it was also verified that the managers consider the AI as a tool to gain more knowledge in their work environment and that informal learning almost always influences the decision-making of respondents.

The article is divided into five parts. This first one, already described, presents an initial contextualization, the second brings the theoretical referential, the third reports the methodological procedures, the fourth presents the analysis of the data and the last one emphasizes the final considerations of this research.

## II. REVIEW OF LITERATURE

### Organizational Learning

Learning, in the organizational context, can be considered as a response to changes faced by organizations, since it seeks to develop the capacity to learn continuously, based on organizational experiences, and translate such knowledge into practices that contribute to a better performance [28].

Studies about learning in organizations have increased in recent years, especially those related to theories and tools that provide means for greater efficiency of people or processes, as well as for the management of knowledge acquired by individuals in their professional routines [30].

The learning process aims to promote changes in the cognitive, psychomotor and attitudinal domains, and may occur both to respond to current work needs and to develop relevant skills for future activities [1]. This process may be implicit or explicit, formal or informal [30; 27].

### Informal Learning

The formal learning and training methods, such as courses, lectures and workshops represent the main tool structured by organizations with respect to the field of learning of individuals [30]. However, it should be noted that these types of learning resulting from practical work situations do not appear in isolation. There is an interaction in the course of the development of daily activities [34].

Santoro and Bido [27] corroborate that formal strategies are generally planned by the company, while informal strategies are used by people as a way of solving a more immediate problem.

Antonello [3] brings a summary of the most important aspects of informal learning, which is set out in Table 1:

Table 1: Synthesis of the main aspects of informal learning. Source: Antonello (2005).

Informal Learning	
Definition	It is an activity that involves the pursuit of understanding, knowledge or skill. It occurs outside the curriculum that constitute educational programs, courses or workshops.
Emphasis	It implies valuing not only the relational side (the role of the individual within a social group), but also the quality of learning. It usually involves some degree of awareness that the person is learning.
How it occurs	It can occur from a formally structured experience, based on specific activities for this purpose. It can be planned or unplanned. It can occur in communities of practice.
Result	The individual can acquire skills by being involved in an ongoing process of learning. Learning is not just reproduction, but reformulation and renewal of knowledge and skills.

Barros et al. [5] brings that the approaches in informal learning research in organizations are the following: cognitive, behavioral and sociocultural. The cognitive perspective considers learning from the information process that occurs within the cognition of each individual, starting from the operational to the conceptual level. The behavioral perspective focuses on the action,

that is, the responses of the individuals after the stimulus of a learning process. However, it does not focus on the cognitive process and the context that the individual is inserted. The sociological view considers the meanings, actions and knowledge acquired by the individual, the result of social and collective practices. In this way, the organizational learning is based on the culture, the socialization and the practices of the individuals [13]. According to Svensson, Ellstron and Aberg [29], the central point of departure for informal learning is for people to act, to perform tasks, to make affirmations, to solve problems, and to cooperate with others. The interaction between the individual and the environment occurs continuously and this forms the basis for the learning process.

### Learning Strategies

For Deo [12], the world of work has undergone constant changes that have repercussions on the way organizations and workers learn the skills needed for professional performance. As the people do not learn in the same way, it is necessary to understand each person's learning strategy, from how each individual hold information, how they mentally order it, and even how they transform it into action.

Strategies of learning at work can be understood as practices that people use to help acquire knowledge and skills in their professional context [17; 7].

Leading into consideration the need to improve some items of the Holman, Epitropaki and Fernie [17] scale, they better represent the idea of the individual's effort to learn something. Brandão [6], in his work, proposed the validation of a new scale as well as to investigate the frequency with which employees of a Brazilian public bank used such strategies. The description of the types of strategies used in the Brandão Scale is presented in Table 2.

Table 2: Learning Strategies of the Learning Strategies Scale at Work. Source: Brandão (2009).

Strategy	Description
Active reflection	Reflection of the individual on the component parts of his work, as well as the reflection of mental structures that relate the work of the person to different aspects of the organization.
Search for help Interpersonal	Active search of the individual for the help of other people.
Search for help in written material	Research and localization of information in documents, manuals, regulations, books and other non-social sources.

Reproduction	Memorization of information without reflection on its meaning.
Practical application	The individual's attempt to learn through experimentation.

Brandão and Borges-Andrade [7] affirm that, although these strategies are conceptually distinct, the study did not show empirical differences between them. As these strategies have the same cognitive bias, respondents appear to have understood these items as representative of the same practice. According [10], this may have arisen from the occupational role of the respondents, who were managers, and understood by their professional practice that it is not possible to dissociate the two types of reflection.

### Organizational Knowledge Management

Frizzo and Gomes [14] affirm that acquiring knowledge is not limited to data that individuals capture on a daily basis in the organizational environment, but also when that information becomes information that is correctly passed on and understood by the same, that is, when the information is understandable and helps in the development of the organization.

Organizational knowledge, according to Nonaka and Takeuchi [23], is based on the identification of tacit knowledge treating it as the main element in the creation of organizational knowledge. This understanding makes clear the direct dependence of knowledge on people and, of course, on human action, which involves the creation of an organizational environment conducive to the development of skills such as autonomy, creativity, sharing and availability of information.

D'Arísbo et al. [11] brings that knowledge is subjective, aesthetic and created by practice. The consequence of this is that knowledge affects and is affected by the environment at all times. In this sense, the human being must be understood, since he is an essential part of the knowledge process.

In this way, it is perceived that the definition of knowledge is linked to movement-fluidity, action, intention-and thus is a mechanism of strategic importance in an organizational world of constant change.

### Organizational Knowledge Management

For Nespolo and Dias [22], decision making is a procedure that is present in all activities carried out, whether organizational or not. As a process that favors the effectiveness of decisions, organizational learning has received increasing attention in debates in the country's academic, editorial and business circles, as described in Valladares and Leal Filho [31].



Recent studies on decision-making, such as those by Reis and Löbler [35], Oliveira, Miranda and Amaral [24] are examples of national surveys that demonstrate the growing interest in the subject.

For Caravantes et al. [8] decision-making can be approached in many ways, but generally the main ones are: the rational and the behavioralist. It stands out by the model behavioralist has:

1. The decision maker has imperfect information (incomplete and possibly inaccurate).
2. The decision-maker has a defined rationality and is restricted to values, experience, habits, etc.

Ansoff [2] brings the classification of the decision making as to its scope, shown in Table 3:

Table. 3: Classification of the decision making regarding its comprehensiveness. Source: Ansoff (1965).

Classification	Concept
Strategic	More related to the external environment of the organization. Top management responsibility.
Administrative	They refer to the structuring of resources in order to optimize performance, related to the organization and to the acquisition and development of resources. They are usually associated with intermediate levels of management, managers.
Operational	Concerning the problems of the day to day, aiming the optimization of efficiency. They absorb considerable attention and energy. Usually delegated to lower hierarchical levels. Although different decisions are interdependent and complementary.

According to Gontijo and Maia [15] "decision-making happens all the time, at all levels, and directly influences the performance of the organization (...). In fact, it is impossible to think of the organization without considering the constant occurrence of the decision-making process". Thus, the decision-making process is the regulatory point of organizations, making it conceive lines of thought that would guide it to a specific point in the future [24].

### III. METHODOLOGY

For the application of the quantitative approach, we opted for the survey method, which is characterized by the use of well-defined variables [20]. A survey, according to Babbie [4], can have three purposes, the one used in this research was descriptive and the model used was the

intersectional one. The research was carried out through questionnaires read and filled directly by the managers, by means of an *online* tool, in nine campuses of the institution studied and rectory.

The universe studied was 125 managers of the Federal Institute of Rondônia (IFRO). It was obtained the return of 46% of the managers of the researched institution, that is, 57 managers belonging to the Management Positions and Gratified Function.

To measure the reliability of the data using the Cronbach Alpha model, the IBM SPSS Statistics software was used. Reliability, that is, "the degree to which a variable or set of variables is consistent with what we intend to measure" [16].

The data collection instrument described 28 strategies, in which respondents should indicate the frequency with which they use each one at work, using a Likert scale of five points, ranging from 1 (Never do) to 5 (I always do).

### IV. DATA ANALYSIS

In the category of practical application, we emphasize the proposition 25 that obtained as a degree of agreement the value of 78.9, considered thus, moderate degree, alias all the prepositions of this strategy fit, by their values, in the degree of moderate agreement.

Table 4 presents a summary of the interpretation of the degree of agreement of the factors.

Category	GCF	Interpretation
1- Active reflection	86,04	Substantial concordance
2- Search for interpersonal help	80,35	Substantial concordance
3- Search for help in written material	75,44	Moderate concordance
4- Reproduction	69,72	Low concordance
5- Practical application	75,44	Moderate concordance

Table. 4: Interpretation of the degree of agreement of the factor (GCF). Source: Prepared by the authors (2019).

Looking at Table 4, analyzing the degree of agreement of the factor (GCF), it can be seen that the "active reflection" strategy is the one most used by the researched managers, who seek to learn, from the reflection on component parts of their work. This category obtained as a degree of agreement of the factor (GCF) 86.04, considered in this way, with a substantial agreement of the managers.

Next, we have the category "search for interpersonal help" as the most used by managers, with the (GCF) of 80.35 obtaining also as an interpretation of the value, of substantial agreement. According to Brandão [6], this category consists of the active search of the individual for

the help of other people, that is, they seek the help of more experienced colleagues, the same team and even other areas of work within the institution to learn. Costa's research [10] showed that the "search for interpersonal help" was used primarily by the respondents, which differs from this research, which brought the category as the second most used, but what highlights the same as important for the management. The strategies of "search for material help", "practical application" and "reproduction" are the least used by the managers of this research. But these seek to learn, respectively, from the research in documents, manuals, norms, books and other non-social sources; seek to learn in the workplace by testing in practice new ways of performing the work and encompassing new knowledge,

and in addition, it finds that the managers participating in the research memorize the information without reflection on its meaning. The first two strategies cited above have moderate agreement with the same value of agreement degree 75.43 and the reproduction category has a lower agreement, considered low, with the degree of 69.69.

After step 1 we present the analysis of the paraconsistent logic made on the propositions of learning strategies, as shown in Figure 1. In step 2, after the transduction process, we have an "OR" and "AND" network for the 5 learning categories. According to Carvalho [9] in the "OR" connectivity the output is the highest value of the two inputs and in the "AND" connective the output is the smallest value of the two inputs.

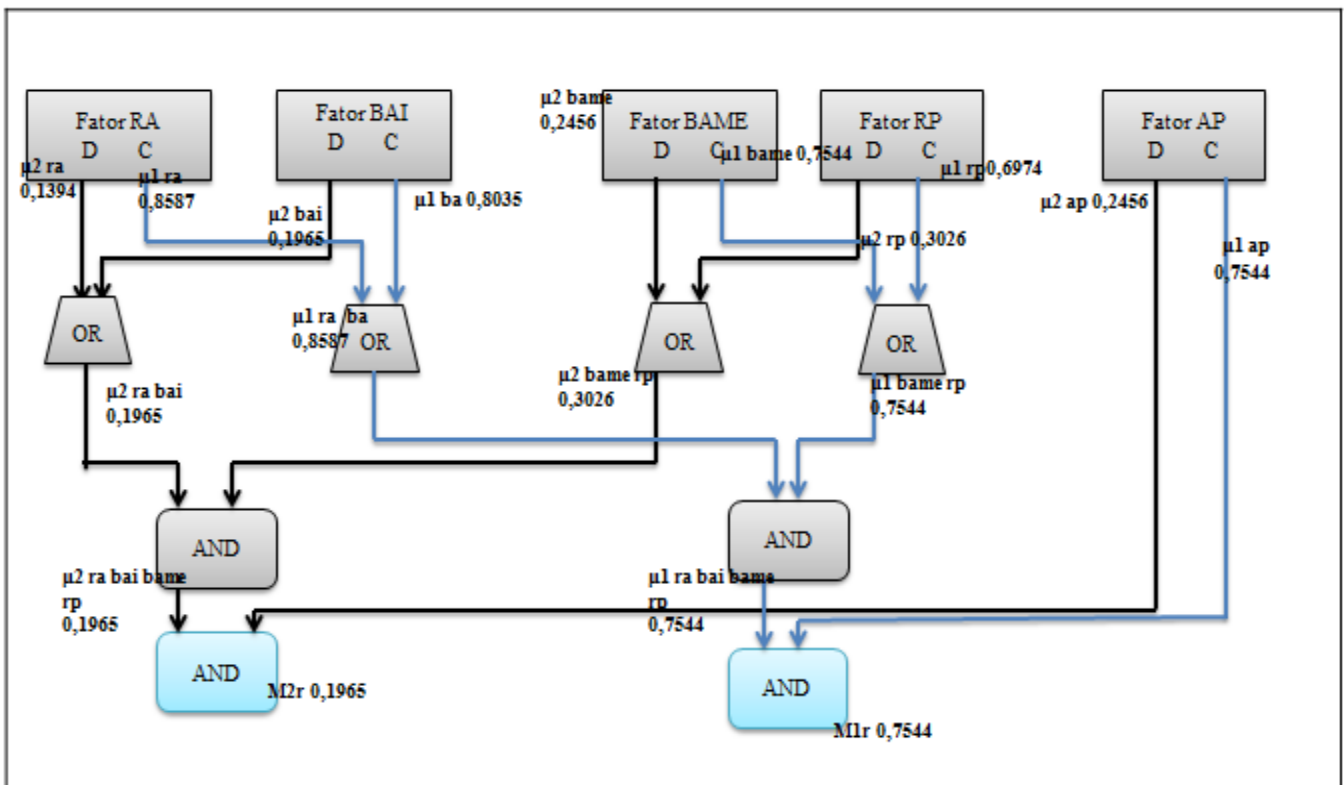


Fig.1: Analysis by the Paraconsistent Logic of the propositions regarding the Learning Strategies. Source: Prepared by the authors (2019).

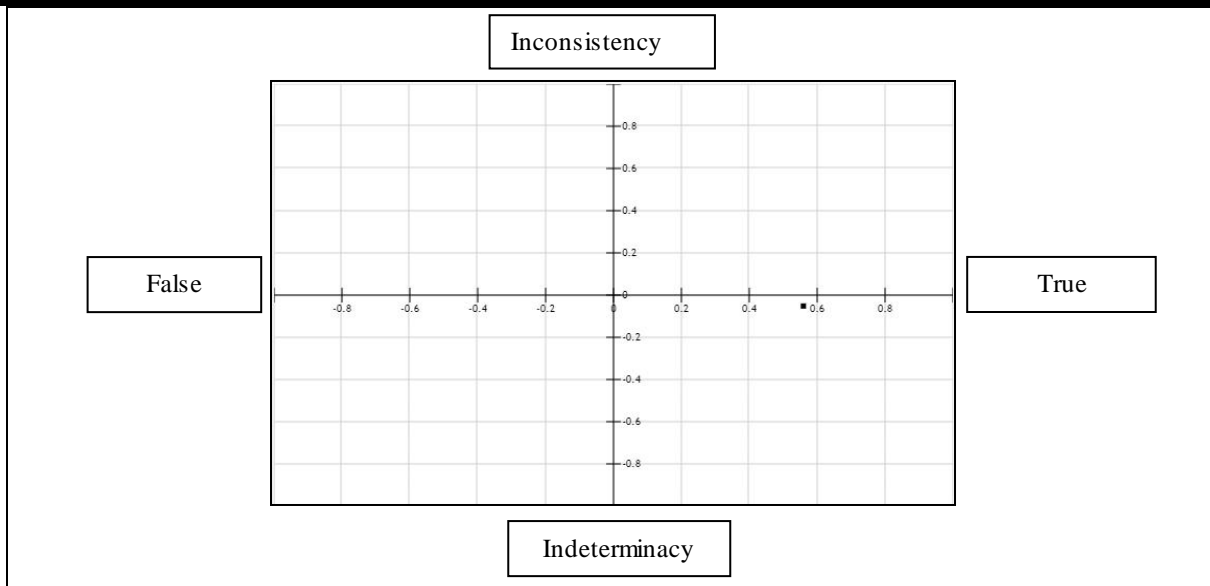


Fig.2: Unit Square of the Cartesian Plane for interpretation of the result of the analysis by the Paraconsistent Logic.

Source: Prepared by the authors (2019).

After conversion of belief  $\mu_{1R}$  and disbelief  $\mu_{2R}$ , the values were transformed into a certain degree of certainty ( $G_1 = \mu_{1R} - \mu_{2R}$ ) and degree of contradiction ( $G_2 = \mu_{1R} + \mu_{2R} - 1$ ), which presented the following values:

$G_1 = 0,5579;$

$G_2 = -0,0491;$

At the end of this step, for the five categories, the value pair ( $G_1, G_2$ ) is valid (0.5579; -0.0491). In step 4, which is the interpretation of the result in the QUPC - Unit Square of the Cartesian Plane, when interpreting the acquired values the degree of certainty of 0.5579 is to the right of the central axis, being close to the unit value that expresses the "truth"; therefore being in the region "almost true" and the degree of contradiction -0.0491 is practically on the horizontal axis denoting that there is no lack of conflicting information or information.

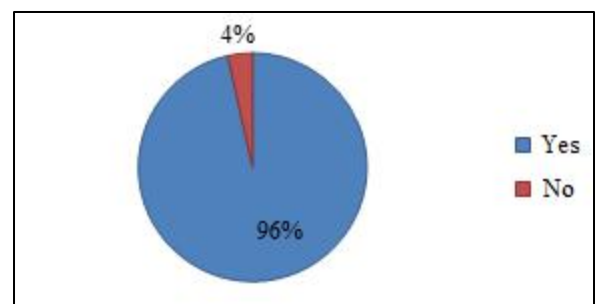
Figure 2 shows the result obtained positioned in the QUPC - Unit Square of the Cartesian Plane. Note that the values 0.5579 and -0.0491 refer to measures placed on scales ranging from -1 to 1. To facilitate understanding and interpretation, normalization is recommended, that is, the conversion of these values into scales ranging from 0 to 1.

Step 5, which is the normalization process, making use of the convention to describe the interpretation and synthesis of the information obtained by Likert scale with respect to the normalized degree of certainty  $G_{1n}$  and the degree of normalized contradiction  $G_{2n}$ , which convention is contained in Table 7, it is possible to affirm that the respondents, with respect to the five categories considered (active reflection, search for interpersonal help, search for help in written material reproduction, practical application) regarding the

managers' learning strategies, with data that can be considered consistent ( $G_{2n} = 0,47545$ ) and contains substantial adhesion ( $G_{1n} = 0,77895$ ).

**Informal learning as a strategic tool for gaining knowledge**

The second objective of this research was to verify if the AI is seen as a strategic tool for the managers to obtain knowledge, and before this, as can be observed in Graph 1, managers were asked if they considered the AI to acquire knowledge and 96% of the managers of the organization studied have confirmed that this is a strategy to obtain knowledge.



Graphic. 1: Informal Learning as a strategic tool for obtaining knowledge. Source: Prepared by the authors (2019).

This result corroborates with the analysis of Von Krogh, Ichijo and Nonaka [32], who report that one of the central aspects for creating and generating knowledge is "managing conversations", that is, providing good relationships between employees and managers, of AI

characteristics, as well as providing an enabling environment for knowledge, where personal and organizational barriers are eliminated.

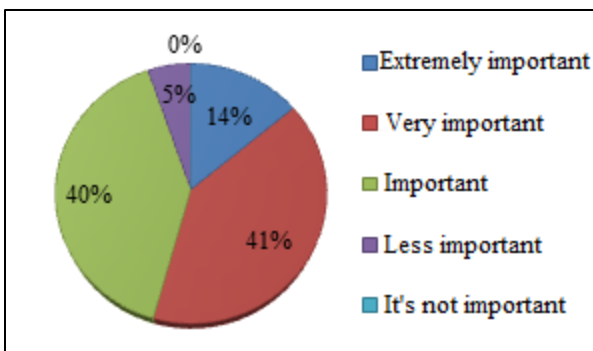
In this way, conversations become effective and instigate the sharing of tacit knowledge. Thus, it also meets the category of learning strategies, the search for interpersonal help, the second most used by the respondents of this research, which reports precisely the interaction, conversation among the colleagues of the institution, the search for their help.

Antonello [3] reports that all learning situations contain formal and informal characteristics, but the nature and balance between these vary significantly from occasion to occasion.

**The importance and influence of AI in decision-making**

In order to answer the third objective of this research, which is to analyze if informal learning influences the managerial decision making in the research organization, respondents were asked about the importance of AI in the decision making process of the same and, as observed in the Graph 2, between important and very important icons, 95% of managers consider that the AI is at least important when they make a decision.

Huang [18] complements that there are the scheduled and unscheduled decisions. Scheduled decisions are repetitive and routine and provide stability, efficiency and cost savings. There is no difference between the way and the way the decision is actually made. On the other hand, unscheduled decisions do not follow the same reasoning. Therefore, it is a challenge for managers, the lack of a path composed of steps to be followed for decision making. These decisions are of great importance as they may direct future action, and as the future is uncertain, the consequences can be serious implications for managers.



Graphic. 2: Importance of Informal Learning in Decision Making. Source: Prepared by the authors (2019).

Regarding AI's influence in decision-making, 70% of managers affirm that it always or almost always

influences decision-making in the institution's activities, as shown in Table 5, that is, we can see that AI influences the process decision-making process of the researched managers.

Variable	Percent Response
1 (Never)	0%
2 (Almost never)	7%
3 (sometimes)	23%
4 (often)	60%
5 (ever)	10%

Table. 5: Compilation of data regarding the influence of AI in decision making. Source: Prepared by the authors (2019).

Panosso [26] suggests that in addressing the issues of identification and evaluation of informal learning, it is crucial not to forget its contextual nature. This perspective implies valuing not only the relational side (the role of the individual within a social group), but also the quality of learning. Learning in individual terms means acquiring performance skills by engaging in an ongoing process of learning. As such, learning is not only reproduction, but also reformulation and renewal of knowledge and skills [3]. And this includes decision-making from the acquired knowledge.

**V. CONCLUSION**

In this article we have tried to analyze the learning strategies used by the managers, verifying if the informal learning is seen as a strategy of knowledge and analyzing if the same influence in the decision making of the management of the studied public organization. To describe this phenomenon is important, since one can analyze the most used forms of learning, providing the creation of strategies to strengthen the ways of making organizational learning viable.

In relation to AI, it is also important to study the conception that the managers have of it as a tool to obtain knowledge and its influence in the decision making brings the relevance that this type of learning is already having in the organizational environment of the researched managers.

It should be emphasized that in this research the paraconsistent analysis was used and it can be affirmed that the respondents, regarding the five categories considered (active reflection, search for interpersonal help, search for help in written material reproduction, practical application) of managers, with data that can be considered as consistent, have a substantial adherence.

The first specific objective of the research is to identify the learning strategies used by managers at work; it was

possible to recognize, using the Brandão scale [6], that managers primarily use the strategies "active reflection" and "search for interpersonal help", which obtained a concordance of the factor considered substantial. The uses of these strategies denote that the learning is obtained through the reflections of the elements of the work, there is the quest to improve it, through the help of other people, that is, that learning happens naturally, not systematically, on the day the day of the manager. In addition, the results pointed out that the research subjects use the different learning strategies, and that there is no great variability between them.

In relation to the second objective of the research, which aimed to verify if the informal learning is seen as a strategy of knowledge for the managers of the Institution researched; it has been found that they consider AI as a tool to gain more knowledge in their work environment. Studies of the knowledge creation theory of Nonaka and Takeuchi [23] argue that tacit knowledge is socialized, then outsourced and combined in new ways and then internalized, opening the window for the generation of innovations. And this brings strong relationships with the learning of these managers and their way of managing.

When responding to the third specific objective of the research, to analyze whether informal learning influences the managerial decision-making in the researched organization, it was found that managers in the vast majority (95%) consider that AI is important and very important for the decision-making process that almost always influences decision making.

With this information in mind, the institution can develop strategies to stimulate new ways of making informal learning possible, for example, to create environments that provide this type of learning exchange, whether it is a specific room for snacking on servers or an environment outside the administrative building. organization, so that the employees can talk, because, as Madergan observes [34], the organization consciously creates an environment that favors the interaction, exchange of experiences and knowledge between colleagues facilitates the learning of individuals within the institution, which comes to become a benefit to the organization.

Thus, this research can be expanded by investigating different institutions from different regions of Brazil in order to verify the relationships between the learning strategies used by managers and decision making. Another possibility is to investigate the learning strategies used by the managers, trying to compare the strategies from the training, position of the managers, in order to bring new findings related to the themes proposed in this article.

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# Twin Tower High Rise Building Subjected To Seismic Loading: A Review

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**Abstract**— *The figurative tower which compliance all the structural state of affairs are in trend. These structures are not only constructed to deliver the present need but also to show the domination among all over the world which is also used as benchmark in the world. A number of structures were build till date and all of those are symbolic marvels like Petronas Tower in Kuala Lumpur, Huaguoyuan towers in China, Imperial Tower in India, Palm Tower in Doha and the list is myriad. Also a lot of twin towers are under construction not only across the world but also in India too. Such structures are made possible by bridging the gap between these two towers by various means like making the bridge or by RCC frame, steel connections, etc. In this paper various papers are studied to comprehend the concept and optimize the need. The study on various research papers along with existing towers help in deciding the objectives of the study and so the optimizing parameters.*

**Keywords**— *Connected structure, lateral loading, linked building, response spectrum analysis, Staad pro, Twin tower.*

## I. INTRODUCTION

Conventional practices across the world to combat the seismic forces and wind effects as it is more important phenomenon now a days because of increasing construction of skyscraper are obsolete and need new practices and arrangements because the architectural and structural demand is poles apart from earlier construction. To full the increasing demand of living space along with commercial space various efforts are made to fulfill the need of hour.

Twin tower is the best example to rectify such kind of problem which not only comply the demand but also a mark of social and economic prosperity. The major aspect in these kind of building is to bridge the gap by providing a functional link which not only a architecture material but encompasses various functional allocation of the special structure due to a fact that the link proofs the critical fragment of the structure. It is also seen that

without providing this link it is not structurally viable to support such kind of structure and contest seismic and wind loads.

To overcome such kind of problem it has been seen that only bridging is not a single solution but by connected by same means as the rest of building is made in bottom, middle or at the top of the structure. Earlier various efforts are made to accomplish the problem connected structure but nowhere the research is done on optimization of connecting part in the middle of building at varying height.

So a detailed review and study is required in the field of connected or linked structure for their stability analysis which helps in suggesting the recent situation the further need of research to optimize the suggested case contrary to various parameters. So a G+12 storied model is created with 13 different cases against several seismic parameters. They are as follows:-

CASE A= G + 12 (no floor twin)

CASE B= G + 12 (01 floor twin)

CASE C= G + 12 (02 floor twin)

CASE D= G + 12 (03 floor twin)

CASE E= G + 12 (04 floor twin)

CASE F= G + 12 (05 floor twin)

CASE G= G + 12 (06 floor twin)

CASE H= G + 12 (07 floor twin)

CASE I= G + 12 (08 floor twin)

CASE J= G + 12 (09 floor twin)

CASE K= G + 12 (10 floor twin)

CASE L= G + 12 (11 floor twin)

CASE M= G + 12 (12 floor twin)

Response spectrum analysis is performed and the building is analyzed for zone 4.

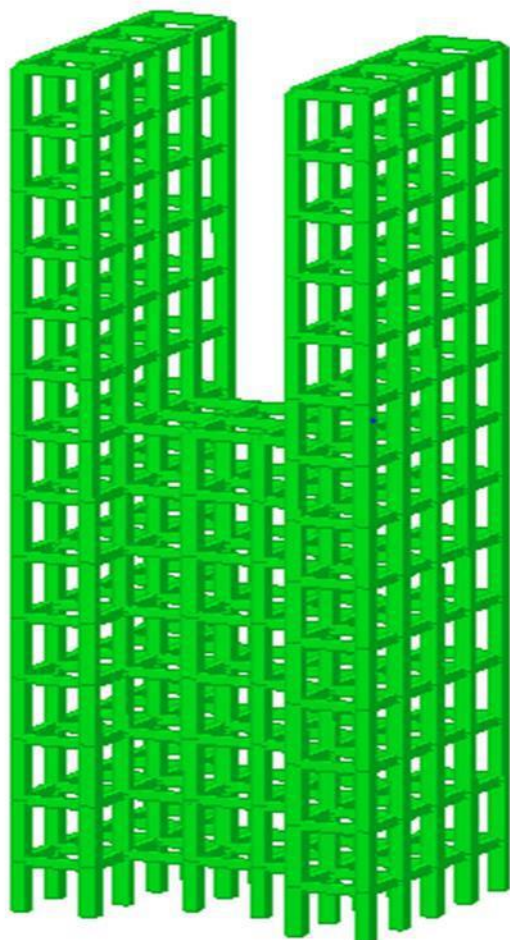


Fig. 1: Isometric view of connected tower having floor twin up to 6th floor.

## II. REVIEW OF LITERATURE

*Wensheng LU and Xilin LU*, in this paper various scaled and connected multistoried high rise tower are modeled tested on shaking table. In this analysis a new concept is taken in to consideration that the effect of flexible transfer floor. Dynamic behaviors of various models are compared between theoretical analysis and tested results. For shaking table test the models of following buildings are made comprises of Guangzhou International Commercial and Trade Plaza, Shanghai Kaixuanmen Mansion, Shanghai BOCOM Financial Tower, Shanghai Chongshou Commercial Plaza and Shanghai Pudong Reception Center. All the models are made up of micro concrete and fine reinforcement. Furthermore theoretical analysis is done by using various models contains multi tower with rigid podium, multi-towers with rigid podium, rigid plate mass spring model and a new multi rigid block model. The results of the study concluded that dynamic behavior of connected tower with respect to conventional multistoried building is usually different. The seismic resistant ability is lower for building with door shape. Large podium shows the significant behavior against the

couple action of high rise building between transfer floors. Drift action generated due to increasing height is controlled by flexible connections between linked buildings. In U shape building the seismic response is very crucial.

*Ji Dongyu and Li Xiaofen*, in this paper an effort is made to analyses 23 storied high rise building in which the bottom three floors are made for commercial housing and the rest of 20 floors are two symmetrical towers connected at 20th story by connecting plates. The study is carried out by finite element analysis in ANSYS software in which the aforesaid high rise twin tower is analyzed by time history analysis for seismic response. The building is connected by RCC plates and pile foundation is adopted at base. Building is analyzed for seismic intensity of 7degrees. Model is tested against various seismic parameter like horizontal displacement, horizontal acceleration, etc. in this analysis is focused on third floor and twenty third floor of the building to find the behavior of seismic parameters against seismic action. The results of the study shows the maximum horizontal displacement at twenty third floor is 0.078m at 2.26s and the horizontal acceleration for the same level is 1.90m/s<sup>2</sup> at 1.64s. Similarly for third floor the maximum value recorded of horizontal displacement is 0.006m at 4.20s also horizontal acceleration is found 0.69m/s<sup>2</sup> at 4.45s. These numerical value obtained by time history analysis in ANSYS suggest that the assumed connected structured model is safe for seismic action taken for consideration also economic and reasonable as per engineering practices.

*Diagoro Isobe, Li Thi Thai Thanh and Zion Sasaki*, this study presents the performance against collapse behavior of connected high rise tower by numerical simulations. In this study numerous simulations are done for to analyses the actual cause of collapse of World Trade Center tower in terrorist attack dated on 9/11. To examine the impact forces of dynamic unloading in the core columns a fully scaled structure of World Trade Center is modeled to analyze aircraft impact assessment. Several numerical codes are assumed and analyzed to assess the cause of that havoc. For analysis a linear Timoshenko beam element is taken for consideration. The results of the study suggests that whole collapse in World Trade Center is not only because of reduction of strength of members due to increase in temperature and buckling but because of the fact that the connections in the members is very weak and also due to impact caused by aircraft which creates havoc in column section by destruction of its splices. It is also observed that out of the two towers of World Trade Center one were remained stand for a longer



time with respect to another one due to reason of symmetrical structural deficiency.

**Xiaohan Wu, Jun Wang and Jiangyong Zhou**, in this paper author perform research on four multistory tower interconnected on the top floor by a sky corridor bridge. In this analysis seismic action is controlled by tuned mass damper. Corridor is taken as friction pendulum tuned mass damper. The connector bridge used to take path between four towers is connected by flexible links. Perform 3-D software is used to analyze the 3-D model of the framed multistoried connected tower developed by Nosa CAD, Elastoplastic time history analysis is used to analysis the model in Perform 3-D and the seismic parameters are haul out from software and compared against nonlinear response obtained in the result. The model is compose of 8 multi storey framed structure in which 6 storey is used for commercial purposes and bottom three storey is used for basement. All the building specifications are taken as per Chinese Code like C30 concrete is used in RCC members and C60 is used for core tube wall. The result of the study shows that the concept of frequency pendulum tuned mass damper is found successful which reduce not only seismic action and also deformation along with damage extent. When the tower and corridor are connected by rigid connections then the relative displacement developed in the tower is resisted by isolation devices.

**S Radhakrishnan, Dr K g Selvan, Dr S Senthil Kumar**, author raises an serious issue with this paper regarding poor construction practices and negligence of primary conditions like soil report etc. in this paper the case study is done on an under construction 11 storied building that is a twin tower that is swallowed by collapse located at Moulivakkam, porur. The major issue raised is that one building is fallen by itself during its own construction and the other tower that was half built was devastated by imploding. There is very extensive research work is carried out by the author to find out all the possible reason of this havoc. Actually the main reason of all this incident is the death of 61 workers in the construction site by collapsing of building by its own which bring this media and finally to court. To analyze the case study the authors firstly identify the builder with all of its qualification with all the proper approvals released by the state authority. Later the architectural and structural plans are again assessed according to building requirements. After that the soil study is carried out. Timeline is also presented in the paper as evidence to show the exact details chronologically. The results of the study shows that lack of knowledge and construction practices adopted by builders are the primary reason of this havoc. The team

selected for this kind of construction right from labor to architect and engineers is not adequate and qualified for this type of construction. Also the material should be chosen for these types of structures are not as per specification. Soil testing is not performed in proper manner as foundation plays important role in this type of structure. Also the structural drawings are not completely tested and the work is not executed in the site as per instruction. Similarly various loopholes are found in this construction work which results in happening of such perilous disaster.

**M. R. Willford and R. J. Smith**, here author presents the design of two multistoried connected tower situated in manila, which is a susceptible area confined by typhoon winds and affected by seismic forces evaluated as UBC-97 and zone 4. The building height is 210m and 30m in plan. The building is designed for both wind and seismic forces by performance based method. Both the towers are made up of reinforced concrete and random arrangement of columns and walls at the perimeter of the structure along with an outrigger system that is 2 stories deep for 50 percent height of tower. Vertically acting fluid viscous dampers are used to connect outrigger with the adjacent column. The damping system used in the tower is termed as Arup damped outrigger system which is a non-tuned system and utilizes much lower space as compared to tuned devices. The result of the study shows that with the use of this non tuned damping system wind action is considerably controlled. Other than that seismic forces are resisted by the adopted performance based design which not only make structurally viable but also economical. In this design method 30% concrete is saved as compared to conventional code based design procedure. Also the steel density is controlled by a proportionate amount of 100 kg/m<sup>3</sup> that is not possible by code's analysis and design.

**Andrew Luong and Michael Kwok**, in this study authors makes an attempt to the solution of vertical irregularity of structures by connecting towers. Various key aspects are taken into consideration comprises of wind tunnel action, resistance against vertical earthquake loading, comfort under vibration and wind action and lastly diaphragm action in critical members. One storey deep steel trusses are used to support the connecting portion of tower at the lowest floor. Belt trusses are used to counter lateral forces. The building is spread in a very large area of 4,50,000 m<sup>2</sup>. The results of the study shows that simply the linking of top part of the cantilever linked path is not simple but made possible by steel bracing system, external continuous dia-grid tube system. The wind and seismic action is resisted by reducing the floor plates in the east-west direction and upper half portion of the

structure. Also the building make economically feasible by using composites i.e. steel and RCC members wherever required along with small outriggers which helps in reduction of structural steel to a considerable amount and approximately  $250\text{kg/m}^2$  is utilized which is about  $50\text{-}100\text{ kg/m}^2$  lesser from conventional methods.

**Eldemery Ibrahim**, in this paper author marks an impact of high rise multistory building its necessity in the present developing world and the effect they imposed. With an example it is explained that high rise is not only solution especially for every part of the world like In Egypt its whole population chosen only 4% of land space out of entire Egypt. In the present time it is assumed that tall skyscraper is the landmark and new pride figure for any country. In this paper author explaining the effect of multistoried structure and the requirement of setting limit by the respective government while using these tall buildings as a tool of urban development and need of making guidelines to control the alarming situation produced by this. Various facts are analyzed its requirement and so its impact in the society, how sustainable are these buildings, their influence in developing countries and developed countries where the effective available land share is a big constraint whether to use it as assets or ignoring in the crowd and name of urbanization. In the conclusions is demonstrated that this skyscraper phenomenon is gobbling the world. By comparing two countries one is developing i.e. Egypt and another one is developed i.e. Japan the situation is very differ for both the cases because in the previous case the land resources are present in adequate amount but in later case land scarcity proofs the use of high rise structure is the only solution left for their present and upcoming population increment. In the former we have option to utilize deserts as option but in the second case we do not have any option left other than multistory concept.

**Ji Dongyu, Li Lamei**, in this paper the study presents the vibration model for a structure to analyze the impact and finding probable options to bear dynamic actions. In this exploration Simulation is done by Finite element method. The building is used for teaching purpose which is spread in a vast area of  $8425\text{ m}^2$  where ground floor is kept slightly lofty with a height of  $7\text{m}$  in 6 storey building and in rest of building is floor height is kept constant for  $4.2\text{m}$ . The building is analyzed as per Chinese building code and all the input parameters are set as per their standards. C40 concrete is used in construction, modulus of concrete is  $32.5\text{ GPa}$  whereas Modulus of elasticity for foundation is kept  $0.261\text{ GPa}$ . To perform the real time simulation Saint-Venant's principle is used in which the length of foundation taken as  $100\text{m}$ , width is taken  $30\text{m}$

and the depth of foundation is taken as  $2\text{m}$ . The result of the study shows that the required dynamic characteristics are found to be more complex for assumed framed structure of teachers building. While taking about deciding parameters the vibration mode of first and second order proven to be of higher importance than transitional vibration mode. Finally the stiffness of the building is found minimum in case of transverse direction and maximum in case of vertical direction whereas longitudinal direction comes at middle in between these two directions.

**Niels H. Harrit et. al.**, In this paper author presents the study in which a new material is accidentally discovered from dust generated from 9/11 terrorist attack. While checking the various samples after destruction of huge twin tower some specific red/grey chips were found in every sample collected for detailed analysis. Overall 4 samples are collected from different locations. One of those samples is collected from Manhattan, just after 10 minute of collapse, on the very next day two samples are taken and finally after one week last sample is collected. The red/grey chips found in all the samples collected from different sources and on different dates. Various modern techniques are used to analyze these chips consists optical microscopy, scanning electron microscopy, X-ray energy dispersive spectroscopy and differential scanning calorimetry, in the red material granular particles are found of  $100\text{nm}$  mostly composed of oxides of iron and some very small plate like structure is found in which traces of aluminum is identified. When tested by ignition they shows a different exothermic behavior that is much lower than normally found thermites. Based on various conclusion drawn from chemical analysis it is concluded that the red/grey chips found in the dust is unreacted thermitic material, also the material is chemically active, nanotechnology is incorporated in this material and the most important is that this material is explosive in nature and highly energetic pyrotechnic.

### III. CONCLUSIONS AND OUTLINE OF PROPOSED WORK

So far by reviewing and studying numerous research papers it has been analyzed that in the field of stability of multistoried twin tower against seismic and wind loads it is required to analyze the connected structure with various possibilities of structural stability by various means and its optimum location in the building. Here we come at conclusion drawn from studying the above review the position location of connector in the building is optimized so as to resist seismic loading.

The conclusive outcomes drawn from the study are enlisted below:

1. A multistoried building is taken for analysis with 13 floors in which floor twins is modeled up to 12<sup>th</sup> floor. Total of 13 cases are proposed with floor twins are varies floor height and the optimum condition is identified to resist seismic action. The tower is analyzed for zone 4 against medium soil type.
2. The study is conducted for both the directions viz. lateral and longitudinal direction.
3. Study is completed against various seismic parameters consists maximum displacement and storey drift in bot X & Z direction.
4. Conclusively the optimum case out of various cases is suggested with the help of above numerical data and Staad analysis.

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# Electric Load and Solar Irradiance Forecasting in Microgrid using High Order MIMO Fuzzy Logic Approach

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**Abstract**— In the modern world, the concept of microgrid is rising at a very rapid rate. With the high participation of the renewable energy resources, the system is considered to be highly advantageous. But, with such integration comes the problem related to their uncertain nature. The major source of energy in the microgrid is considered to be the solar PV which depends upon the value of solar irradiance i.e. uncertain in nature. This uncertainty is dependent upon the various weather based parameters like temperature, wind speed, rain etc. Along with the uncertain source, the load in the system is also variable in nature; depending upon the similar weather based parameters. Thus in this paper, using the high order multi input multi output (MIMO) fuzzy logic approach the forecasting of both the solar irradiance and electric load has been done. The proposed approach is validated by comparing with the real time values of the parameters.

**Keywords**— Forecasting, Solar Irradiance, Load, Microgrid, MIMO, Fuzzy Logic.

## I. INTRODUCTION

For the utmost few years, the use of renewable energy sources (REs), especially, solar energy has been in vogue across the globe. So, in less than a decade, the most famous: solar energy has achieved a growth of 40-50 % as the unquestionable origin of electricity generation [1]. With the fast and linearly increasing growth of these resources, their incorporation with the main utility grid has been encouraged by many developing nations across the globe, including the European, African states and specially in Asian states like India. Plainly, this integration of REs mainly solar, wind and biomass with the grid possesses various overall benefits to the power system, but also includes several challenges like its inter integration, high initial capital cost, operation and maintenance cost, frequency or voltage mismatch, limited system expansion, and so on [2].

Apart from these challenges, the primary being utility grid integration and frequency mismatch resulting in

power supply unbalancing and finally fluctuations, the other problem connected to the REs is their unpredictable power generation, whereas in case of the microgrid system the unpredictable nature of the load is also a concerned issue. Initially, the solution identified for treating such problems was the battery energy storage system (BESS). Merely, the issues pertained due to its functioning, high cost, large space requirement and requirement for charging and discharging and thus restricted its applications. Therefore, leading towards a true and suitable solution of forecasting (solar forecasting) [3].

Sweeping over the drawbacks of BESS, solar power forecasting can be specified as the expectation of the future value of solar power generation depending upon the various uncertain meteorological parameters and the latter, i.e. the load can be defined as the prediction of the future value of the electric load based on the previous available data [4]. In accession to this, the solar power generation depends upon the value of solar irradiance (SI) or precisely the global horizontal irradiance (GHI) which further relies upon the various weather based parameters like temperature, wind speed, movement of the cloud, amount of rain, location, humidity, shadowing effect, etc. Similar to solar, the electric load too depends upon the alike parameters. Thus, the foremost step in the solar power forecasting system is the forecasting of available GHI along with the data analysis of the various parameters for load forecasting [5]. Hence, with the accessibility of accurate solar irradiance and the load. many problems like uncertainty in solar power generation, system's reliability and stability concerns can be resolved. With the principle advantage of accurate solar and electric load forecasting affecting the operation and economics of power system, it too includes the diminution in cost of BESS, thus, a preferred solution [6] [7].

Thus, increasing the role of the solar based REs; dependent upon the various meteorological parameters, the need of accurate forecasting of the solar irradiance

and further solar power along with the prediction of the total electric load of the location (known as microgrid) for its incorporation with the grid is very important [8].

Presenting the concept of accurate forecasting into the microgrid environment, the power system has various short and long term advantages. Amending the system characteristics, these advantages can be identified on the footing of their time interval as well as the length. Being time and distance dependent, these advantages are classified as:

- Short term benefits: The problem of potential difference and frequency regulation can be easily rectified within a short time interval, i.e. ranging from 0-15 kms and a few min. and a few min. Moreover, the issue of grid stability present at the local level can also be solved by the very short term forecasting of both the solar based power and the electrical load.
- Medium term benefits: Considering the medium term, i.e. for a few hundreds of kms and a few hours, working in microgrid environment, forecasting of the total available load and the power generation source provides the benefit of burning down the transmitting and distribution (T&D) cost, i.e. by reducing the T&D losses of the arrangement. It also minimizes the overall cost of storage system by optimally scheduling the size of the reserves.
- Long term benefits: Depending upon the long term forecasting, i.e. on monthly to yearly basis and mostly at the state level, the issues related to congestion management, generation planning, system expansion, etc. can be eliminated. As well, offering diverse types of incentives to the power system; accurate forecasting leads to successful power trading of the imaginations.

The various other benefits include:

- Improved unit commitment
- Optimal planning
- Optimal power generation

- Power trading
- Smart Grid integration
- Reliability issues

Thus, there are several benefits of the forecasting in microgrid and the power system environment. Solar irradiance forecasting is the foremost step in the solar power forecasting under with the impact of various weather based parameters. In summation, these particular parameters affect other very essential ingredient of the microgrid system, i.e. electrical load. Thus, the various independent parameters, i.e. the meteorological parameters affecting the solar irradiance forecasting are shown in Figure 1.

The figure shows parameters like season of the year, time of the day, temperature, wind speed, rain and humidity etc. that directly affects the GHI and the electrical load, along with cloud movement, dust and the aerosol particles that affect the level of GHI available. Whereas, the effect of these parameters also depends upon the location of forecasting. Moreover, the identification of various measurable parameters is of utmost importance when dealing with the effect of parameters, i.e. the meteorological parameters which can be easily measured in the real time. The identified parameters like relative temperature, wind speed, relative humidity, rain, time of day/ season of year and atmospheric pressure can be measured using devices like anemometer and barometer, i.e. relative humidity, relative temperature and wind speed can be measured using anemometer whereas, barometer device can be used for measuring atmospheric pressure [9] [10].

In the past, various forecasting techniques such as time series based statistical method; physical methods, ensemble methods, etc. have been proposed [11]. These widely used methods utilize the historic data of various parameters for the purpose of forecasting. In addition to these statistical and physical forecasting approaches, artificial intelligence and fuzzy logic based approaches

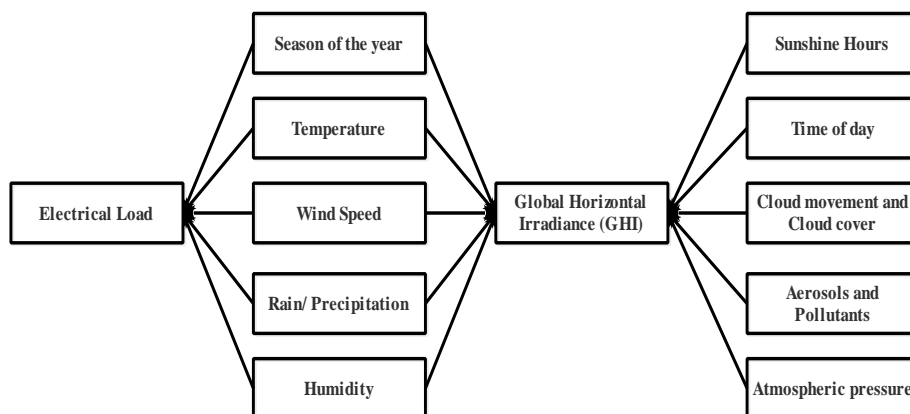


Fig.1: Various parameters affecting electrical load and GHI

form an integral part of accurate estimation of solar energy [12] [13]. Fuzzy logic based system being user friendly, robust and simple to design is preferred over the Artificial Neural Network (ANN) [14] [15]. As per the literature, the work done in the area of forecasting these parameters are well discussed in [16] [17], [18] [19] [20] [21] [22] [23] and [24].

For effective and efficient forecasting, in addition to various methodologies, the other important parameter is the time horizon of forecasting. Basically, it can be defined as the time interval for which the forecasting is intended for. These horizons can be classified as long term, medium term, short term and very short. Among all, the very short term, i.e. few minutes to a few hours ahead and short term, i.e. few hours to a few days ahead are highly effective. The reason lies in the fact that, very short and short term time horizon provides high accuracy level and least calculated error. Referring to the accuracy of the forecasting method, the error evaluation of a certain method is done using various conventional methods like Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Bias Error (MBE) and Mean Square Error (MSE) [25].

Thus, the main objectives of the work is to accurately forecast the available solar irradiance and the real time electrical load dependent upon various parameters and further in future to analyze its role in the planning of a solar based microgrid. To achieve the objective, i.e. accurate forecasting, the high order MIMO fuzzy logic based approach has been used. The proposed method uses the real time data of measurable parameters. These parameters can be measured using various devices like pyranometer, anemometer, rain gauge and barometer. The accurate evaluation of the proposed system is done using various error indices like MAPE, MBE and RMSE.

**II. PROPOSED METHODOLOGY**

Being simple, robust and user friendly, the fuzzy logic based approach can be termed as the simplified form of classical logics involved in forecasting. The working of fuzzy logics is based on the non-linear mapping of input variables, i.e. uncertain parameters to the output. The benefit of using fuzzy logics concerning the purpose of forecasting lies in the absence of the exact model of the situation or in other words the presence of uncertainty or ambiguity in the system. Fuzzy logic allows solving difficult decision making problems with many inputs and output variables. The Figure 2 shows the basic architecture of the fuzzy logic system with all its major components.

The blocks, membership function editor, rule editor and fuzzy system editor are the path to provide the input

and its related conditions to the system, whereas, the rule viewer and surface viewer give the output of the system.

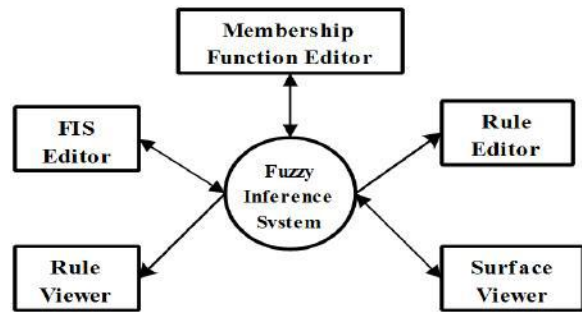


Fig.2: Components of Fuzzy logic models (FIS)

The generalized flowchart for developing fuzzy logic prediction models is given in Figure 3, showing basic steps used for the fuzzy logic approach.

The input given to the designed FIS system, i.e. the uncertain parameters can be defined as the crisp values limited to a specific range. Following the input process, the fuzzification of these inputs, i.e. these crisp values are evaluated in parallel using the fuzzy reasoning system, i.e. designed rules, which includes IF-THEN logics. The results of the activated rules are combined together and defuzzification is done.

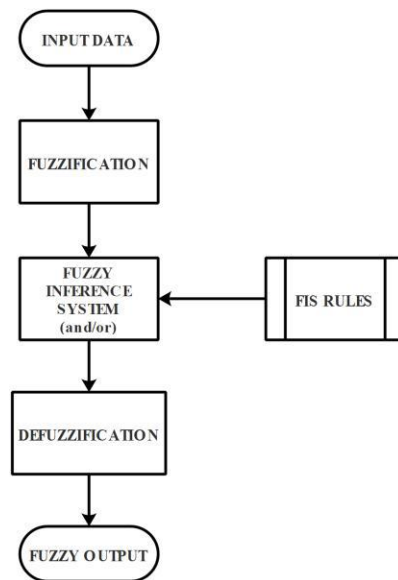


Fig.3: Working flow chart for fuzzy logic models

The output of the system after defuzzification process depending upon the various uncertain parameters (input variables) and the designed set of rules is again a crisp value. Considering the property of fuzzy logic system, all these uncertain inputs and dependent output are to be fuzzified in respective membership function in the range of [0, 1].

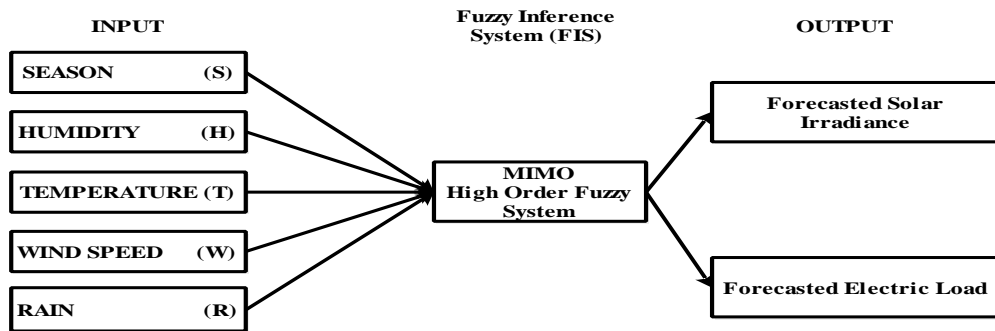


Fig.4: Layout of proposed model

2.1 Layout of proposed methodology

Utilizing the advantage of the fuzzy tool in Matlab Software which includes verifying its ability to correlate the various parameters with each other and give accurate output depending upon the rule base. Thus, on the basis of the literature survey, the measurable parameters on which the forecasting of solar irradiance and the electric load are directly dependent are identified as season of the year, relative temperature, relative humidity, wind speed and rain. The output of the designed system is the forecasted solar irradiance (W/m<sup>2</sup>) and the electrical load (kWh). The block layout for the fuzzy logic based approach is shown in Figure 4. The figure shows all the above mentioned five uncertain input parameters and the required output parameter as solar irradiance and the electric load. Here, season of year is represented by S, humidity by H, relative temperature by T, wind speed by W and rain by R.

The system has been termed as the MIMO high order fuzzy system due to its multi number of inputs and the multi number of output and high order as high order system is the one depending upon the number of inputs and their respected membership functions, thus resulting in large number of rules (up to 450) to be designed. Also, increasing the number of rules leads to increase of accuracy level of the system such that a number of rules are dependent on the number of membership functions. Thus, depending upon the minimum and maximum values of each parameter observed, the membership functions for all are distributed. Below the Figure 5 to Figure 10 shows membership functions all the input and output parameters, designed on the behalf of their maximum and minimum observed values.

For the proposed system, the various membership functions are given as:

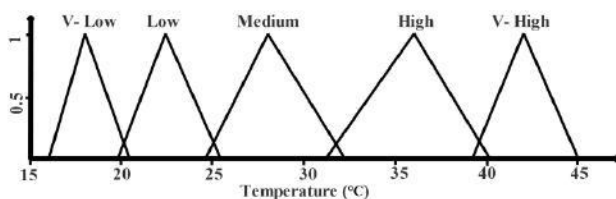


Figure 5 Membership function for temperature input

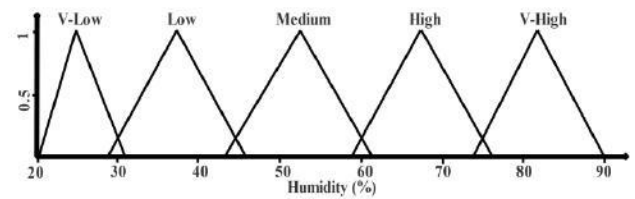


Fig.6: Membership function for humidity input

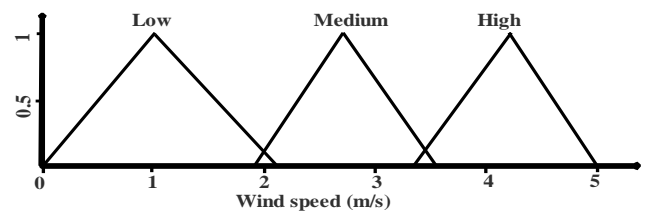


Fig.7: Membership function for wind speed input

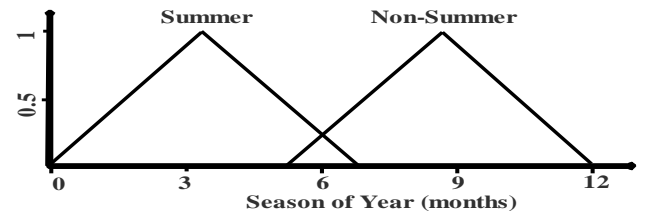


Fig.8: Membership function for season of year input

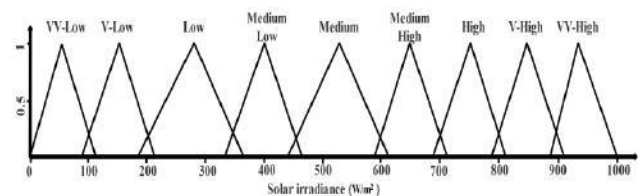


Fig.9: Membership function for solar irradiance output

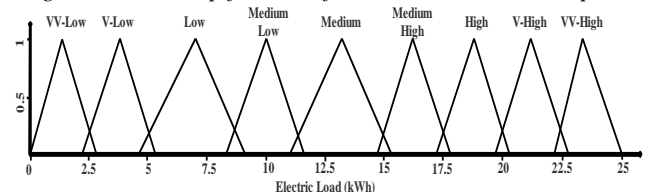


Fig.10: Membership function for electric load output

In reference to the above model and the membership functions, below the sample set of rules are given as:

Table.1: Sample set of rules for fuzzy logic system

Season	Temp.	Hum.	Wind speed	Rain	Solar Irr.	Electric Load
Summer	Very High	Med.	Med.	High	H	MH
Summer	Very High	Med.	High	High	MH	MH
N-Summer	Very Low	Low	High	High	VL	M
N-Summer	Low	Very Low	Med.	Low	M	MH
N-Summer	Med.	High	High	High	ML	L
N-Summer	High	High	Med.	Low	M	L
N-Summer	Very High	Med.	High	Low	MH	L

For the purpose of data collection of various parameters, the different devices have been studied and used which includes, the pyranometer device for solar irradiance, anemometer device for temperature, humidity and wind

speed, rain gauge for the precipitation and the energy meters for electric load data. Below the sample data has been shown in table 2.

For the purpose of system validation in comparison to the real-time values of the parameters, few error indices are given as: mean bias error (MBE), mean absolute error (MAE), root mean square error (RMSE), mean square error (MSE) and mean absolute percentage error (MAPE) [equation 1- 5]

$$MBE = \frac{1}{N} \sum_{i=1}^N [Y'_i - Y_i] \tag{1}$$

$$MAE = \frac{1}{N} \sum_{i=1}^N |Y'_i - Y_i| \tag{2}$$

$$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (Y'_i - Y_i)^2} \tag{3}$$

Table.2: Sample set of real time data logged using various measuring devices

Date	Time	Temp.	Unit	Hum.	Unit	Wind Speed	Unit	Rain	Unit	Solar Irradiance	Unit	Load	Unit
01-01-18	12.30	20.6	°C	20.9	%	1.56	m/S	0.7	mm	235	W/sqmtr	10.54	kWh
15-01-18	3.30	23.5	°C	22.37	%	1.4	m/S	0.7	mm	290	W/sqmtr	13.22	kWh
02-02-18	12.30	20.9	°C	25	%	1.29	m/S	0.71	mm	330	W/sqmtr	14.76	kWh
15-02-18	3.30	22.8	°C	24.29	%	1.04	m/S	0.738	mm	406	W/sqmtr	13.43	kWh
02-03-18	4.30	23.6	°C	24	%	0.7	m/S	0.76	mm	465	W/sqmtr	11.49	kWh
02-03-18	4.30	23.6	°C	24	%	0.7	m/S	0.76	mm	465	W/sqmtr	11.49	kWh
02-04-18	2.30	32.5	°C	10.06	%	1.24	m/S	0.35	mm	739	W/sqmtr	15.89	kWh
02-05-18	11.30	24.6	°C	20.4	%	1.85	m/S	0.90	mm	759	W/sqmtr	7.21	kWh
03-06-18	2.30	28.6	°C	30.2	%	2.33	m/S	0.91	mm	840	W/sqmtr	16.84	kWh
06-07-18	12.30	29.8	°C	24.3	%	2.03	m/S	0.89	mm	795	W/sqmtr	15.65	kWh
13-09-18	12.30	24.9	°C	55.6	%	3.10	m/S	2.08	mm	450	W/sqmtr	14.98	kWh
16-10-18	2.30	23.5	°C	35	%	2.63	m/S	1.96	mm	420	W/sqmtr	11.8	kWh
14-11-18	10.30	15.6	°C	26.8	%	2.98	m/S	1.85	mm	197	W/sqmtr	16.65	kWh
18-12-18	4.30	9.65	°C	30.6	%	1.59	m/S	1.65	mm	265	W/sqmtr	18.65	kWh



MSE

$$= \frac{1}{N} \sum_{i=1}^N (Y'_i - Y_i)^2 \tag{4}$$

MAPE =

$$\frac{100}{N} \sum_{i=1}^N \left| \frac{Y_i - Y'_i}{Y_i} \right| \tag{5}$$

### III. RESULTS AND DISCUSSIONS

Corresponding to the five input parameters; time of day, relative temperature, relative humidity, wind speed and rain, the MIMO high order fuzzy logic based systems have been developed. Considering the membership functions of each parameter the number of rules calculated are 450, out of which sample rules are given in Table 1 as mentioned in section 2. The results of the developed system shown in Figure 11 with input values: 4th month of the winter season, relative temperature 32.5 °C, relative humidity 10 %, wind 1.24 m/s and rain of 0.35mm on per unit scale.

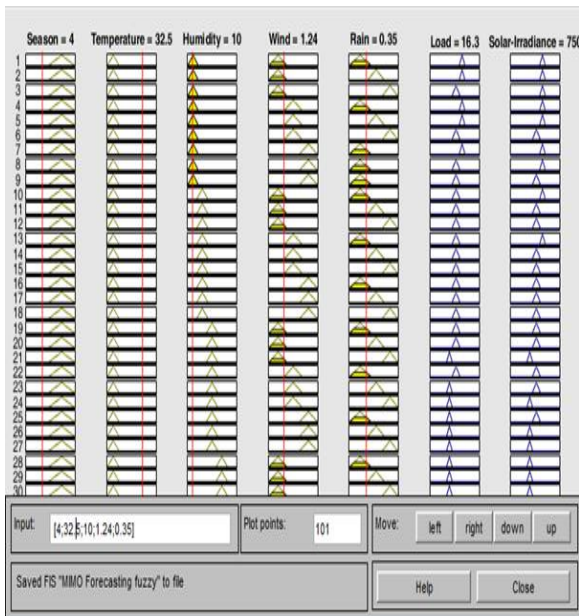


Fig.11: Rule viewer of Fuzzy Logic approach

The rule viewer window to the designed fuzzy logic system shows the crisp value of all input variables and its corresponding output i.e. forecasted solar irradiance which is 750 W/m<sup>2</sup> whereas the forecasted load is 16.3 kWh. Thus, the result obtained from the developed fuzzy model which is forecasted solar irradiance for a particular value of season of year, relative temperature, wind speed, relative humidity and level of rain, given by 750 W/m<sup>2</sup> and must be compared with the actual value of the solar irradiance which is 739W/m<sup>2</sup> and electric load value of 15.89 kWh for the purpose of model validation.

The graph plots display the comparison of the proposed approach with respect to the actual values measured. Also, for the purpose of system validation,

various error indices like MBE, RMSE and MAPE have been used.

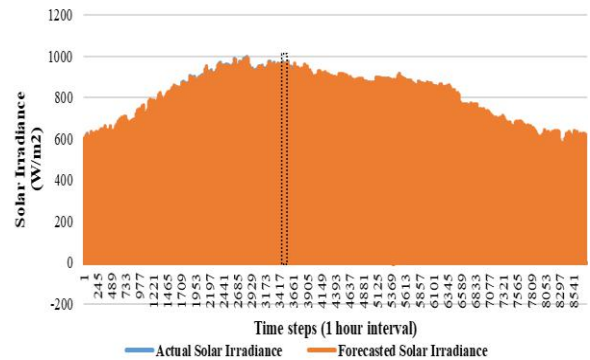


Fig.12: Graph Plot for Actual irradiance and Fuzzy forecasted irradiance

The graph plot in Figure 12, shows the comparison of fuzzy forecasted solar irradiance with the actual solar irradiance value. As discussed above, fuzzy logic based forecasting methodology being more flexible and accurate shows very less variation in comparison to the actual value of solar irradiance, such that at only few instances the high value of error exists.

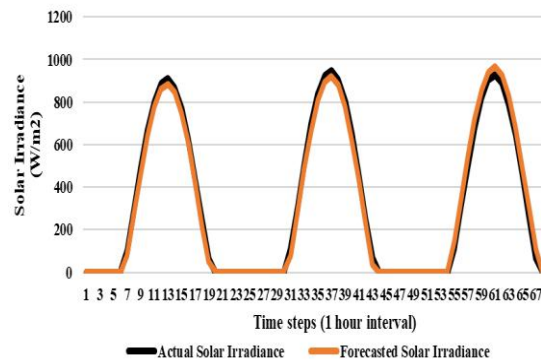


Fig.13: Graph Plot for Actual irradiance and forecasted irradiance (Close in view)

Referring to the above plot, the Figure 13 shows the close in view of the compared values such that to witness the fluctuations in the forecasted value of the solar irradiance. Thus, based on the recorded values of the solar irradiance in the year 2017, the forecasted value of the solar irradiance is compared with the values of the next year i.e. 2018. The plot significantly shows little deviation in the forecasted values from the actual values, whereas follows the similar trend of high irradiance in the mid of the day and low in the other time of day.

Alike, the previous comparison of actual solar irradiance with the forecasted irradiance, in Figure 14 the comparison of actual electric load with the forecasted electric load in kWh has been shown. The plot shows the variation in the electric load with the passing time of the year whereas the average load being around 10.34 kWh with the peak at 20.65 kWh and minimum at 2.17 kWh.

The dotted block represents the close in view represented in the figure shown below.

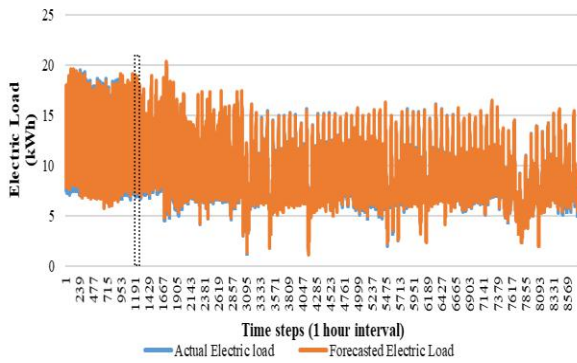


Fig.14: Graph Plot for Actual Electric load and Fuzzy Forecasted load

As per the figure, the variation in the electric load. i.e. between the actual electric load and the MIMO fuzzy forecasted electric load is evident in nature such that the error between the two has been evaluated using the MAE, RMSE and the MAPE respectively.

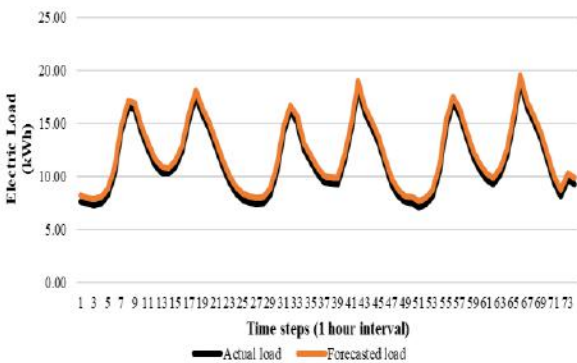


Fig.15: Graph Plot for Actual Electric load and Fuzzy Forecasted load (close in view)

Using Equation 1, Equation 3 and Equation 5 mentioned in section 2, the error analysis in the proposed fuzzy logic system with the actual values of the load and the available solar irradiance has been done and shown in Table 3.

The table shows the error available in the forecasted values against the actual values of both the parameters, i.e. solar irradiance and the electric load. Whereas, the system can be considered fit for the future work as the error percentage (MAPE) and the RMSE value are in the satisfactory range.

Table 3 Error evaluation of proposed methodologies

	Error Evaluation		
	MBE	RMSE	MAPE (%)
Proposed Methodology (Solar irradiance)	1.948858	0.051538	9.285

Proposed Methodology (Electric load)	0.086467	0.239733	2.446480
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IV. CONCLUSION

In this paper, considering relative temperature, relative humidity, wind speed, rain and the season of year as independent uncertain input variables, a high order MIMO fuzzy logic based approach for short term solar irradiance and electrical load forecasting has been done. For the purpose of real time data measurement of parameters at the set location, i.e. 30° 21' 21.63" N and 76° 22' 19.71" E, various devices like Pyranometer and anemometer devices have been used. The results of the proposed high order fuzzy logic based approach dependent upon the designed rule base of 450 rules show crisp value for forecasted solar irradiance and electrical load with an error of 0.051 and 0.239 RMSE respectfully and 9.285% and 2.446% MAPE respectfully in comparison to the real time observed values. In addition, for the purpose of solar power generation and the variations present in it the power equation for the solar panel depending on the forecasted values of solar irradiance and the standard test conditions of solar panel has been well discussed.

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# MOST as a tool to Support the Deployment of New Manufacturing Products

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**Abstract**— During the process of choosing a new product, the selection of those that are financially viable and economically profitable is crucial. It is essential to consider as important all the elements that influence the cost of a product. At this point of feasibility analysis, the role of process engineering is to analyze the manufacturing process and to predict, with maximum precision, the time required to manufacture a given product, since the manufacturing time directly influences the value of direct labor cost. The purpose of this research is to use MOST (Maynard Operations Sequence Technique), from Predetermined Motion Time System, to estimate the time required to manufacture a new product. This work, classified as an exploratory case study with qualitative and quantitative analyzes, was developed in a multinational industry of the audio sector located in the Manaus Industrial Pole. The analysis of the new product using image and/or sample served as the basis for the choice of assembly sequence, the first step to be developed for the use of MOST. Afterwards, the indices were applied for each activity performed during the manufacturing and finally the standard time of assembly of the product was calculated. The result of this research shows that through MOST it was possible to estimate the standard time of a new product and obtain the labor cost of R\$1.82.

**Keywords**— Maynard Operation Sequence Technique (MOST), Predetermined Motion Time System (PMTS), Standard Time, New product.

## I. INTRODUCTION

Due to the globalized market, companies focus on continuous improvements within their production process and tend to reduce their wastes so that they can improve their performance, thus reducing their set-up, loss and cost indexes, which has attracted managers to more production with less [1].

Lifting the cost of a new product is usually done in the planning phase. However, estimating the cost at this stage

may contain risks due to lack of accuracy of the data leading to decision making based on the analyst's instinct. Without the correct data the analysis of implementation of a new product can be overestimated, that is, with values above the real cost. Although this is a widely used position, because overestimating is safer than underestimating, this miscalculation can determine the cancellation of the new product implementation [2].

The manufacturing cycle time is one of the most relevant information in the analysis of a product's implementation. Knowledge of the time required to perform a particular task is necessary, among other factors, to meet the production plan, determine performance and establish costs. In the introduction of a new product, if the company uses a technique of Predetermined Motion Time System (PMTS) the process of planning and costing can be carried out with greater assertiveness [3].

The standard time is also used to determinate the resources available for production effectively during the production scheduling process. Provide data for balancing analyzes of the production structure, comparing manufacturing schedules and analyzing capacity planning. It also provides standard cost data, costing of production to be useful in budget calculations during the introduction of new products [4].

The activities performed within the manufacturing are composed of basic movements performed by the operator in order to achieve a determined result. They are movements that resemble processes such as reaching, moving, rotating, pressing, grasping, positioning, releasing, eye movements (revising), trunk, arms and legs, walking. The PMTS techniques propose analyzing each step of the operation, dividing it into basic human movements and computing the time required for each movement, where each has its associated value and time [5].

Since 1970 the Maynard Operation Sequence Technique (MOST) is one of the most applied in the world. It is five times faster to apply than other traditional PMTS methods [3]. Using MOST it is possible to calculate the time before production starts, resulting in a useful method for product design, tool selection and project development together with production scheduling and control.

## II. LITERATURE REVIEW

### 2.1 Time Study

Frederick W. Taylor is considered the father of the Scientific Administration, because at the end of the 20th century, through his works, he suggested systematizing the concept of productivity. Taylor focused on task management analysis, where he broke down tasks into elementary subtasks and worked extensively to make each of these tasks more efficient. With this, it has developed work methods and processes to obtain higher productivity at the lowest possible cost [6] [7].

The method that Taylor used to develop his study of Scientific Administration consisted in identifying the beginning and end of a production activity, dividing it into elementary activities, measuring with a timer, the time required for each one, and then reassembling it so that the total time for its execution was minimized [7]. Thus, the study of time was born, that is defined as a technique to measure and record the time that the operator takes to execute a certain task under specific conditions, method and rhythm [5].

Knowledge of the time required to perform a given task is directly related to the concept of productivity. For Taylor the improvement of work efficiency would be achieved by analyzing and improving working methods, reducing the time required to perform work and developing working patterns.

Before conducting the Time Study, it is important to ensure that the Motion Study has been performed so that all excess work has been eliminated and also that the total work content is as close as possible to the content of the basic work unit, that is, the minimum work required to perform the task [5].

### 2.2 Motion Study

The Motion Study is concerned with finding the best method of performing a given task. This study, pioneered by Frank B. Gilbreth and his wife Lillian M. Gilbreth in 1912, began when Frank, after opening his own contractor, noticed that each mason had his own method of doing the work and that two men would never worked equally well. In addition, he noted that they did not

always use the same sequence of movements. A bricklayer, for example, used a sequence of moves when he wanted to do the job faster, but he did other moves when he worked slowly, and still others when teaching a person how to lay bricks. From these observations Gilbreth began to develop the best method (standard method) to perform a certain task [8] [9].

The Gilbreth couple extended the concepts of scientific management for the identification, analysis and measurement of the fundamental movements involved in the work. Using a cinematic camera, they began to record the task if they analyze the movements. In this way, they were able to categorize human movements into 17 basic elements or "therbligs", anagram of the name Gilbreth [10] [11] [12].

The therbligs could be plotted on a SIMO (Simultaneous Motion Chart) along with the time each move would take. Then, by examining the graphs, it was possible to determine which therbligs were taking too long and / or which could be eliminated by rearranging the movements. It is worth mentioning the time values associated with each therbligs were not pre-determined values. The Gilbreths believed that with an improved method of work, the shortest cycle time would naturally arise [10].

Understandably, there were those who followed Taylor and his Time Study, and there were those who followed the Gilbreth couple and their Motion Study. However, there was a third group interested in using the best of each technique together. From this union of the Time Study and Motion Study came the PMTS [3].

### 2.3 Standard Time

The time set for the execution of a task or job is called the "Standard Time". This time is obtained by applying techniques that help determine the time that a qualified operator takes to complete a specific task when working at a defined speed (work pace). The various advantages of an organization maintaining a standard time database range from estimating the cost of labor to establishing production capacity, critical factors and influencing productivity [4] [13] [14].

The standard times are influenced by the type of material flow within the company, the nature of the process chosen, the technology used in the production and the characteristics of the activity performed. Even so, the greater the difficulty of measuring time, the greater the human intervention in the activity. Already in automated lines, time measurements vary very little [3].

To determine the standard time it is necessary to analyze the execution of the activity by a qualified operator. The qualified operator is neither the best nor the worst, but someone who is skillful and can perform activities consistently throughout the work day. He is a motivated operator with the experience and skills to perform work at acceptable levels of quality and quantity in a safe manner [4].

Another factor that must be considered during the measurement of the standard time is the work pace. Work pace is the rate at which the operator is steadily developing his activity for a full day's work. It cannot be too fast or too slow, it should be medium. You should keep this median, since the worker rarely keeps up the same rhythm of work for long hours. At certain times, the worker will perform faster or slower than the normal pace. The normal rhythm represents an ideal standard that the average worker should be able to maintain in the long run [4] [8] [15] [16].

The last two factors that influence the measurement of the standard time are the method and the tolerances. As already described, the concern with the correct definition of the method before performing the measurement is highlighted since the time of Taylor. Tolerances are the addition of a time, often calculated in percentage form, to the measured time referring to the personal needs of the operators like fatigue, waits, breaks besides inevitable small delays [3] [4] [8] [15] [16].

2.4 Predetermined Motion Time System

The PMTS is a system of techniques that use time patterns associated with human movements to define the time required to perform operations. They are job measurement systems to determine workforce performance on an assembly line. Unlike techniques classified as Direct Observation or Estimation, techniques classified as PMTS calculate the time of an operation by deriving predefined time patterns for various movements [17] [18] [19].

PMTS techniques are employed in the construction of standard times at various macro levels, operations, characteristics and products, and form the basis of activities related to industrial engineering and costing procedure. PMTS techniques are mainly used in an industrial environment to analyze the methods of manual operations resulting in the definition of the standard time in which an operator must complete the operation [20].

Typically, PMTS techniques divide the whole operation into basic human movements, also called micro-movements, and classify each of them based on the nature of the movement (ie, movement elements such as 'understand', 'put' and 'reach', and mental functions such as 'identify', 'find', and 'decide') and the condition in which the movement is being performed. The times defined for basic human moves are employed in the sum of the time for an operation at defined levels of performance [19] [21].

Using the PMTS techniques to measure the time of an operation has become a matter of establishing the best basic motion sequence to execute a given task and from the catalog or data table assign the appropriate predetermined time for each movement of that standard sequence. Since the times for all movements are predetermined, it is possible to accurately predict the times of future operations, that is, operations that are not current [3] [8] [20].

The main uses of PMTS techniques can be divided into two classes: Method Evaluation and Standard Time Establishment. Table 1 shows the main reasons for using PMTS techniques divided into two categories suggested by [9].

Numerous techniques have been developed within the PMTS concept. The most used are: Methods of Time Measurement (MTM), o Modular Arrangement of Predetermined Time Standards (MODAPTS), and Maynard Operation Sequence Technique (MOST) [17] [18] [19] [20] [21].

Table 1: Main uses of PMTS

Method Evaluation	Standard Time Establishment
Improvement of existing methods.	Direct use of synthetic times for the establishment of standard times.
Evaluation of proposed methods before production starts.	Compilation of standard data and formulas for specific classes of work in order to make the establishment of standard times faster.
Evaluation of projects of tools, devices and equipment.	
Product design assistance.	Verification of the standards established by time study.
Training of supervisory personnel to guide them in relation to the study of movements and times.	Auditing of standard times.

Source: [9].

## 2.5 Maynard Operation Sequence Technique – MOST

MOST is a PMTS technique that allows you to establish the standard time of any manual activity, and some tool operations, using the concept that every operation is formed by fundamental activities combined with each other. For MOST, with the exception of activities that involve "thinking", the purpose of a job is to achieve a goal by moving objects. This is why MOST is a system that concentrates effort in measuring work through the interaction movements between man and object [3] [22].

A standard operation is a sequence of movements, combined with each other, that have certain beginning and end, performed in a workstation. The organization of the movements directly impacts the standard operation time. Each operation is formed by sub operations that can be conceptualized as blocks that fit, that is, they are part of the work developed within the operation [3] [23].

These movements of interaction between man and object follow, almost always, the same sequence. For example, to write a sentence in a notebook using a pen, it is first necessary to 'reach' the pen, then 'pick up' the pen, then 'move' the pen to near the notebook sheet and finally 'position' the tip of the pen on the notebook sheet line. These 'reach', 'pick up', 'move', 'position' moves are common in manual activities and within MOST are identified as sub activities. Each activity of an operation is formed primarily by a sequence of sub activities [3] [23].

In MTM the sequence of movements is determined randomly by the analyst, already in MOST this sequence is fixed. That is, to move an object from one point to another, the operator follows an already defined sequential model of sub activities. However, there are different types of activities according to the behavior of the operator in relation to an object. For example, "loading a carton from one end of the workbench to the other" is different from "pushing the carton from one end of the workbench to the other," both require different efforts and therefore different times [4] [24].

For these type of variations, BasicMOST defines three main Sequence Models: General Move Sequence, for spatial moves of free-form objects in the air, Controlled Move Sequence, for moving objects in contact with surfaces or attached to another object during movement and Tool Use Sequence when the activity is developed using a manual manipulation tool [4] [24]. The main function of Sequence Models is to make the analyst turn his attention to the process by analyzing a structured and standard format. Sequential Models provide a consistent

analysis of activities by reducing the omission of sub activities [3].

An analysis with MOST is done by combining several Sequence Models that will ultimately compose a sub operation or an operation directly. That is, hierarchically, the operation is divided into sub operations (this division can be at the discretion of the analyst, because if you prefer you can divide the operation directly into activities). The sub operations are divided into activities, which are classified within the Sequence Models which are then divided into sub activities. Finally, each activity receives a parameter that at the end of the calculations will form the standard time.

### 2.5.1 BasicMOST

BasicMOST was the first version of the MOST System to be launched and is able to adjust to most of the work operations performed in the industry. While MiniMOST and MaxiMOST have applications in operations made exclusively by certain industries, all companies have some type of operation where BasicMOST is the most logical version to be used [2].

An object can be moved only in two ways: either it is acquired and moves freely to the destination or it is moved in contact with another surface. For these two situations BasicMOST uses two Basic Sequence Models, the General Move and the Controlled Move. When the activity uses a manual manipulation tool, it needs to be analyzed according to a third Sequence Model, Tool Use, which is actually the combination of the two Basics Sequence Models. There is also a fourth Sequence Model is used for heavy object handling activities using, for example, cranes [24].

#### 2.5.1.1 General Move Sequence Model

The Sequential Model of General Moves deals with the spatial displacement of one or more objects that follow an unobstructed path through the air. If the object is in contact, restrained, or adjacent to another object during movement, the General Move Sequence Model is not applicable [2].

The General Move Sequence Model follows a fixed sequence of sub activities identified through the steps described as: REACH with one or two hands at a distance, an object directly or in conjunction with the steps of body movement; GAIN object control manually; MOVE the object at a distance to the positioning point, either directly or in conjunction with body movements; PLACE the object in a temporary or final position;

RETURN the starting position. This Sequential Model takes the form of a fixed series of letters, called parameters, which represent each sub activity [2].

An activity classified as General Movement follows three distinct phases: GET, PUT, and RETURN. The GET phase describes the actions to reach the object with body movements (if necessary) until the moment in which the control of the object is obtained. Its parameters are 'A' means Action Distance, 'B' stands for Body Motion, and 'G' means Gain Control. The PUT phase describes the action performed to move the object to the other location and has parameters 'A', 'B' and 'P' which means Placement. The last phase, RETURN, simply refers to the return of the operator to the initial position on the workstation its only parameter is 'A' [23].

2.5.1.2 Controlled Move Sequence Model

The Second Sequence Model is called as Controlled Move. Describes the manual movement of objects in a "controlled" path, that is, when moving, the object must follow at least one specific direction in contact or attached to another object. This sequence is also used to analyze activities with manipulation of levers or cranks, push a button or power switch or simply drag an object under a surface [2] [24].

Like the General Move Sequence, the Controlled Move Sequence Model follows a sequence of predetermined sub activities: REACH one or two hands at a distance, an object directly or in conjunction with the body's movement steps; GAIN object control manually; MOVE the object in a controlled and determined path (within reach or with steps), ALLOW a certain time for a machine to carry out its process; ALIGN the object after following the controlled path, or at the end of the machine's processing; RETURN the starting position [2].

The Controlled Move Sequence Model also follows three distinct phases: GET, MOVE or ACTUATE and RETURN. The GET and RETURN phases describe the same sub activities, with the same parameters of the General Move Sequence Model. The big difference is in the MOVE or ACTUATE phase, which describes two types of actions. 'Move' simply means to move an object through a controlled path and 'Actuate' refers to the action of moving a particular object. For this new MOVE/ACTUATE phase, new parameters are established: 'M' stands for Move Controlled, 'X' means Process Time and 'I' means Aligment [23].

2.5.1.3 Tool Use Sequence Model

This model covers activities that use manual tools for actions such as fastening and loosening, for example, in addition to activities involving cutting, surface treatment and measurement. This sequence of movements also includes actions with tools that are not classified as equipment as pencil, to write and marker to mark, and activities classified as information recording. The Use Tool Sequence Model also involves activities performed with mental actions such as reading and inspection [24].

The sequence phases of the Tool Use Sequence Model follows the activities: GET TOOL, PUT TOOL/OBJECT IN PLCE, TOOL ACTION, PUT TOOL/OBJECT ASIDE, and RETURN. The only phase that is common to the other Sequence Models is the 'Return' phase, because it is the return of the operator to the initial position. The GET TOOL phase deals with the action of reaching a tool or object at a certain distance, directly or in conjunction with body movements, so it receives the parameters 'A', 'B' and 'G'. The PUT TOOL phase refers to the action of moving the tool or object at a certain distance to the place where it will be used, directly or in conjunction with body movements, thus receiving the parameters 'A', 'B' and 'P'. The TOOL ACTION phase is the action to apply the tool and its parameter varies according to the type of tool being used: 'F' for fastening tools, 'L' for loosening tools, 'C' for cutting tools, 'S' for surface treatment tools, 'M' for measuring tools, 'R' for tools used to record information, and 'T' for thinking-related actions. Then the other "PUT TOOL" phase is the action of holding the tool, if it is used again, drop it or place it next to it, return the tool to the initial position or move it to another position, also either directly or in conjunction with body movements, to receive the parameters 'A', 'B' and 'P' [2] [23].

2.5.2 Total Time

The result of the MOST operation analysis is the sum of the indices applied to each subactivity multiplied by ten. This result is obtained in TMU (Time Measurement Unit) [23]. A TMU equals 0.00001 hours. Table 2 presents the calculation for TMU conversion in units of conventional times (hours, minutes and seconds).

Table 2: Converting TMU in Conventional Time Units.

TMU	CONVENTIONAL TIME UNITS
1 TMU	0,00001 hours
1 TMU	0,0006 minutes
1 TMU	0,036 seconds

Source: [3].



The TMU value for each activity assessed under the MOST System is the result of the sum of the sub-activity indices multiplied by ten. This calculation applies to all Sequential Models (General Movement, Controlled Movement, and Tool Usage).

After the analysis result being converted into conventional time units, the so-called normal time is obtained. The standard time is obtained after applying the tolerances (concessions for personal needs, fatigue, flexion, standing work, among others), since MOST analyzes the activities considering an operator with 100% efficiency [25]. According to [26], tolerances have traditionally been determined by adding adequate percentages for each factor in an empirical way. For example, 5% for personal needs, 2 to 3% for short and inevitable delays and 5 to 8% or more for fatigue-induced rest related to light industrial work.

**III. MATERIALS AND METHODS**

The present research was carried out within the context of a multinational electronics industry, located in Manaus, capital of the state of Amazonas, from January to November 2018. It is classified according to objectives and its procedures as exploratory and study of case, respectively. Exploratory, as it seeks to deepen knowledge on the topics Cost of Manufacturing, Study of times and movements and Synthetic Time Default Systems. It is a case study, since it intends to study a real case seeking to understand the relationship between variables to develop theories. The research uses qualitative and quantitative methods in data collection and analysis. Qualitative, because certain evidences will be obtained through observations and reports, but because it

is a study that relates monetary units with units of time will be classified as quantitative [27].

A case study in the area of Production Engineering should follow steps. The theoretical-conceptual frameworks for the work are established, and then, how many and which cases will be studied. Afterwards, one must define the methods and techniques for data collection and analysis. Finally, the protocol that will contain the context of the research, the procedures that will be adopted in the field and the control variables must be elaborated [28].

The research design is the graphical presentation of the activities script that will be developed throughout the research for the elaboration, accomplishment and conclusion of the case study. Figure 1 shows the steps defined for the present case study.

The research begins by reviewing the literature in search of concepts that the author intended to address. After this process, the problem that was the subject of the case study was defined and from that point the profound literature review was begun to understand the problem and the ways of solving it.

The methodology was defined with steps and procedures to be adopted. Then, the research starts with the collection of data and definition of the premises for the application of the BasicMOST tool. It continues with the application of the proposed tool within the company environment. Then, the results are collected, and for the validation of the research proposal, comparative analyzes of these results are made with the methods currently applied by the company. Finally, the conclusions of the study are made, verifying that the objectives have been reached and future studies are being carried out.

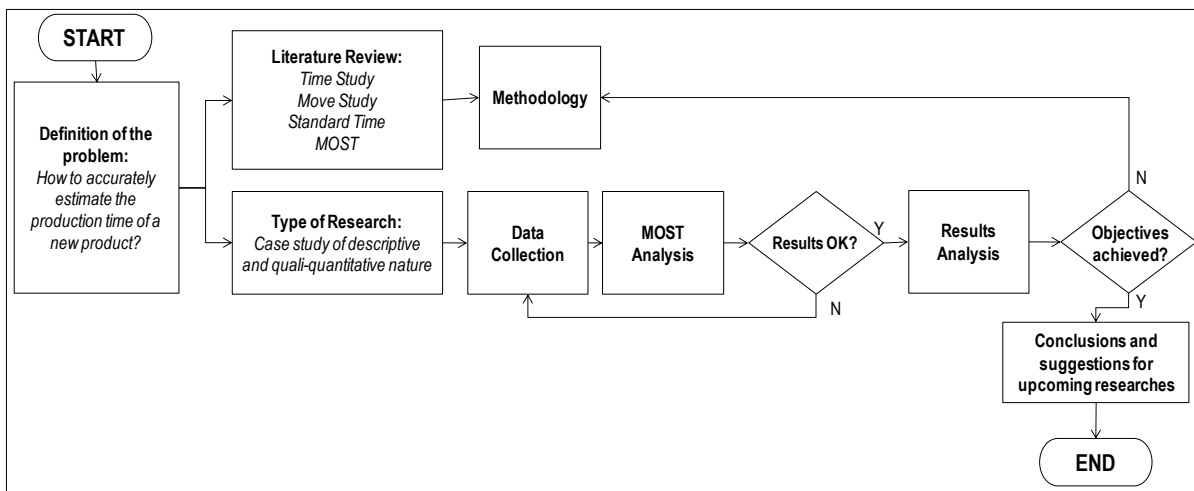


Fig 1: Research Design.  
Source: Authors, (2018).

3.1 Applying BasicMOST

BasicMOST is based on moving objects. The analyst should follow certain guidelines to develop a consistent analysis. You should not skip or change any of them, as a consequence it may result in an incomplete analysis, with erroneous results. The flow of Figure 2 shows all the basic thought processes and decisions that need to be considered to get the BasicMOST analysis.

- (1) Determine the start and end of each activity. All have a starting point and end when all activity is performed.
- (2) Describing the sequence of movements of each activity is similar to describing a stepwise method.
- (3) The analyst should study the activity in order to establish the most effective method of accomplishing the task.

(4) All activities that use tools should be analyzed as Tool Usage.

(5) Use the indexes for the tool described in the table Indexes of the Tool Use Sequence Model. If the tool is not discussed in the Table, use comparison with analog tool or use indexes of other tools such as MiniMOST, MTM-1 and MTM-2.

(6) If the object manipulated during the operation needs to follow a controlled path then the activity should be analyzed as Controlled Movement. If the object is moved freely in the air, use the indexes of the General Movements frame.

(7) Verify that all activities required to perform the operation have been described before finalizing the analysis.

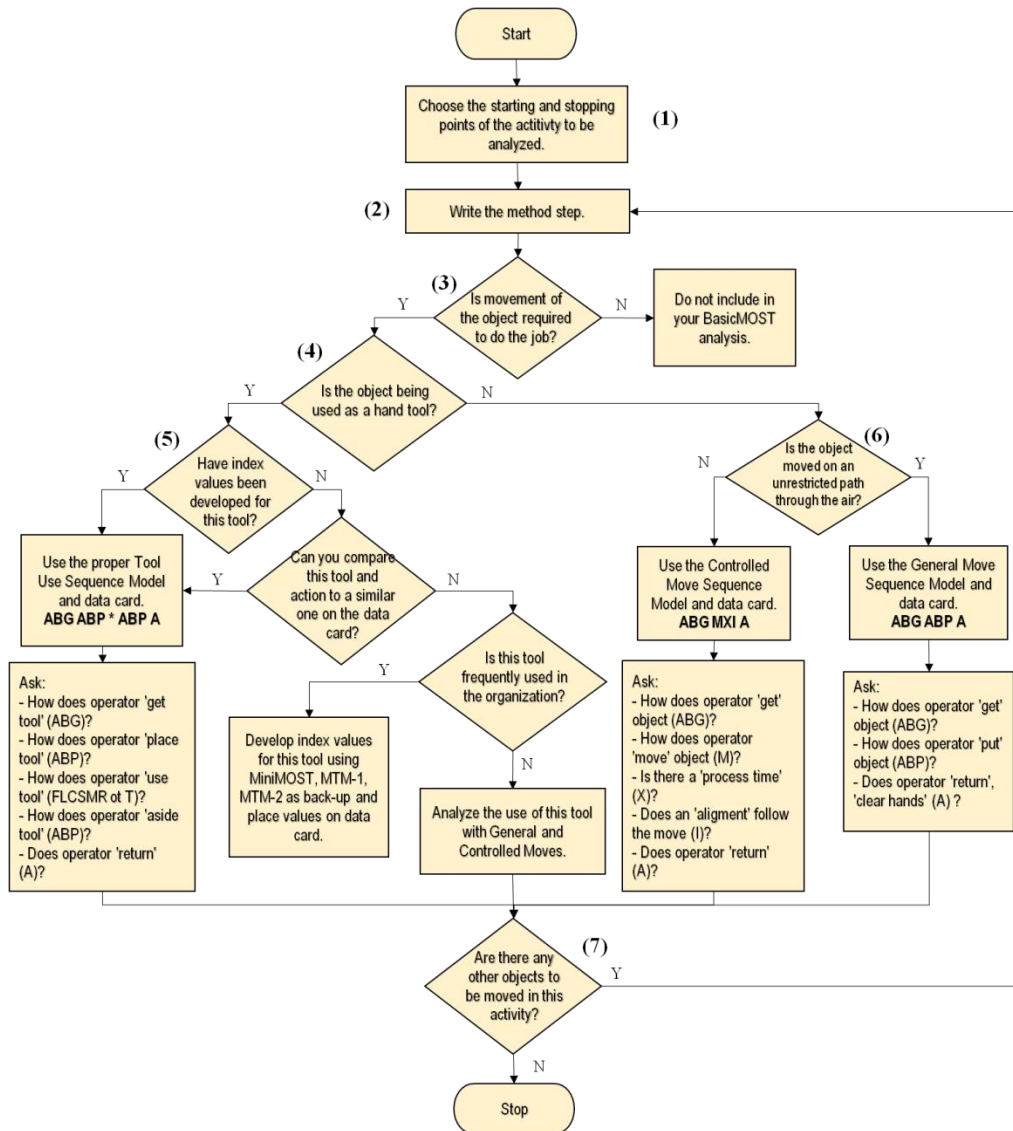


Fig. 2: BasicMOST Analysis Decision Diagram.

Source: [3].

Following the steps described in the flowchart and answering the questions is fundamental for the effective application of BasicMOST. These responses will help the analyst determine the correct sequential model to be used and the index value for each parameter (sub activity), avoiding ignoring any other objects being moved or analyzing any unnecessary activity.

3.2 Calculating the Total Time Activity

The TMU value for each activity assessed under the MOST System is the result of the sum of the sub-activity indices multiplied by ten. This calculation applies to all Sequential Models (General Move, Controlled Move, and Tool Use). For the example phrase of General Move we have the application of the indices and calculation of the total time demonstrated in Eqs.1:

**Pick up a heavy box, bend and place it on pallet.**

$$A_3 \quad B_0 \quad G_3 \quad A_1 \quad B_6 \quad P_3 \quad A_0$$

$$(3 + 0 + 3 + 1 + 6 + 3 + 0) \times 10 = 160 \text{ TMU} \quad (1)$$

This activity takes 160 TMU to be performed, which means, 5.76 seconds.

3.3 BasicMOST Form

To facilitate the application of the MOST indexes, a data insertion form was developed. The document was developed based on the models found in the literature, but

with the differential of using the program Microsoft Excel®, whose function of including formulas makes it more practical to obtain the results. Figure 3 shows how you would formulate it, and how it is divided and how it will be filled out.

IV. RESULTS

4.1 Steps for manufacturing a new product

Within the manufacturing industry the case study product will go through three pre-defined steps for all of the company's products: assembly, testing and packaging. The assembly consists of the mechanical union of the parts (raw material) that make up the product. The Test evaluates whether the features of the product meet the specifications and perform the visual inspection of the product. Finally, Packaging is the stage in which the product will be packaged for safe transportation.

Sample analysis, technical specifications, layout definition and assumptions allow the evaluator to list all the actions required to assemble, test and package this case study product, named IWICS6 (In-Wall/In-Ceiling Speakers). For the manufacturing process of this product, a total of 36 activities were described, where 16 were classified as Assembly, 5 activities were classified as Test and 15 as Packing. All these activities are evaluated for the composition of the standard manufacturing time.

BASICMOST ANALYSIS FORM																
PRODUCT:								DATE:								
ID NPI:								ANALYST:								
STEP N°	METHOD STEP DESCRIPTION	BasicMOST Sequence Model	Sequence Models												Fr	TMU
			i	i	i	i	i	i	i	i	i	i	i	i		
		General Move	A	B	G	A	B	P	A						0	
		Controlled Move	A	B	G	M	X	I	A						0	
		Tool Use	A	B	G	A	B	P	*	A	B	P	A		0	
		Controlled Move	A	B	G	M	X	I	A						0	
		Controlled Move	A	B	G	M	X	I	A						0	
		Controlled Move	A	B	G	M	X	I	A						0	
		<Sequence Model>													0	
		<Sequence Model>													0	
		<Sequence Model>													0	
		<Sequence Model>													0	
														Sum	0	

Fig. 3: BasicMOST analysis form.

Source: Authors, (2018).

4.2 Definition of types of movements and application of MOST indexes

After inserting the activities, it is necessary to determine the Sequence Model of each one: General Move, Controlled Move and Tool Use, to apply the indexes and

frequencies to obtain the normal time of the operation. In the elaborated form, the evaluator chooses between the three options and the sequence of movements (parameters) appears automatically. After this, the

evaluator determines the indexes for each and the frequency, if it is greater than 1.

In the product packing box two pieces are packaged. This information is relevant, because in the analysis carried out in an initial stage, all the activities were directed to the assembly of only one piece. To convert the result of the analysis into two pieces, it is not correct to multiply the value of all activities by two, since activities classified as Packing are common for both pieces. Thus, only the activities listed from 1 to 25 were multiplied by two (representing the two-piece assembly by adding a Fr2 column to the form). Figure 4 shows the two-part analysis of the first 10 activities. The end result of the normal time was 7600 TMU or 4.56 minutes.

4.3 Parameter Indexing Analysis

Activity analysis shows how the MOST methodology is simple and easy to apply. Activity number 34: "Picking

up the FIFO label and paste in the carton" was also classified as General Move. Its description is slightly different, in relation to activities 1 and 5, but it fits perfectly in the phase diagram determined for this Sequential Model, as shown in Table 3.

Table 3: Phases, parameters and, index values of Activity 34

General Move Sequence Model		
Pick up the FIFO label	and paste into carton box	
GET	PUT	RETURN
A <sub>1</sub> B <sub>0</sub> G <sub>3</sub>	A <sub>1</sub> B <sub>0</sub> P <sub>6</sub>	A <sub>0</sub>

Source: Authors, (2018).

The particularity of each activity reflects in the change of applied indexes. For activity 34 the following indices were applied:

FORMULÁRIO DE ANÁLISE BASICMOST			
PRODUCT:	IWICS6	DATE:	09/30/2018
ID NPI:	170417	ANALYST:	Natália Silva

STEP Nº	METHOD STEP DESCRIPTION	BasicMOST Sequence Model	Sequence Models											Fr	TMU	Fr2	Min		
			i	i	i	i	i	i	i	i	i	i	i						
1	Pick up the plastic frame and position it on the device.	General Move	A 1	B 0	G 1	A 1	B 0	P 1	A 0								40	2	0.048
2	Pick up the EVA and position it in the plastic frame	General Move	A 1	B 0	G 1	A 1	B 0	P 3	A 0								60	2	0.072
3	Pick up the speaker and posicionar on EVA	General Move	A 1	B 0	G 3	A 1	B 0	P 3	A 0								80	2	0.096
4	Pick up the screwdriver and tighten the speaker on the frame	Tool Use	A 1	B 0	G 1	A 0	B 0	P 3	F 3	A 1	B 0	P 1	A 0	4			320	2	0.384
5	Pick up the support brackets and position it on the jig	General Move	A 1	B 0	G 1	A 1	B 0	P 1	A 0					4			160	2	0.192
6	Remove the product from the device and position it on the other jig	General Move	A 0	B 0	G 3	A 1	B 0	P 3	A 0								70	2	0.084
7	Screw the bracket into the frame	Tool Use	A 1	B 0	G 1	A 0	B 0	P 3	F 3	A 1	B 0	P 1	A 0	4			320	2	0.384
8	Rotate 180° the product	Controlled Move	A 0	B 0	G 1	M3	X0	I 0	A 0								40	2	0.048
9	Apply glue to the towers	Controlled Move	A 1	B 0	G 1	M3	X0	I 1	A 1					4			280	2	0.336
10	Attach the support bracket on the towers	General Move	A 1	B 0	G 1	A 1	B 0	P 3	A 0					4			240	2	0.288

Fig. 4: BasicMOST Analysis Form for the first 10 activities of the IWICS6.

Source: Authors, (2018).

A<sub>1</sub> - because the object is within reach of the arms.

B<sub>0</sub> - because there was no movement of the body.

G<sub>3</sub> - indicating disengaging or collecting, because although it is a lightweight object (a label), it is likely to be glued to a roll.

A<sub>1</sub> - because the object where the label will be glued is within range of the arms.

B<sub>0</sub> - because there was no movement of the body.

P<sub>6</sub> - which indicates positioning carefully, as there is a marking on the carton where the label should be glued, as shown in Figure 5.

A<sub>0</sub> - because there is no return action to the starting position.



Fig. 5: Application of the FIFO label in the carton.  
 Source: Authors, (2018).

In the case of activities considered Controlled Move, we can exemplify activity number 29: 'Pick up the tape passer pass the tape to the bottom of the cardboard box'. As discussed in the previous chapter, the activities of this

sequential Model are divided into 3 phases: GET, MOVE/ACTUATE, and RETURN. Table 4 shows how activity 8 is divided in relation to the phases of the Controlled Move.

Table 4: Phases, parameters, and index values of Activity 29.

Controlled Move Sequence Model		
Pick up the tape passer	pass the tape to the bottom of the cardboard box	
GET	MOVE/ACTUATE	RETURN
A <sub>1</sub> B <sub>0</sub> G <sub>1</sub>	M <sub>3</sub> X <sub>0</sub> I <sub>6</sub>	A <sub>1</sub>

Source: Authors, (2018).

The GET phase, corresponds to part of the activity "pick up the tape passer", the sub activities will always be A (Action Distance), B (Body Motion) and G (Gain Control) equal to the General Move Sequential Model. Therefore, the analysis of this phase follows the concepts already discussed.

The difference between these two models is in the intermediate phase MOVE/ACTUATE, where the other parameters are: M (Controlled Move), X (Process Time) and I (Alignment). Following the index were applied:

M<sub>3</sub> – because the tape passer will travel a path established by the carton design larger than 30 cm, as shown in Figure 6.

X<sub>0</sub> – because there is no machine process.

I<sub>6</sub> – For the adhesive tape should be aligned with two points with a distance greater than 10 cm.

In the RETURN phase, the analyst chose not to mention, but the ribbon dowel will return to the starting position.

Therefore, this parameter received index 1. Thus, the result in TMU for this activity is demonstrated in Eqs. (2):

$$A_1 \quad B_0 \quad G_1 \quad M_3 \quad I_0 \quad I_6 \quad A_0$$

$$(1 + 0 + 1 + 3 + 0 + 6 + 0) \times 10 = 110 \text{ TMU} \quad (2)$$

Therefore, activity 29 needs 0.066 minutes or 3.96 seconds to be performed.



Fig. 6: Path traveled by tape passer.  
 Source: Authors, (2018).

Only three activities were classified within the Tool Use Sequence Model. Two referring to the use of electric clamping tool and one for the inspection action. The

division of activity 4 in the phases of the Tool Use Model is presented in Table 5:

Table 5: Phases, parameters, and index values of Activity 4.

Tool Use Sequence Model				
Pick up the screwdriver		and tighten the speaker on the frame		
GET TOOL	PUT TOOL or OBJECT IN PLACE	TOOL ACTION	PUT TOOL or OBJECT ASIDE	RETURN
A <sub>1</sub> B <sub>0</sub> G <sub>1</sub>	A <sub>0</sub> B <sub>0</sub> P <sub>3</sub>	A <sub>1</sub> F <sub>3</sub>	A <sub>1</sub> B <sub>0</sub> P <sub>1</sub>	A <sub>0</sub>

Source: Authors, (2018).

The TOOL ACTION phase is what differentiates the Tool Use Sequence Model from the other models, and according to the type of tool there is a specific parameter. For the other phases the table is used with the Indexes of the General Move Sequence Model. It is also common to find in this phase the application of partial frequencies, which requires the addition of a parameter Action Distance (A). Therefore, the following index values were applied for Activity 4:

A<sub>1</sub> - the screwdriver is within range of the arms.

A<sub>1</sub> - The screwdriver is within reach of the arms.

B<sub>0</sub> - there were no body movements.

P<sub>1</sub> - place the screwdriver on the side.

A<sub>0</sub> - there was no return to the starting position.

B<sub>0</sub> - there were no body movements.

G<sub>1</sub> - gain control of the screwdriver.

A<sub>0</sub> - zero because the new A index of the Tool Use phase will override this index.

B<sub>0</sub> - there were no body movements.

P<sub>3</sub> - screwdriver positioning receives index 3.

A<sub>1</sub> - the screws are within reach of the arms, with a distance of more than 5 cm, as exemplified in Figure 7.

F<sub>3</sub> - because the diameter of the screw is less than 6mm.

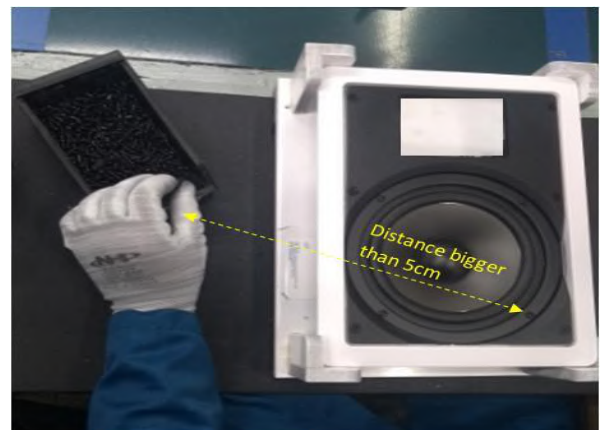


Fig. 7: Screw distance bigger than 5cm.  
 Source: Authors, (2018).

The calculation result in TMU for Activity 4 should consider the partial frequency that is related to the number of screws to be tightened. Therefore the calculation for this activity is demonstrated in Eqs. (3) below:

$$A1 B0 G1 A0 B0 (P3 A1 F3) A1 B0 P1 A0 \quad (4)$$

$$\{1+0+1+0+0+[(3+1+3)\times 4]+1+0+1+0\}\times 10 = 320\text{TMU} \quad (3)$$

$$320 \text{ TMU} = 0,192 \text{ min} = 11.52 \text{ seconds}$$

At the end of the application of the MOST tool the normal time was equal to 2.616 minutes to realize the final production of the product IWICS6. The standard time is obtained after the application of the tolerances.

#### 4.4 Tolerances and Standard Time.

In the present study, 5% for muscle fatigue, 5% for delays and 5% for special needs will be considered for the calculation of tolerance. Therefore the total value of the PR & D tolerance will be 15%. This percentage applied to the normal time of 4.56 obtained from the MOST analysis yields the standard time in Eqs. (4).

$$\text{Standard Time} = 4,56+15\% = 4,56*1,15 = 5,22 \text{ min} \quad (4)$$

Therefore, the standard manufacturing time of the IWICS6 product is 5 minutes and 13 seconds.

#### 4.5 Manufacturing Cost based on MOST Standard Time

The manufacturing cost comprises the sum of the expenses with goods and services applied to the manufacture of a product [25]. In this way, the calculation of the manufacturing cost of the product is given by the sum of the Direct Labor (DL), Direct Materials (DM) and General Manufacturing Expenses (GME) costs, as stated in Eqs. (5) below:

$$\text{\$Manufacturing Cost} = \text{\$DL} + \text{\$DM} + \text{\$GME} \quad (5)$$

With the standard time result obtained from the application of the MOST technique is possible to calculate the cost of the DL by multiplying the standard time by the man/hour rate of the previous month. However, you must convert the default time to the unit of time hours. As the analysis was performed in September 2018, the man-hour rate considered will be the one of August of the same year (R\$ 20.93). Therefore the cost of the DL will be according to Eqs. (6).

$$\text{DL Value} = (5.22 \div 60) \times 20.93 = \text{R}\$1.82 \quad (6)$$

The sum of the Bill of Material (BOM) items in this product costs R\$75.19, and therefore this is the value of

DM. The GME attributed to this product is R\$23.68. Thus, the calculation of the manufacturing cost of the product is done through Eqs. (7).

$$\text{\$ IWICS6} = \text{R}\$1.82+\text{R}\$75.19+\text{R}\$23.68 = \text{R}\$100.69 \quad (7)$$

## V. CONCLUSION

Looking at the impact of manufacturing time on the cost of DL during the process of deploying new products, this study sought to use MOST, PMTS tool, to estimate the total manufacturing time of an audio product manufactured by a multinational electronics industry. Within this purpose, the research was able to identify that the PMTS techniques already have advantages over other methods of standard time measurement, especially when it comes to products that will still be implanted. And the MOST presents the differential of the ease in applying the indexes, since the sequences for each activity are already defined, making the analysis simpler.

Another objective of the study was to define the assumptions and manufacturing steps of the new product, a key factor for the application of MOST, which is a technique for a detailed description of the method to obtain the standard time. The application of the technique resulted in a manufacturing standard time closer to the process reality, without overestimating it, a factor that could jeopardize the viability of the project.

The study presented the formation of the cost of manufacturing for new products and based on this knowledge and using the result of the MOST application, the research showed that the manufacturing time has a direct impact on the cost of manufacturing and therefore it should be analyzed wishing to obtain the lowest time. However, without omitting any activity, and as the results show, MOST met expectations and obtained the lowest cost of DL.

MOST has proved to be an effective technique to estimate manufacturing time of new products, since in addition to imposing the deep analysis of the manufacturing method, the technique allows the analyst, only knowing the product and the means by which it will be manufactured can apply the indices according to each Sequential Model and at the end, after applying the tolerances, obtain the standard time.

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# Evaluation of Water Quality for Bathing Conditions in the Hydrographic Basin of Francisquinha in Porto Nacional

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**Abstract**— *The search for recreational activities is letting the bathers vulnerable to possible contamination in the bathing places, generated by waste from the sewage, accumulation of waste, pollutants present in the atmosphere, pesticides used in plantations that somehow reach the riverbeds, among several others that end up causing, for the most part, the emergence of bacteria such as total coliforms and Escherichia coli (E. coli). The objective of this article is to evaluate the water quality of the Francisquinha stream in the municipality of Porto Nacional - Tocantins, promoting a bathing conditions study, where microbiological analyzes were performed through the indicators of the total coliform group and Escherichia coli (E. coli) defined by CONAMA Resolution No. 274/00. Through the Colilert technique employed, it was possible to detect simultaneous, specific and confirmatory identifications of these bacteria. The results of the monitoring of the chosen points were compared with the parameters established for bathing purposes, with the conditions being categorized as being proper or inappropriate for bathing.*

**Keywords**— *Bathing conditions; water quality; total coliform and Escherichia coli (E. coli).*

## I. INTRODUCTION

Water is a natural element extremely necessary for human survival. Throughout history, regarding economic and social activities across the globe, water resources have always had a fundamental importance, with the increasing diversification of anthropic activities as a consequence of economic and social development, it implies a greater demand for water in quality and sufficient quantity to meet the need of the users.

Among these functions, we have the following: domestic supply, industrial supply, irrigation, animal use, ecological preservation of fauna and flora, creation of species, generation of electric power, navigation, landscaping, dilution of residue, recreation and leisure.

The use of water for recreation purposes is of great importance for human culture due to the increasing use of these waters by the bathers and may contain health risks if they are contaminated by waste from sewage or garbage that ends up being washed away or dumped directly on the river.

There are also other pollutants found in the atmosphere or in the soil as well as the application of toxic products in agriculture, which when they reach the body of water, they also deposit pathogenic microorganisms and toxic elements. These factors can cause great imbalance to the aquatic environment that consequently generate serious risks to the health of the users.

Primary contact refers to activities such as swimming, surfing, water skiing and diving, in which especially children may have water ingestion or contact with the eyes, ears, membranes, mucous membranes or even skin cuts. Therefore, it is very important to make the evaluation of the quality of the water for bathing purposes in order to know if the place evaluated will meet the requirements for proper bathing conditions.

In 2001, the Luís Eduardo Magalhães Hydroelectric Power Plant was built in the municipality of Lajeado - TO, as the Rio Tocantins contained at that time a great potential for electricity generation. As a result, the river eventually became a lake, causing the water level to rise during the damming, with the submersion of the riparian forest, beaches and buildings located on the banks of the lake.

Therefore, the water quality for recreational activities may have suffered changes, being affected due to possible contamination caused by this event.

CONAMA Resolution 274/00 states that fresh, brackish and saline waters will have the quality levels evaluated by specific parameters and indicators, in order to ensure the bathing conditions (primary contact recreation such as diving, swimming, water skiing and

sport fishing). Therefore, were determined the Most Probable Number (NMP / 100ml of water) of the group of fecal coliforms (thermotolerant) and *Escherichia coli* (*E. Coli*) present in the waters of the Tocantins River basin and the Francisquinha stream, were determined.

The Francisquinha basin, located in the municipality of Porto Nacional-TO, has part of its location adjacent to the Francisquinha sewage treatment plant, and the stream is a good object of studies to evaluate its bathing conditions since because of the presence of sewage in its surroundings, there is a great possibility that the water under evaluation is contaminated by the sewage present there

With this perspective, the purpose of this study was to evaluate the water quality conditions for bathing purposes of the Francisquinha river basin in the Tocantins river. The presence of fecal coliforms (thermotolerant) and *Escherichia coli* were also verified. Physical and microbiological parameters of the water were also analyzed at two monitored points, one next to the Francisquinha ETS, known as Point 1 (P1), and the other

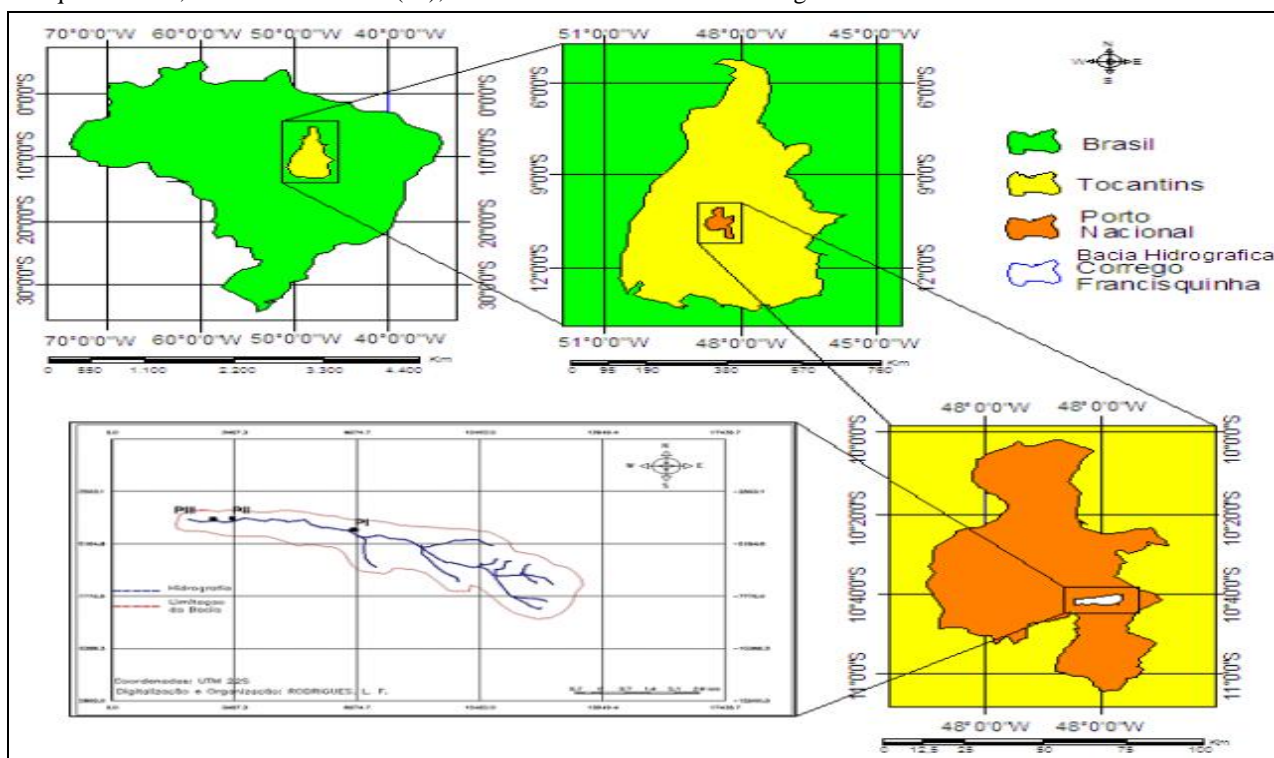
in the exit to Palmas - TO, better known as Point 02 (P2), so that finally, the data of this monitoring will be transmitted on to the public institutions and the community

**II. MATERIAL AND METHODS**  
**RESEARCH TYPE**

The research Project is an experimental one, with a descriptive analysis with surveys performed in loco, with the objective of obtaining a evaluation of the bathing conditions of the Francisquinha stream, establishing the water collecting and analysis places of the study.

**LOCATION OF THE STUDY AREA**

The Basin of the Francisquinha Stream is located in the State of Tocantins. The municipality of Porto Nacional is located in the geographic center of the State, in the eastern mesoregion, with an average altitude of 212 meters above sea level and a surface area of 4,449.9 km<sup>2</sup> and it has as coordinates 10°42'29 "latitude and 48°25'02 "west longitude.



**TRADUÇÃO DAS PALAVRAS DA FIGURA:**

Brasil – Brazil

Tocantins – Tocantins

Porto Nacional – Porto Nacional

Bacia Horográfica Córrego Francisquinha - Hydrographic Basin of the Francisquinha Stream

*Fig.1: Map of the location of the Hydrographic Basin of the Francisquinha Stream*

Source: Rodrigues (2015)

Location of Point 01 (P1)

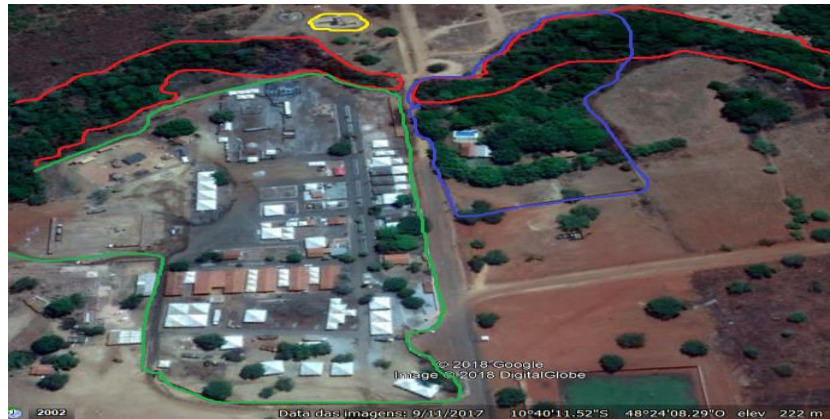


Fig.2: Satellite location of Point 1 and its surroundings

Source: Own elaboration (2018)

Legend:

- Agricultural of Porto Nacional - TO
- Zuíno Farm
- Francisquinha Stream
- Francisquinha Sewage Treatment Plant

Location of Point 02 (P2)



Fig.3: Satellite location of Point 2 and its surroundings

Source: Own elaboration (2018)

Legend:

- Francisquinha Stream
- Access to the stream
- Highway

**MONITORING POINT AND ITS DIAGNOSTICS**

With the aid of a GPS - *Global Positioning System*, two collection points were determined, which are in the perimeter of the Francisquinha stream, according to the geographical coordinates represented in Table 01.

*Table.1: Point of collection of water samples*

POINTS	GEOGRAPHICAL COORDINATES	
	Latitude ( $\phi$ )	Longitude ( $\lambda$ )
P1	S 10° 40,325'	W 48° 24,202'
P2	S 10° 40,093'	W 48° 23,874'

Source: Own elaboration (2018)

According to table 05, the sample was collected in the downstream and upstream areas of the basin, with Point 1 (P1) being located in the Zuíno farm, Guaxupé sector, alongside the agricultural of Porto Nacional - TO, and Point 2 (P2), located off the exit to Palmas - TO, just off the highway. Thus, water collection sites were identified through GPS and photographic records.

**STUDIES CONDUCTED**

For the study in the river basin of the Francisquinha stream, were performed the Total Coliform and *Escherichia Coli* tests and pH, turbidity and electrical conductivity analyzes, according to the Standard Methods norms (APHA, 2007). The fecal coliform test verifies the presence and number of fecal bacteria in the beach water sample. This bacterium may be a vehicle for the transmission of diseases such as hepatitis or gastrointestinal disorders (INMETRO, 2018).

This indicates that the water in the basin may be contaminated with sewage water for being in an area located next to the sewage treatment plant, causing great risks for children who can ingest the water more easily

Thus, 6 water samples (microbiological and physical-chemical) were analyzed, collected in six consecutive weeks, and in each collection of the two points, the samples were collected and sent to the laboratory on the same day for analysis

The parameters of pH, electrical conductivity and turbidity were made on the site, and for the electrical conductivity parameter was used the conductimeter, for the turbidity one was used the turbidimeter and for the pH one it was used the pH meter equipment, according to the protocols of use of these equipment.

The microbiological and physical-chemical samples were collected in 100 ml bottles, then packed in ice-containing thermal boxes and taken for processing in the laboratory at the IFTO - Instituto Federal de Educação, Ciência e Tecnologia do Tocantins, in Porto Nacional.

In art. 2º (CONAMA, 2000), fresh, brackish and saline waters intended for bathing (primary contact recreation) had their condition evaluated in the proper and improper categories, as shown in table 02.

*Table.2: Fecal coliform limit, Escherichia coli limit and percentage of time according to their categories*

Category	Fecal Coliform Limit (Thermotolerant) (Most Likely Number per 100ml)	<i>Escherichia coli</i> Limit (Most Likely Number per 100ml)	Percentage of time
	<b>Safe Water</b>		
Excellent	250	200	Maximum values in 80% or more of the time
Very Good	500	400	
Satisfactory	1.000	800	
<b>Unsafe Water Category</b>			
	Unsafe > 1.000	> 800	Greater than the indicated value in 20% of the time

Source: Own elaboration (2018)

For the fecal coliform test, the CONAMA Resolution (2000) establishes that at least 80% of the analyzed samples present a bacterial count lower than

1000 per 100 ml of sample, for the bathing conditions of the beach to be considered satisfactory (INMETRO, 2018).

According to the CONAMA (2000) Resolution number 274, the water will be considered unsuitable for primary contact when, in the section evaluated, one of the following occurrences is verified:

- a) not meeting the criteria established for the safe water category;
- b) value obtained at the last sampling is greater than 2500 fecal coliforms (thermotolerant) or 2000 *Escherichia coli* or 400 enterococci per 100 milliliters;
- c) high or abnormal incidence in the area of transmissible diseases by water, indicated by the sanitary authorities;
- d) presence of waste or disposal, solid or liquid including sanitary sewage, oils, greases and other substances, which may offer health risks or render the recreation unpleasant;
- e) pH <6.0 or pH > 9.0 (fresh water), except for natural conditions;
- f) flowering of algae or other organisms, until proven to offer no risk to human health;
- g) other factors that temporarily or permanently contraindicate the exercise of primary contact recreation.

The pH test is an indicator of the acidity level of the water. If the water in the stream has a pH level below the range determined by the Resolution, the user may experience some type of skin or eye irritation (INMETRO, 2018).

The resolution number 274 of CONAMA (2000) also states that stretches of beaches and balnearies will be interdicted if the environmental control body of the area, at any of its instances (municipal, state or federal), finds that the poor water quality for primary contact recreation justifies the measure.

## METHODOLOGICAL PROCEDURES

### Sample collection plan

In order to verify the fecal coliforms (thermotolerant) and *Escherichia coli* of the water of the Zuño balneary, in the Francisquinha stream, weekly samples were collected at two points, during six consecutive weeks, in the months of December 2018 and January 2019.

### Laboratory analysis

The COLILERT technique was used to determine The Most Likely Number (NMP/100ml) of bacteria from the fecal coliform group in 100 ml of water, according to the methodology of the Standard Methods for the Examination of Water and Wastewater - APHA, 2005 / American Public Health Association.

According to the COLILERT method, after collecting the water in a bottle of 100 ml, the reagent was added to the collected sample and taken to the incubator for 24 hours at  $35 \pm 0.5$  ° C. After removing the sample

from the incubator, the results were read where the sample had a colorless appearance, the result would be negative for Total Coliforms and *Escherichia coli*, if it presented a yellowish appearance, the result would be positive for Total Coliforms and presented a yellow/fluorescent appearance, the result would be positive for *Escherichia coli*, in terms of presence or absence of bacteria.

In terms of quantification, the reagent was added to the sample, soon after the sample mixture was placed in the Quanti - Tray carton and then placed in the carton in the wipe coating. After this was done, the rubber coating was placed next to the carton and passed in the sealer to allow the mixture to be distributed and the sample distributed throughout the carton, and then placed in the incubator for 24 hours at  $35 \pm 0.5$  ° C and at lastly the reading was made comparing with the table of the most probable number, the amount of Total Coliforms. To quantify the *Escherichia coli* bacterium, it was necessary to place a UV lamp in a dark environment to make the reading.

In this context, the laboratory results of the water quality parameters were compared with the criteria of CONAMA Resolution number 274/00, which define the balneary conditions classified in the categories safe or unsafe for recreation of primary contact. Evidence of high fecal coliform values will indicate fecal water contamination, which may pose a risk to the health of the bathers.

Therefore, the water analysis of the Francisquinha stream was guided through sampling collecting, laboratory analysis, correlation with legislation and other parameters pertinent to the evaluation of water for recreational use.

## III. RESULTS AND DISCUSSIONS

The monitoring of the microbiological quality of the water under study was performed during the months of December 2018 and January 2019, in the middle of the rainy season. During this period the water presented a dark coloration that comes from the solids carried to the river bed. It is worth to note that the dark coloration of the water alone is not indicative of contamination, as even when the water presents a transparent color it may be contaminated.

During the monitoring period, it was observed that the water presented a polluted aspect, making the bathing conditions in the area to be of a negative factor.

The results obtained in the course of the research were presented and discussed through the indicators of total coliforms and *E. coli*, considering the classification criteria of CONAMA Resolution Number. 274/00, for

safe and unsafe waters for bathing purposes, based on the average of six consecutive samples.

According to table 3, the electrical conductivity presented a variation of 9.81 us/ cm to 17.87 us / cm in point 1 (P1), already in point 2 (P2) the conductivity ranged from 8.55 us/cm at 11.28 us/cm. The turbidity in

those 6 weeks had a variation of 8.98 NTU to 19.4 NTU in the first point (P1), in the second point (P2), there was a variation of 8.88 NTU to 17,6 NTU. All these results were obtained in the monitoring period, also observing a variation in pH from 5.86 to 8.76 in point 1 (P1), already in point 2 (P2) a variation of 5.88 to 8.78.

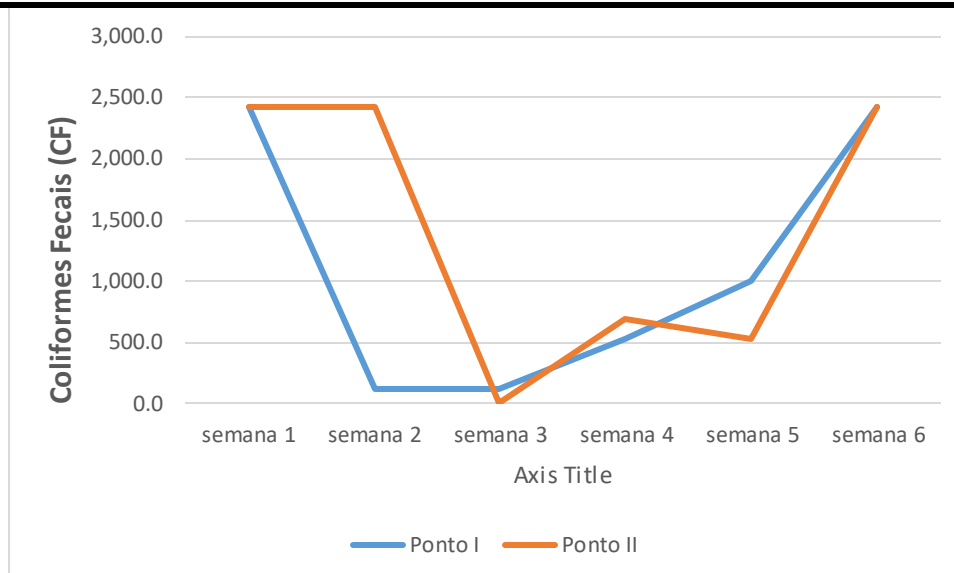
Table 3 - analyzes of the 6 consecutive weeks of the two monitored points

WEEKS	POINT 1		POINT 2	
	Parameter	Value	Parameter	Value
01	Electric Conductivity	11,95 us/cm	Electric Conductivity	11,28 us/cm
	Turbidity	14,8 NTU	Turbidity	12,2 NTU
	pH	5,86	pH	6,08
02	Electric Conductivity	9,81 us/cm	Electric Conductivity	8,55 us/cm
	Turbidity	8,98 NTU	Turbidity	8,88 NTU
	pH	6,71	pH	6,29
03	Electric Conductivity	10,33 us/cm	Electric Conductivity	8,98 us/cm
	Turbidity	12,7 NTU	Turbidity	11,5 NTU
	pH	5,97	pH	5,88
04	Electric Conductivity	17,87 us/cm	Electric Conductivity	9,63 us/cm
	Turbidity	16,8 NTU	Turbidity	14,9 NTU
	pH	6,57	pH	6,52
05	Electric Conductivity	10,12 us/cm	Electric Conductivity	9,20 us/cm
	Turbidity	13,8 NTU	Turbidity	11,5 NTU
	pH	8,76	pH	8,78
06	Electric Conductivity	11,86 us/cm	Electric Conductivity	9,77 us/cm
	Turbidity	14,41 NTU	Turbidity	12,76 NTU
	pH	6,62	pH	6,64

Source: Own elaboration (2018)

At the end of the analysis, all the water samples presented a yellow coloration and fluorescence characteristics, showing a variation in the NMP/most probable number of Escherichia coli concentration, but in the last monitoring, according to figure 4, the numbers have equal values, again indicating a maximum *E. Coli* concentration in the two analyzed points. The concentration of Fecal Coliforms remained constant

throughout the monitoring period, also indicating a maximum concentration. The results obtained at both points over the course of the 6 weeks obtained an average of 1105.03 of *E. coli* at point 1 (P1) and 1413.9 of *E. coli* at point 2 (P2), thus showing that the results obtained in this period of analysis remained above the values recommended by CONAMA Resolution 274/00, which means that the water is unsafe for bathing purposes.



#### Tradução das palavras da figura

Cloriformes Fecais (CF) – Fecal Cloriforms (FC)

Semana 1, semana 2, semana 3, semana 4, semana 5, semana 6- week 1, week 2, week 3, week 4, week 5, week 6

Título do Eixo – Title of the axis

Ponto 1 – Point 1

Ponto 2- Point 2

Fig.4: Overall result of *E. coli* analyzes for the two points

Source: Own elaboration (2018)

According to Cynthia (2018) in a study performed on the beach of Formigueiro, microbiological analyzes of the total coliforms and *Escherichia coli* were also performed to verify the bathing conditions of the beach. The obtained values were superior to 2,419,6 NMP/100 mL<sup>-1</sup>, and the agents responsible for these values were animal feces (cattle, chickens, etc.) and human feces from private septic tanks and animal husbandry along the banks of the basin, being able to generate the excessive increase of these bacteria both on the beach of Formigueiro as in the stream Francisquinha, due also to the period of rain that carries the garbage on the banks of the stream increasing the pollution there.

With the Sewage Treatment Plant being operated alongside the Francisquinha basin, this may also be another factor that explains the high concentration of *E. coli* present in the water.

#### IV. CONCLUSION

The present research was performed with the purpose of evaluating the water quality conditions of the stream for purposes of recreation of primary contact, through indicators of fecal pollution, such as bacteria of the total coliform group and *E. coli*.

The results obtained from the microbiological analyzes of water samples collected in the river basin of the Francisquinha stream in Porto Nacional - TO,

confirmed that the total coliform bacteria were present at the two monitoring points during the study period.

The levels of *E. coli* bacteria highlighted high concentrations that allow the classification of the water in the areas unsafe for bathing purposes, according to Resolution number 274/00 of CONAMA. Therefore, the water of the Francisquinha basin, during the analysis period, based on the bacterial indicator of the *E. coli* group, did not meet the recommended standards for bathing conditions (primary contact recreation).

Measures must be taken by the city hall to perform an appropriate cleaning work in the basin, specifically at the points in question, to meet the standards recommended by CONAMA Resolution number 274/00. They are: a) establishing a water monitoring program as an adequate practice to provide greater sanitary security to swimmers and to encourage the use of the stream throughout the year as an acceptable place for recreation and leisure; b) application of legislation instruments to contain the advance of contamination, such as the criteria determined by Resolution number 274/00 of CONAMA and Environmental Legislation; c) periodic cleaning of the basin and waste margins in order to prevent them from being carried to the water body during the rainy season; d) supervision of local commercial establishments, ie bars and restaurants, requiring the adequate treatment of domestic sanitary effluents; e) implantation of information devices (plates) by the public



power with indication of the condition of the water, thus offering better orientation and sanitary safety to the bathers; f) To have proper supervision in the ETE Franscisquinha for them to be cautious with all the sewage that circulates there next to the stream.

Since the analyzes did not meet the standards recommended by CONAMA Resolution number 274/00, monitoring of water quality should be maintained, being a constant concern of the State and Municipal Secretariats of the Environment, searching partnerships with academic institutions, in order to develop preventive actions through scientific research to provide a clean and uncontaminated environment for tourists and local users, and the competent environmental agencies to take preventive actions to maintain the health of the population.

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# Mapping of Nitrate Contamination (NO<sub>3</sub>-) in an Urban Area on the Brazil/Bolivia Border

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**Abstract:** The objective of this research was to map and evaluate nitrate contamination in an urban area on the Brazil / Bolivia border. The evaluation of the groundwater table occurred in the water of cacimbas wells or Amazonian wells with an average depth of 10 meters in the city of Nova Mamoré, in the State of Rondônia, located in the southern region of Western Amazonia bordering the Republic of Bolivia. **METHODS:** Eighty (80) water samples were collected in the city's urban center, defined and evaluated for nitrate (NO<sub>3</sub>-) in

a proportion above or below the values defined by Ministry of Health Ordinance No. 2.914/2011, which governs standards of water standardization and potability in Brazil. From the data obtained, maps with georeferenced information were made to locate the areas with the highest and lowest contamination potential. The use of geostatistics assisted in the accomplishment of the spatialization of the samples and in the analysis of the spatial patterns allowing a higher quality of the generated data. Results: Sixty-two and a half percent

(62.5%) of the samples presented nitrate levels above 10 mg/L, making it unfit for human consumption. Conclusions: This study indicated that the source of the contamination originates from the result of anthropogenic activities, evidenced by the inefficiency of the sanitary sewage system, one of the basic sanitation axes in which, specifically, it addresses the collection, treatment and adequate disposal of sanitary sewage and other hygiene practices. It is necessary, the urgent insertion of public policies in the sector of basic sanitation in Nova Mamoré and in the Amazonian cities.

**Keywords— Mapping. Wells. Contamination. Nitrate (NO<sub>3</sub><sup>-</sup>). Indicative Kriging.**

## I. INTRODUCTION

Brazil is considered a country where water resources are abundant. Approximately 12% of the planet's fresh water is concentrated in the Brazilian territory, more specifically in the northern region of Brazil, where about 7% of its population lives. It is the region with the lowest demographic density in the country, 0.4 inhab / km<sup>2</sup>, which would make it a region with excellent quality of life indicators for its inhabitants in terms of water resources; low supply in the provision of basic sanitation services, places it in the ranking of the worst Brazilian region in this indicator.

As mentioned by several authors in urban areas and in rural areas, water quality is questionable [1]; [2]; [3]; [4]. The consumption of water in the northern region of Brazil occurs without major concerns and this fact shows both the lack of efficacy in the treatment of water by the public authorities and the lack of knowledge of the population that consumes it without further questioning.

The concern with the quality of the water must be observed from the moment it is destined, be it for the productive system, watering of animals or directly for the human consumption. The prevailing uses are established in regulations, where different standards and parameters were established according to the activity to be performed, but it is in the direct use associated to human consumption that the present study evaluated the consequences of the low water quality, considering for analysis the small urban nuclei of the North region of Brazil, specifically in the State of Rondônia, where the capture of water in most of its cities is carried out through cacimbas wells, that is, with the use of groundwater.

The scientific awakening with the quality of water for human consumption has become a growing interest in the subjects related to the possible negative consequences on the life of the human being. Queiroz [5] states that abundant and quality water is essential to public health, preventing diseases such as diarrhea and intestinal infections.

Paraguassu-Chaves et al [6] points out several health problems associated with non-standard levels of nitrate and nitrite, which can promote diseases such as childhood cyanosis and possibly different types of cancer.

According to Ordinance no. 2.914/2011 of the Brazilian Ministry of Health [7] and the World Health Organization, which provides for the procedures for controlling and monitoring water quality for human consumption and its drinking water standard, the concentration greater than 10 mg/L, of Nitrogen (N) in the form of Nitrate (NO<sub>3</sub><sup>-</sup>), is unfit for human consumption.

Considering the question of the population health and socioenvironmental risk involved, the present work mapped and evaluated the concentration of contamination in the free aquifer of the city of Nova Mamoré, in the State of Rondônia, located in the southern region of Western Amazonia.

According to Tomaz [8], lack of water is one of the serious global problems that can affect the survival of humans. Disorganized use, wastefulness and growth in demand are contributing factors to intensifying the scarcity of potable water on the planet.

Brazil has one of the largest hydrographic basins in the world. However, the severe shortage of drinking water in several regions has been caused by the imbalance between the demographic, industrial and agricultural distribution in relation to water availability.

The underground water potential in the Amazon region has an important contribution to human supply according to Campos [9]. Its use is made in an unplanned way and without adequate knowledge of its potentialities and qualities.

Studies on contaminating agents in groundwater have been occurring gradually in the North, [10]; [11]. The city of Nova Mamoré in the state of Rondônia, located south of the Amazon on the border with Bolivia, is an example of an isolated area with contamination problems in its groundwater.

For Alaburda & Nishihara [12], virtually all human activities pose some risk of environmental pollution and often become sources of groundwater contamination. Among the substances that may constitute a risk to human health are the nitrogen compounds in their different states of oxidation: ammoniacal and albuminous nitrogen, nitrite and nitrate.

The use of groundwater in Brazil has increased as a result of demographic concentration and economic expansion due to its qualitative and quantitative advantages over surface waters. The logic of this demand has directly influenced its quality and, consequently, the health of the populations, since these sources are degraded, according to studies done by Hirata and Cagnon [13].

According to IBGE [14] in Brazil, the underground aquifer supplies approximately 20% of the total households and of these, 68.78% are located in the rural area, covering 12% of the entire population of the country.

In the State of Rondônia, groundwater represents an important resource in human supply. According to the Water and Sewage Company of Rondônia - CAERD [15], of the total water distributed by the company, about 35% originates from the underground spring.

According to Campos [9], groundwater, because it is a low-cost alternative, is accessible to all, especially the low-income population, both in daily supplementation and in the total replacement of water provided by the public service.

However, Melo Junior et al [16] point out that in Rondônia, another aspect that is characterized by the inefficiency of basic sanitation services is the lack of sanitary sewage in the urban area that perpetuates to the present day.

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The ineffectiveness of these services forces the local population to build black and septic tanks for effluent disposal within the immediate vicinity of their land which in practice contaminates groundwater. Wells and nearby cesspits provide drastic consequences and a negative influence on the quality of life of the population.

According to IBGE [14], 41% of the Brazilian population, approximately 76 million people, use rudimentary pits or do not have any sanitation system and only 32%, or 61 million are correctly connected to the sewage network. This procedure is manifested in the inadequate deposition of effluents, which are often released directly into the aquifer, as an alternative, due to the low supply of sewage collection network in all municipalities of the State of Rondônia, which has a percentage of 2% of service.

For Lima [17], water supply, be it public or private, may be compromised by the lack of sanitary sewage in urban areas, where different substances, whether natural or anthropogenic, are present.

According to Finotti et al. [18], Brazilian groundwater reserves are already seriously compromised. Through studies carried out in all parts of Brazil, we can see the significant degree of contamination found in groundwater, whether urban, industrial or agricultural.

Nitrate is found naturally in groundwater but its presence at high concentrations is a result of human activities, mainly due to the use of in situ sanitation systems the nitrogenous substances of the organic waste are oxidized by chemical and biological reactions and the result is presence of nitrate in the soil and consequently to groundwater [19].

Freezer and Cherry [19] state that nitrate is extremely soluble in water and can move easily, contaminating the aquifer at long distance due to its persistence and mobility. The nitrate present in the soil or directly in the water has very easy to contaminate the groundwater. According to Brazil's regulatory standards for the public or individual water supply system, water containing concentrations greater than 10 mg/L of nitrogen (N) as nitrate (NO<sub>3</sub><sup>-</sup>) is classified as unfit for consumption (Ministry of Health of Brazil, Ordinance 2.914/2011).

In the case of the city of Nova Mamoré, the basic sanitation, specifically, water supply and sanitary sewage collection, of the municipality is administered by CAERD. The number of households with access to the general water network is still very low, only 16.88% of the households, while 83.67% are supplied by wells or spring on the property.

This fact, in itself, demonstrated the need for studies in relation to physical and chemical data, in order to evaluate water quality throughout the urban perimeter of the municipality of Nova Mamoré, aiming at the diagnosis of parameters of water contamination.

In this aspect, the present study had as general objective to map the plume of contamination of groundwater (free aquifer), potentially impacted by nitrate ( $\text{NO}_3^-$ ), in the municipal headquarters of Nova Mamoré - Rondônia, under the prism of geostatistics using the Indicative Kriging. And as specific objectives, (a) Register cacimbas wells in the study area to carry out the chemical analysis of nitrate ( $\text{NO}_3^-$ ); (b) Identify the areas of isoprobability of nitrate contamination ( $\text{NO}_3^-$ ) with cut-off level  $<3$  mg/L; (c) Identify areas of isoprobability of nitrate contamination ( $\text{NO}_3^-$ ) with cut-off content  $>10$  mg/L; and (d) map nitrate ( $\text{NO}_3^-$ ) isoconcentration areas in the Free Aquifer of the study area.

Through a simple method, geostatistics and kriging, it was possible to determine the anomalous areas and the plume of contamination of the water table in the city of Nova Mamoré and demonstrated through maps with georeferenced information, the areas of greatest and least contamination potential in order to have a spatial model of the problem in question.

## II. METHODOLOGY

### 2.1. Methodological procedures

Some hypotheses were formulated to explain the origin of nitrate in groundwater in the city of Nova Mamoré. 80 shallow wells were delimited, the water table was delimited for the study and water samples were collected in the urban area of the city, in the wells cacimbas, defined and evaluated for the existence of Nitrate ( $\text{NO}_3^-$ ) in a ratio above or below the values defined by Ministry of Health Ordinance No. 2.914/2011, which govern standards of water standardization and potability in Brazil.

The results were spatialized in the form of maps with the use of Geostatistics through the software "ArcGIS for Desktop Advanced 10.2" [20], so that, later, they can serve as a basis for the development of public policies in the prevention of water contamination underground of the city of Nova Mamoré in Rondônia, Western Amazon, in the border with Bolivia.

### 2.2. Field and Laboratory Procedures

Two methods were used to register the wells. The first one according to the National Guide of Collection and Preservation of Samples: water, sediment, aquatic communities and liquid effluents of Water of the Company of Technology of Environmental Sanitation - CETESB [21] and National Agency of Waters - ANA. The second method was Stratified Random, according to Yamamoto and Landim [23] so that a certain number of observations, that is, of samples, can estimate the behavior of the set of all the potential observations of the population, it is necessary that these subsets are collected in such a way that each observation has the same chance of being chosen.

### 2.3. Collection and Preservation of Water Samples

For the field collection of the samples, it was made available by the Water and Sewage Company of Rondônia - CAERD, a technician of its staff. The owners or real estate agents, in the sites of the selected wells, were registered and signed the Term of Free and Informed Consent - TCLE.

For data collection and water samples, they were carried out according to the methodology proposed in the National Guide for Collection and Preservation of Samples: water, sediment, water communities and liquid effluents from the Company of Environmental Sanitation Technology [21] and Agency National Agency of Water [22], adopted by the CAERD Water Laboratory as follows:

a) The waters were collected at the exit of the well, using the local electric pumps. The water drawn in the initial three minutes is discarded to eliminate stagnant water.

Then, the water samples were conditioned in 500 ml plastic bottles, sterilized and adequately identified by Sampling Well (PA), numbered according to the collection sequence, in ascending order, and stored at approximately  $4^\circ\text{C}$  in a polystyrene box with ice to maintain the original characteristics of the waters.

b) The data of the wells, as well as the location of the collection, date and time, depth, rainfall in the last 24 hours, hygienic conditions of the soil were collected and prepared according to the instructions contained in CETESB Guide. wells, cesspools, animals and sewage nearby. At each point of water collection, the UTM coordinates were georeferenced using the Global Positioning System (GPS).

c) the bottles with water samples were transported to the Laboratory of the Federal University of Rondônia, where Nitrate levels were determined.

### 2.4. Ionic constituents

The water samples were previously filtered in cellulose acetate filters of  $0.22\ \mu\text{m}$  porosity and 13 mm in diameter (Sartorius Biolab Products) and analyzed by ion chromatography with conductivity detector (Ion Chromatograph with ion conductivity detector, METROHM - 882 Compact IC plus). The calibration of the equipment was performed by a calibration curve with specific standards, the concentrations of the ions present being calculated by comparison with external standards.

The analytical columns used were: Metrosep A Supp. 5 - 150/4.0 and Metrosep C 4 -150 / 4.0 (METROHM), with the fixed volume of injection of  $100\ \mu\text{L}$  and flow always maintained in  $0.7\ \text{mL min}^{-1}$ . The anion and cation standards were introduced separately with a 5 ml disposable hypodermic syringe into the ion chromatograph injection system.

Determination of Nitrate content with the use of equipment made available by the Federal University of

Rondônia, through the Ion Chromotography with Conductivity Detector technique.

### 2.5. Spatial Distribution of Sampling

Through the random sampling, stratified in the urban area of Nova Mamoré, we selected 80 cacimba wells that are used continuously in the local supply.

Of the thirteen existing neighborhoods in the district of Nova Mamoré, four neighborhoods were excluded from the survey: the neighborhood called the Green Area, which still has no occupation. In the Nova Redenção neighborhood, five wells were selected according to the methodology adopted, but due to the absence of cacimba wells or Amazonian wells, because they were conditioned to the presence of massive rock a few meters deep (Complexo Nova Mamoré) was one of the excluded, the neighborhood Ambrósio, located in the industrial sector, was not allowed the registration of wells and neighborhood hortifrutigranjeiro did not have wells.

The spatial distribution of the samples was found in nine neighborhoods: Centro, Chacareiro, Cidade Nova, João Francisco Clímaco, Nossa Senhora de Fátima, Novo Horizonte, Planalto, Santa Luzia and São José, according to Figure 1.

### 2.6. Contamination Mapping

One of the most efficient methods to characterize the contamination plume in the free aquifer of the Nova Mamoré Urban area, adopted in this work was the geostatistical method of kriging, allowed the

identification of two anomalous areas of nitrate ( $\text{NO}_3^-$ ) occurrences

### 2.7. The Geostatistical Method of Kriging

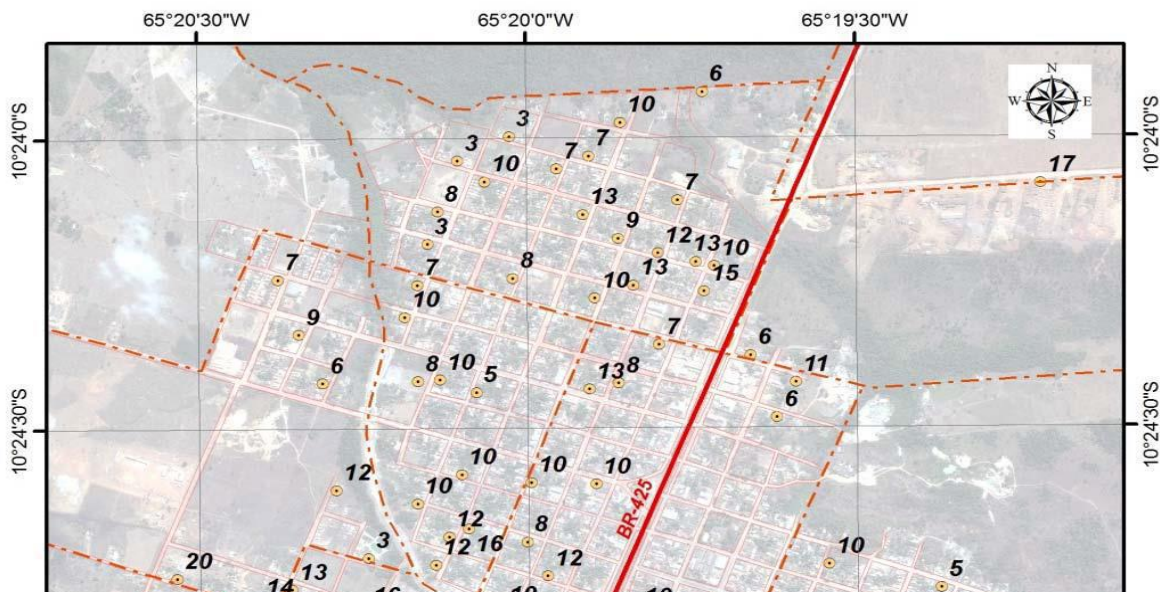
According to Isaak & Srivastava [24] Kriging is termed as spatial estimator of regionalized variables, from adjacent values while considered independent in variographic analysis. Through it, one can obtain: a) The prediction of the point value of a regionalized variable and in a specific place within the geometric space, it is an exact interpolation procedure that takes into account all the observed values. b) The average calculation of a regionalized variable for a larger volume than the geometric support and the estimation of the main trend (drift), similar to the trend surface.

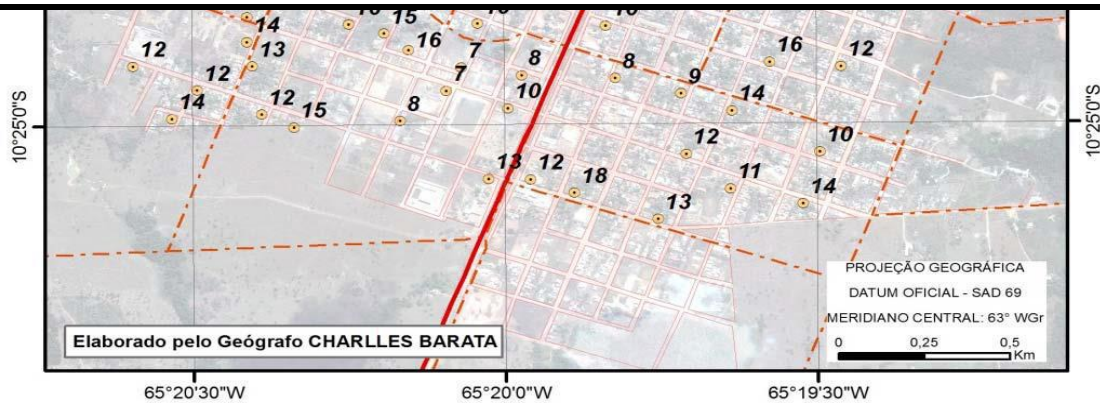
Krigagem provides, in general, non-tendentious estimates with minimal variation, bringing together several types of estimation methods, such as: simple, ordinary, universal, indicative, disjunctive and cokriging [25].

### 2.8. Ordinary Kriging

Ordinary Kriging is a linear estimation technique for a regionalized variable that satisfies the intrinsic hypothesis, whose objective is to minimize the bias estimation error, that is, where the mean residual error is equal to zero [26].

According to Landim [27], the most usual forms of linear kriging are simple, ordinary, universal and intrinsic. Nonlinear Krigages use some nonlinear transformation of the original data and are: lognormal, multigaussian, indicative, probabilistic, and disjunctive





**Legenda**

- 14 Amostra Coletada
- - - Limite de Bairros
- Estrada Federal (BR-425)

Fig.1: Map of the spatial distribution of the registered wells

**III. RESULTS AND DISCUSSION**

**3.1. Histogram and Box Plot Analysis of Nitrate Content Data in the Study Area**

The histogram and the mean concentration graph of Nitrate contents were elaborated using the R Program for Statistical Computation.

Figure 2 shows a heterogeneous distribution of the contamination plume, with 37.5% of the samples having <10 mg/L Nitrate and 62.5% of the samples presenting > 10 mg/L of Nitrate (NO<sub>3</sub>-).

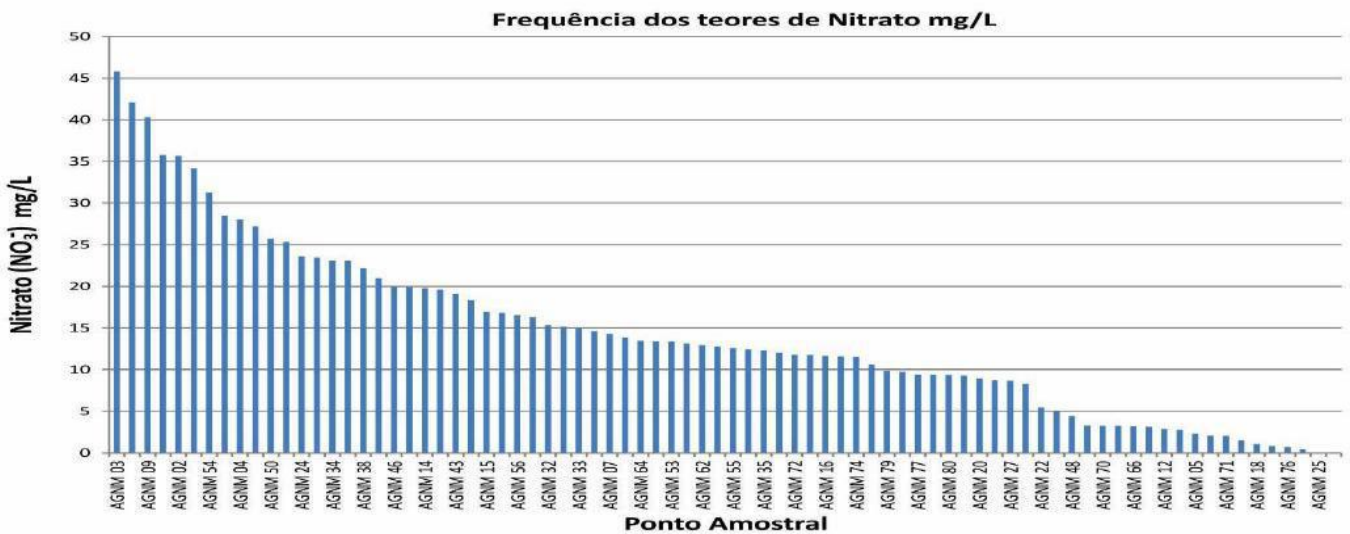


Fig.2: Histogram of nitrate concentration (NO<sub>3</sub>-) in the study area.

The results presented in the histogram show a heterogeneous distribution of Nitrate values and, according to the box - plot relative to figure 3, they are

positively asymmetric, considering the approximation of the median value to the quartiles Q1.

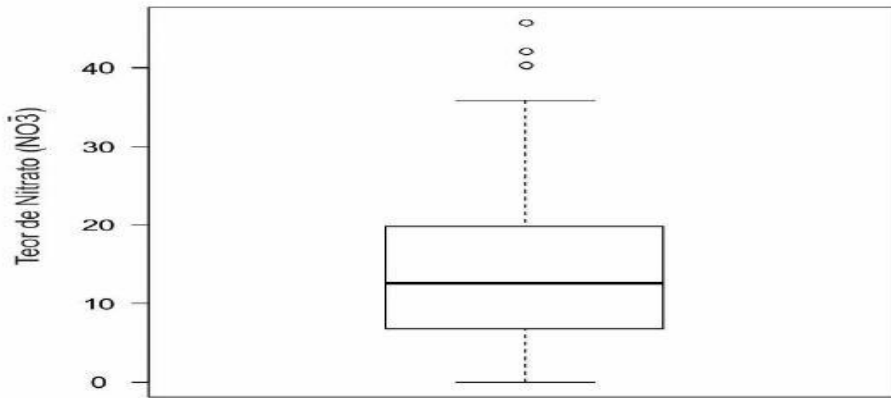


Fig.3: Average NO<sub>3</sub><sup>-</sup> (mg/L) nitrate concentration in the study area.

**3.1.1. Nitrate Isocontents**

By observing the Map of Isocontents of nitrate (NO<sub>3</sub><sup>-</sup>) in figure 4, it can be seen that the highest levels were presented on the lateritic residual plateau, which covers a large part of the urban area of Nova Mamoré. These values are associated to the periods of occupation of the urban space considered older, since the central area of the urban nucleus, denominated "center", was the first one to be occupied.

The oldest population density in the municipality is associated with Nitrate levels ranging from 21.51 mg/L to 45.77 mg/L, with a gradual decrease in the most recent occupation areas (Table 1).

Extreme values of 42.0 and 45.8 mg/L are observed in the urban area of the oldest human occupation, as opposed to minimum values of 0 and 2 mg/L, located outside the central area of the city and associated with the sector with low population density (table 1).

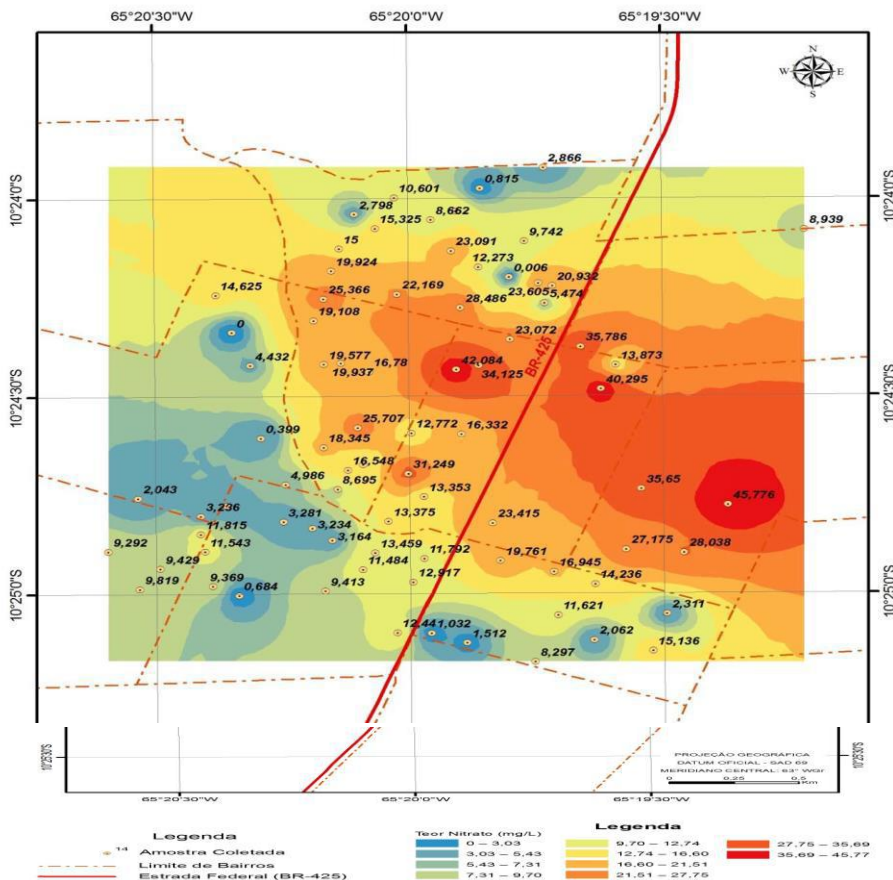


Figure 4: Map of nitrate isocontents (NO<sub>3</sub><sup>-</sup>)



Still based on the existing districts in New Mamore: New city; Chacareiro; Novo Horizonte and Ambrósio, we found levels of Nitrate (NO<sub>3</sub><sup>-</sup>) below 9.70 mg/L and, therefore, lower than the maximum limit of 10 mg/L determined by Ministry of Health Ordinance No. 2914/2011. As a result, the other districts, in a total of

eight, had higher levels than indicated by the aforementioned Ordinance.

### 3.2. Nitrate Content Occurrence Isoprobability > 10 mg/L

The isovalues, determined in the study area with indexes above 10 mg/L, are shown in figure 5.

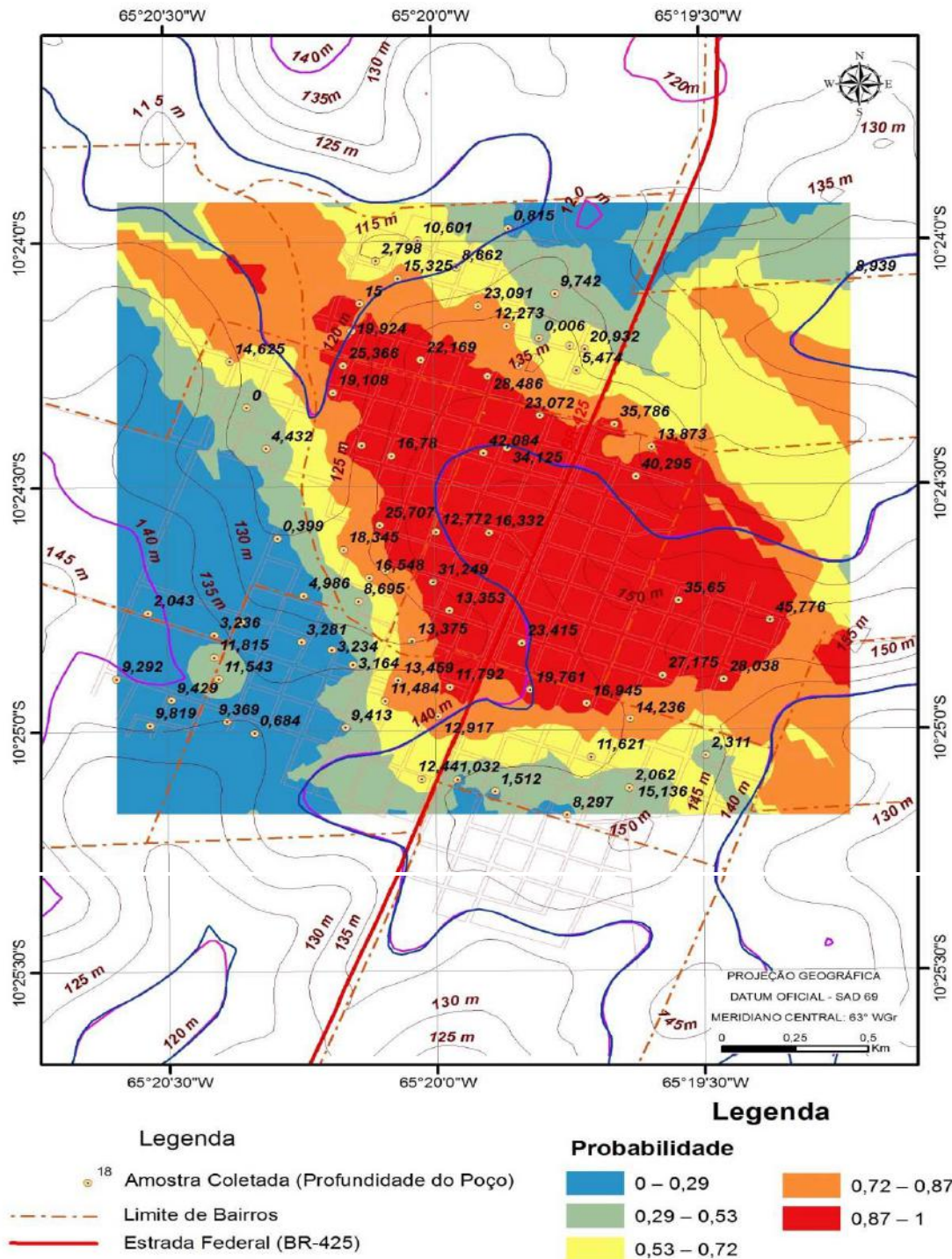


Fig.5: Nitrate concentration map (NO<sub>3</sub><sup>-</sup>) with cut level > 10mg/L

When analyzing the mentioned figure, referring to the isoprobabilade of occurrence values above 10 mg/L, it was verified that the area with the highest occurrence of nitrate levels and with probability of occurrence in a percentage between 70 and 100% is that of the nucleus urban center of Nova Mamoré, cut by Federal Highway BR 425, this act and acted as facilitating agent of the occupation and urban transformation of the city, the consequences of this urban concentration motivated by federal highway BR 425, resulted in the contamination of groundwater of the place studied. The study by Alaburda and Nishiara [12] corroborates, with this study when he mentions that the anthropogenic action contributed to the degradation of the waters associated with low indicators of infrastructure in networks that collect sanitary sewage. Studies carried out by Campos [9], in the municipality of Mirante da Serra, State of Rondônia, showed high values of Nitrate (NO<sub>3</sub>-), above 10 mg/L in the most densely populated areas.

Low probability values of contamination, in general, range from 0 to 53% in areas farther from the central axis with urban influence. It is also observed the appearance of a transition band with probability of up to 53% and greater than 72% of occurrence, above 10 mg/L, which, in this case, is associated with the presence of drainage of the Ambrósio channel and Olaria stream.

Results evidencing the nitrate content, generally exceeding 10 mg/L, which limits the potability for human consumption, were detected in shallow tubular wells and

cacimba type, in the municipality of Urânia-SP, [28]; [29]; [30], a situation similar to that found in the municipality of Nova Mamoré in the cacimba wells mapped.

### 3.3. Nitrate Content Occurrence Isoprobability <3 Mg/L

The probability of having nitrate contents below 3 mg/L nitrate (NO<sub>3</sub>-) in the study area is 70 to 100%, as shown in figure 6, corresponding to the red band of the legend.

In spite of its predominant position of lower third of valley slope, the lowest levels of nitrate are in this range.

In contrast to the lateritic plateau area, in this figure n 18 indicated by the blue color where the probability of finding contents below 3 mg/L is lower than 12%, this low percentage confirms the theories of Campos [9] and Hirata [28]. ], where the anthropic action resulting from urban activities have a strong impact on the quality of groundwater, and in this space the groundwater is already in a high degree of impaction.

The areas with low levels of nitrate are little occupied by the urbanization of the city of Nova Mamoré, where the population concentrated on the axis of federal highway BR 425, shown in figure 6, the high levels of contamination.

At various points, the open ombrophilous forest, which covers approximately 66% of the city of Nova Mamoré, is present in these areas, where the contamination was less than 3 mg/L of nitrate.

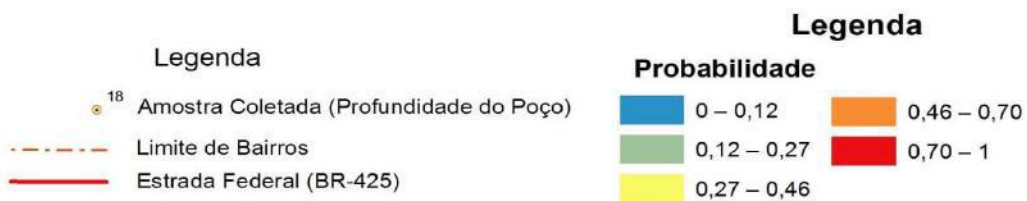
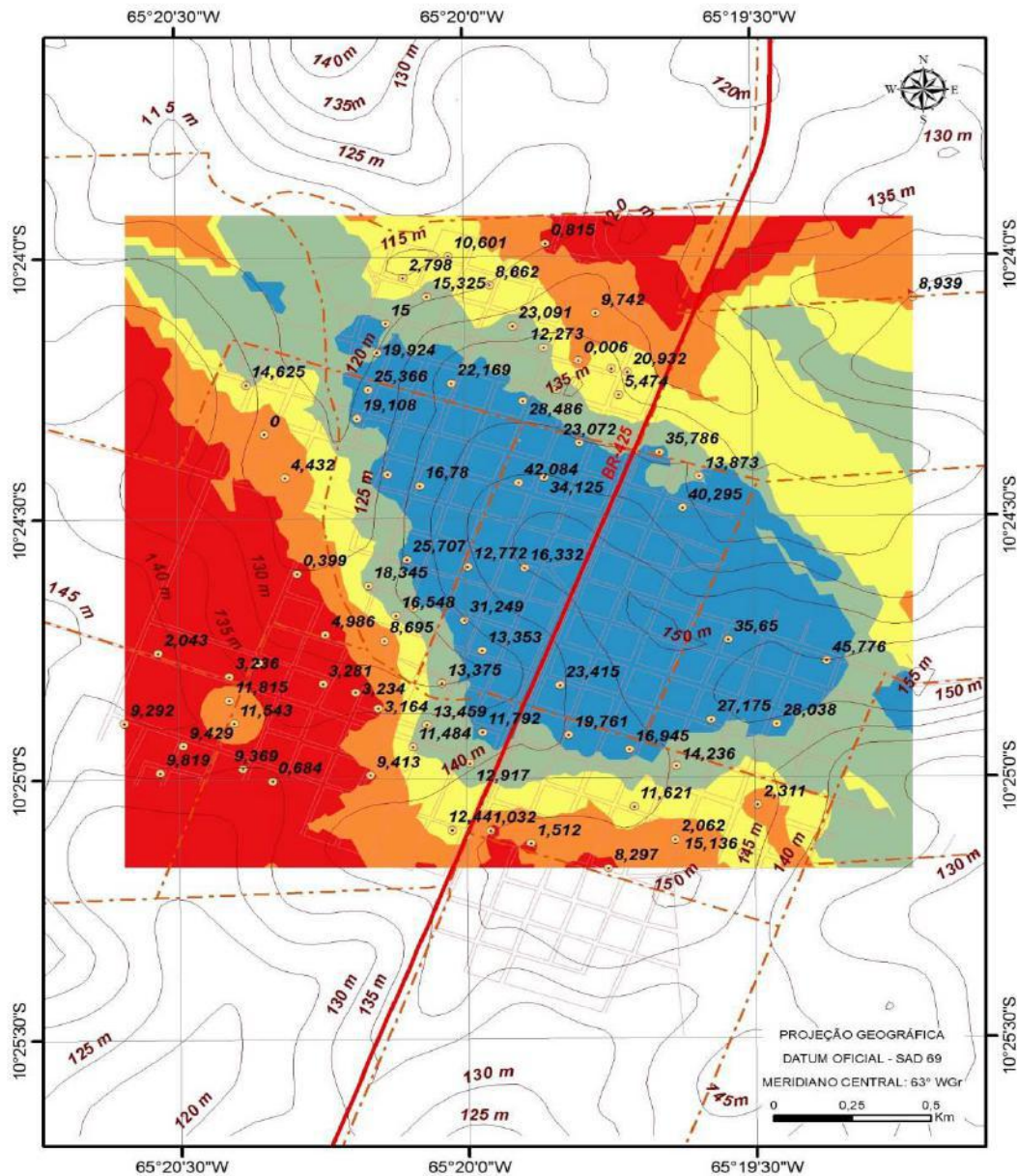


Figure 6: Nitrate concentration map (NO<sub>3</sub><sup>-</sup>) with cut-off level <3mg/L nitrate

Table.1a - Location, Coordinates, Nitrate Content and Depth of PAs

NEIGHBORHOOD	UTM East	UTM North	Well	Content Nitrate (NO <sub>3</sub> <sup>-</sup> )	Depth (m)
Centro	244893,205	8848763,191	21	23,072	7
Centro	244781,464	8848640,577	41	34,125	8
Centro	244700,527	8848621,249	42	42,084	13
Centro	244538,652	8848324,077	51	12,772	10

Centro	244718,647	8848319,848	52	16,332	10
Centro	244584,557	8848027,206	53	13,353	12
<b>Centro</b>	<b>244527,78</b>	<b>8848134,72</b>	<b>54</b>	<b>31,249</b>	<b>8</b>
Centro	244456,574	8847911,841	65	13,375	10
<b>Centro</b>	<b>244832,419</b>	<b>8847905,172</b>	<b>13</b>	<b>23,415</b>	<b>10</b>
<b>Centro</b>	<b>245220,796</b>	<b>8848533,642</b>	<b>9</b>	<b>40,295</b>	<b>6</b>
Centro	245273,949	8848645,686	10	13,873	11
Chacareiro	243782,501	8847849,628	72	11,815	14
Chacareiro	243448,484	8847767,181	78	9,292	12
Chacareiro	243636,935	8847687,452	77	9,429	12
Chacareiro	243563,246	8847592,018	79	9,819	14
Cidade Nova	244409,462	8847764,463	64	13,459	7
Cidade Nova	244254,836	8847822,448	66	3,164	16
Cidade Nova	244182,959	8847878,016	67	3,234	15
Cidade Nova	244079,069	8847908,217	68	3,281	16
Cidade Nova	243875,518	8847981,302	69	3,141	13
Cidade Nova	243796,997	8847768,087	73	11,543	13
Cidade Nova	243825,386	8847606,515	80	9,369	12
Cidade Nova	243919,661	8847563,781	76	0,684	15
Cidade Nova	244365,319	8847686,244	74	11,484	7
Cidade Nova	244230,424	8847585,576	75	9,413	8
Cidade Nova	244546,521	8847628,46	62	12,917	10
Cidade Nova	244490,147	8847391,89	61	12,44	13
Cidade Nova	244585,677	8847738,623	63	11,792	8
João F. Climaco	244612,56	8847390,481	18	1,032	12
João F. Climaco	244740,609	8847345,784	19	1,512	18
João F. Climaco	244986,642	8847257,599	17	8,297	13
João F. Climaco	245198,246	8847360,457	1	2,062	11
João F. Climaco	245409,246	8847310,928	6	15,136	14
João F. Climaco	245459,581	8847483,674	5	2,311	10
João F. Climaco	245200,864	8847621,288	7	14,236	14
João F. Climaco	245052,882	8847678,366	15	16,945	9
João F. Climaco	244859,599	8847729,707	14	19,761	8
João F. Climaco	245067,437	8847476,37	16	11,621	12
Nossa Sra. de Fátima	245951,161	8849279,089	20	8,939	17
<b>Nossa Sra. de Fátima</b>	<b>245147,107</b>	<b>8848730,851</b>	<b>11</b>	<b>35,786</b>	<b>6</b>

Table.1b (continuation) - Location, Coordinates, Nitrate Content and Depth of PAs

NEIGHBORHOOD	UTM East	UTM North	Well	Content Nitrate (NO <sub>3</sub> -)	Depth (m)
Novo Horizonte	243958,804	8848637,255	48	4,432	6
Novo Horizonte	243892,968	8848791,277	45	0	9
Novo Horizonte	243833,775	8848965,835	44	14,625	7
Novo Horizonte	243997,461	8848298,406	59	0,399	12
Novo Horizonte	244087,458	8848082,775	58	4,986	3

Novo Horizonte	243781,897	8847933,585	70	3,236	14
Novo Horizonte	243555,998	8848016,032	71	2,043	20
Planalto	245011,591	8849566,522	12	2,866	6
Planalto	244783,88	8849468,672	31	0,815	10
Planalto	244475,232	8849423,372	29	10,601	3
Planalto	244696,299	8849361,763	30	13,138	7
Planalto	244608,113	8849320,69	27	8,662	7
Planalto	244332,082	8849344,851	28	2,798	3
Planalto	244943,338	8849222,841	26	9,742	7
Planalto	244406,979	8849279,618	32	15,325	10
<b>Planalto</b>	<b>244680,594</b>	<b>8849176,332</b>	<b>34</b>	<b>23,091</b>	<b>13</b>
Planalto	244779,652	8849100,227	35	12,273	9
Planalto	244890,185	8849054,323	25	0,006	12
<b>Planalto</b>	<b>244994,075</b>	<b>8849027,142</b>	<b>24</b>	<b>23,605</b>	<b>13</b>
<b>Planalto</b>	<b>245044,811</b>	<b>8849013,854</b>	<b>23</b>	<b>20,932</b>	<b>10</b>
Planalto	245018,235	8848933,219	22	5,474	15
Planalto	244821,932	8848951,339	36	12,012	13
<b>Planalto</b>	<b>244714,419</b>	<b>8848910,871</b>	<b>37</b>	<b>28,486</b>	<b>10</b>
<b>Planalto</b>	<b>244486,708</b>	<b>8848972,479</b>	<b>38</b>	<b>22,169</b>	<b>8</b>
Planalto	244277,117	8849183,58	33	15	8
Planalto	244249,332	8849080,899	39	19,924	3
<b>Santa Luzia</b>	<b>245520,384</b>	<b>8847770,78</b>	<b>4</b>	<b>28,038</b>	<b>12</b>
<b>Santa Luzia</b>	<b>245312,605</b>	<b>8847784,672</b>	<b>8</b>	<b>27,175</b>	<b>16</b>
<b>Santa Luzia</b>	<b>245365,758</b>	<b>8848067,952</b>	<b>2</b>	<b>35,65</b>	<b>10</b>
<b>Santa Luzia</b>	<b>245678,634</b>	<b>8847993,961</b>	<b>3</b>	<b>45,776</b>	<b>5</b>
<b>São José</b>	<b>244222,152</b>	<b>8848949,829</b>	<b>40</b>	<b>25,366</b>	<b>7</b>
São José	244186,516	8848848,658	43	19,108	10
São José	244385,838	8848609,772	47	16,78	5
São José	244284,969	8848649,637	46	19,937	10
São José	244223,36	8848644,503	49	19,577	8
São José	244222,756	8848255,824	57	18,345	10
<b>São José</b>	<b>244345,37</b>	<b>8848348,841</b>	<b>50</b>	<b>25,707</b>	<b>10</b>
São José	244364,698	8848176,396	55	12,571	16
São José	244310,337	8848151,028	56	16,548	12
São José	244273,493	8848061,635	60	8,695	12

#### IV. CONCLUSIONS AND RECOMMENDATIONS

Eighty cacimba wells were registered in the urban area of the municipality of Nova Mamoré, State of Rondônia, and these were spatialized through the stratified random sampling method, with water collection and chemical analysis of the Nitrate (NO<sub>3</sub><sup>-</sup>) parameter, where high levels of contamination in the most urbanized area. Sixty-two and a half percent (62.5%) of the samples presented nitrate levels above 10 mg/L, the maximum limit allowed for human consumption according to Ministry of Health

Ordinance No. 2.914/2011, which governs standardization norms and of potability of water in Brazil. With the application of the geostatistics method, through the non-linear indicator Kriging, through the study of its spatial distribution and variability, two areas of anomalous levels of Nitrate (NO<sub>3</sub><sup>-</sup>) were identified: one up to 3 mg/L and another above 10 mg/L. The two identified areas demonstrated that the urban occupation evidenced in the BR-425 highway axis, as well as the high number of wells excavated, corroborate

with the theories of the authors mentioned in this study where the lack of basic sanitation, specifically, allied to the high population concentration in this place contributed to the concentration of the contamination in the water table, making underground water unfit for some uses, especially human consumption.

The other area with lower levels of nitrate, less than 3 mg/L, is still little occupied by urbanization, characterized in this study by native vegetation cover and low number of excavated wells.

This study indicated that the source of the contamination originates from the result of anthropogenic activities, evidenced by the inefficiency of the sanitary sewage system, one of the basic sanitation axes in which, specifically, it addresses the collection, treatment and proper disposal of sanitary sewage and other hygiene.

Even with a high amount of Nitrate (NO<sub>3</sub><sup>-</sup>), in the largest number of analyzed samples, we must consider that there are still areas with low levels of Nitrate (NO<sub>3</sub><sup>-</sup>) and those that have not undergone anthropogenic processes.

It is necessary, therefore, the insertion of public policies in the sector of basic sanitation of the municipality.

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# Two Classic Chess Problems Solved by Answer Set Programming

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**Abstract**—The *n*-Queen and the Knight's tour problem are studied by several authors who have proposed some methods to solve them. The ASP (Answer Set Programming) is a form of declarative programming oriented to difficult search problems; however, the literature does not present its use in solving these two classic and interesting chess puzzles. Thus, this work aims to solve the *n*-Queen and Knight's Tour problems by ASP and show it can solve combinatorial problems.

**Keywords**— *Combinatorial problems, Answer Set Programming, Computation applied.*

## I. INTRODUCTION

Answer Set Programming (ASP), is a form of declarative programming oriented to a difficult search problem, mainly NP-hard [16, 17, 18].

The ASP has application in relevant industrial projects because to the availability of some efficient ASP systems [16, 17]. Nevertheless, ASP can be applied to several areas of science and technology, for example: automated product configuration, decision support for space shuttle and automatic route search [17].

The classical problems involving chess are a constant subject of heuristic and optimization studies [10,12,13]. The *n*-Queen Problem consists of finding the position of *n*-queens on a chessboard  $n \times n$ . The Knight's Tour Problem aims to construct a sequence of admissible moves made by a chess knight from one square to another so that they land on each square of a board exactly once. Both problems are interesting classical chess puzzles solved by many computational and mathematical methods [9, 11].

In this sense, the objective of this work is to propose the solution of these two classic challenges of chess through Answer Set Programming (ASP), proving that ASP is able to solve combinatorial problems.

## II. CHESS PROBLEMS DESCRIPTION

### a. The Knight's Tour Problem

The knight's tour problem consists of a series of moves (in an L-shape, see Fig. 1) made by a knight visiting every square of an  $n \times n$  chessboard exactly once [14, 15, 19]. We can define the problem as knight's graph for  $n \times n$  chessboard to be graph  $G = (V, E)$  where  $V = \{(i, j) | 1 \leq i, j \leq n\}$ , and  $E = \{((i, j), (k, l)) | \{|i - k|, |i - l|\} = \{1, 2\}\}$ . Such that, there is a vertex for every square of the board and an edge between two vertices exactly when there is a knight move from one to another. A knight's tour is called closed if the last square visited is also reachable from the first square by a knights move, i.e., an open knight's tour is defined to be a Hamiltonian path; and open otherwise, i.e., closed knight's tour is defined to be Hamiltonian cycle on a knight's graph [19].

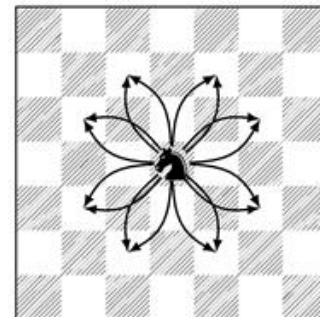


Fig. 1: Knight possible moves in an L-shape

The knight's tour problem is used as the basis of studies for the development of cryptographic schemes [14] and implementation of random binary numbers [15].

The literature points to some methods that propose the solution of the knight's tour problem, such as Artificial Bee Colony [10] and structural algorithms with pre-defined heuristic rules [20].

### b. The *n*-Queens Problem

The *n*-Queens problem is to place *n* queens (a queen can move as far as she pleases, horizontally, vertically, or diagonally. See Fig. 2), on an  $n \times n$  chessboard in such a way that no queen can attack another, i.e., so that no two queens are placed in the same row or column or on the same diagonal. This problem is a generalization of the



original 8-Queen's problem [7]. Survey of known results is given in [1].

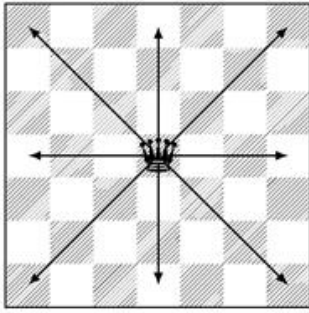


Fig. 2: Queen piece available moves

Let  $K = \{0, 1, \dots, p - 1\}$ , we can uniquely assign to each position on the board a pair  $(i, j)$  of coordinates in the usual manner, with  $i, j \in K$ . Then a solution can be thought of as a permutation  $f$  from  $K$  to  $K$  satisfying (1) and (2) for all  $x, y$  in  $K$ ,  $x \neq y$

- (1)  $f(x) - x \neq f(y) - y$
- (2)  $f(x) + x \neq f(y) + y$

Such permutation  $f$  will be called ordinary solution. Instead of condition (1) and (2) one might also consider permutations  $f$  satisfying (a) and (b) for all  $x, y$  in  $K$ ,  $x \neq y$

- (a)  $f(x) - x \neq f(y) - y \pmod{p}$
- (b)  $f(x) + x \neq f(y) + y \pmod{p}$

A permutation  $f$  satisfying (a) and (b) is called modular solution. Any modular solution is also an ordinary solution.

The  $n$ -Queens problem is often studied because there are several practical applications: VLSI (Very Large Scale Integration) testing, traffic control, parallel memory storage schemes, and deadlock prevention [6, 5], memory storage scheme for conflict free access for parallel memory systems [2,3,4].

### III. IMPLEMENTATION AND EXPERIMENTAL RESULTS

All the experiments presented in this section have been performed with CLINGO 4.5.3.

The CLINGO program shown in Listing 1 solves the open knight's tours problem. In the Listing 1, on line 1 and 2 we define the chessboard and line 3 defines the number of step. On line 5 expresses that at step  $I$  there can be one and only one position. Line 6-9 to force the next steps to execute the knight's tours rule first, we give the definition of next, then say that there can be no steps without the rule being verified and finally we say that you can not go back to the same cell twice. Line 10-14 next steps are related to the rule of the horse and return to the same cell. Line 15 defines the starting position chessboard where the knight's will start.

```
xchessboard(1..m).
ychessboard(1..n).
```

```
time(1..m*n).
xypos(X,Y) :- xchessboard(X), ychessboard(Y).
1 { position(I,X,Y) : xypos(X,Y) } 1 :- time(I).
fromTO(XO, YO, XT, YT) :- xypos(XO, YO),
xypos(XT, YT), |XO-XT| = 1, |YO-YT| = 2.
fromTO(XO, YO, XT, YT) :- xypos(XO, YO),
xypos(XT, YT), |XO-XT| = 2, |YO-YT| = 1.
:- time(I), time(I+1), xypos(XO, YO), xypos(XT, YT),
position(I, XO, YO), position(I+1, XT, YT), not
fromTO(XO, YO, XT, YT).
:- time(IA), time(IB), IA < IB, xypos(X, Y),
position(IA, X, Y), position(IB, X, Y).
:- position(1, X, Y), X+Y>2.
```

Listing 1: Open knight's tours program.

The CLINGO program shown in Listing 2 solves the closed knight's tours problem. The ideal is the same as the open knight's tours program, the difference between listing 1 and 2 are in line 3 which defines an additional step of the knight which is the return of the knight initial position after visiting all the cells and in line 16 forces that return.

```
xchessboard(1..n).
ychessboard(1..m).
time(1..n*m+1).
xypos(X,Y) :- xchessboard(X), ychessboard(Y).
fromTO(X1, Y1, X2, Y2) :- xypos(X1, Y1), xypos(X2, Y2),
|X1-X2| = 1, |Y1-Y2| = 2.
fromTO(X1, Y1, X2, Y2) :- xypos(X1, Y1), xypos(X2, Y2),
|X1-X2| = 2, |Y1-Y2| = 1.
1 { position(I,X,Y) : xypos(X,Y) } 1 :- time(I).
:- time(I), time(I+1), xypos(X1, Y1), xypos(X2, Y2),
position(I, X1, Y1), position(I+1, X2, Y2), not
fromTO(X1, Y1, X2, Y2).
:- time(I1-1), time(I2), I1 < I2, xypos(X, Y),
position(I1, X, Y), position(I2, X, Y).
:- position(1, X, Y), X+Y>2.
:- position(n*m+1, X, Y), X+Y>2.
```

Listing 2: Closed knight's tours program.

Fig. 3-6 show solutions for the open Knight's Tour problem on chessboard (5x5), (6x6), (8x8), and (6x5), respectively.

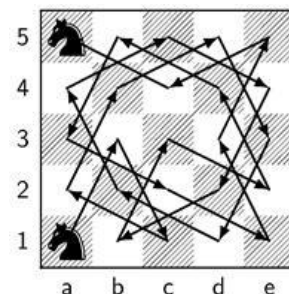


Fig. 3: Open Knight's Tour on chessboard (5x5).

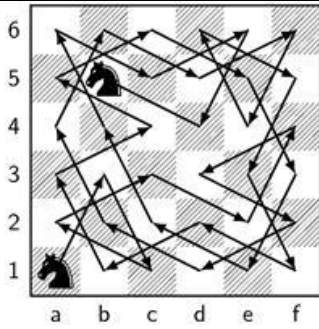


Fig. 4: Open Knight's Tour on chessboard (6x6).

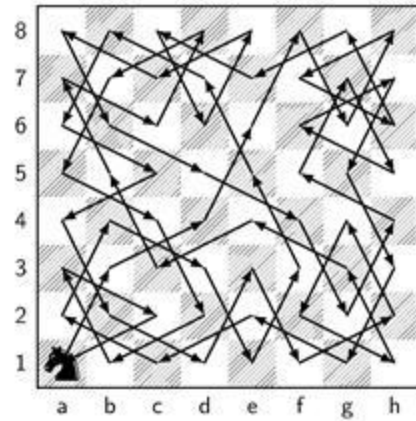


Fig. 8: Closed Knight's Tour on chessboard (8x8).

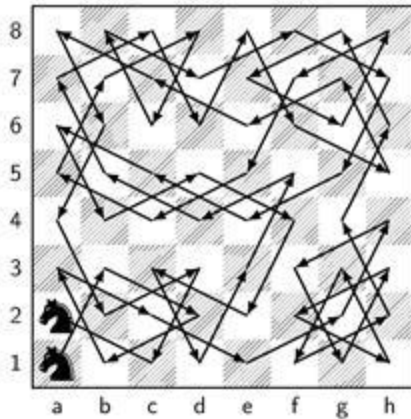


Fig. 5: Open Knight's Tour on chessboard (8x8).

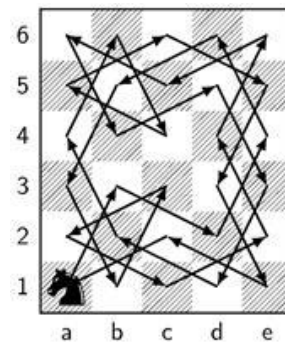


Fig. 9: Closed Knight's Tour on chessboard (6x5).

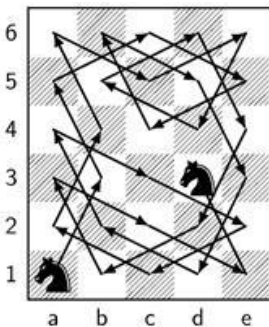


Fig. 6: Open Knight's Tour on chessboard (6x5).

Solutions for the closed Knight's Tour are show in Fig. 7-9 for chessboard (6x6), (8x8), and (6x5), respectively.

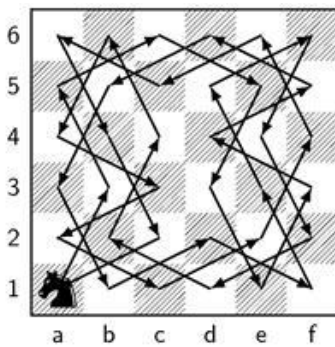


Fig. 7: Closed Knight's Tour on chessboard (6x6).

The CLINGO program shown in Listing 3 solves the  $n$ -Queens Problem. In the Listing 3, on line 1 and 2 we place queens on the chess board exactly one queen per row/column; on line 3 and 4 allows at most one queen per diagonal.

```

1 { queen(I,1..n) } 1 :- I = 1..n.
1 { queen(1..n,J) } 1 :- J = 1..n.
:- 2 { queen(D-J,J) }, D = 2..2*n.
:- 2 { queen(D+J,J) }, D = 1..n-1.
    
```

Listing 3:  $n$ -Queens program.

Fig. 10-13 show solutions for 5x5, 6x6, 7x7, and 8x8  $n$ -queen's problems respectively.

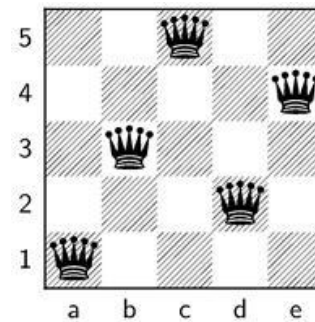


Fig. 10: 5x5 Queen's solution

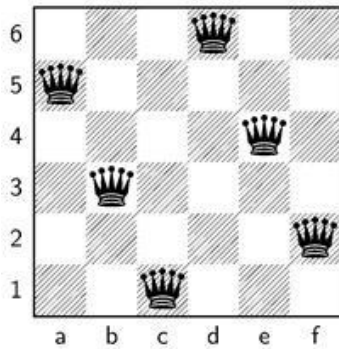


Fig. 11: 6x6 Queen's solution

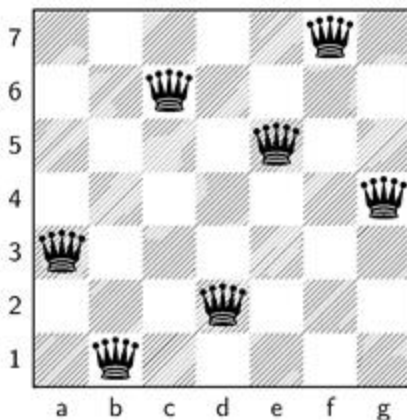


Fig. 12: 7x7 Queen's solution

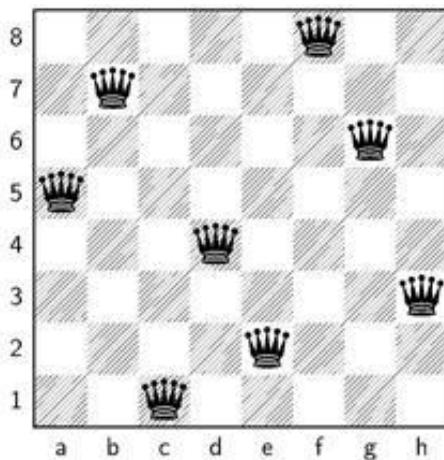


Fig. 13: 8x8 Queen's solution

**IV. CONCLUSION**

This paper presents the solution to two classic chess problems (Knight's Tour and *n*-Queens) through the use of ASP.

We have seen an ASP algorithm for constructing closed and open Knight's Tours on square boards (5x5, 6x6, and 8x8) and not square boards (6x5).

We also present solutions to the problem of *n*-Queens on square boards 5x5, 6x6, 7x7, and 8x8, proving that the ASP algorithm is able to solve combinatorial problems.

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# Grape Wine and Juice: Comparison on Resveratrol Levels

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**Abstract**— *Resveratrol is a polyphenol found mainly in grape seeds, as well in the peel of red grape berries. As a consequence, it is present also in the grape wine and juice. It is a metabolite produced in the secondary plant metabolism in part as a response to bacteria, fungus or virus infection, as well as to mechanical damages and ultraviolet radiation. Resveratrol is known mainly for its antioxidant, anti-inflammatory and antitumoral properties. Thus, this study aimed to evaluate the effects of the vinification process on the variation of resveratrol levels in wine, comparing to the grape juice manufacturing processes and its consequent resveratrol content. Its bio-availability and metabolic pathways should still be more deeply studied, in order to draw conclusions about the real effect of this compound. During the winemaking process, there is an increase in the extraction of phenolic compounds, while in the production of grape juice, the concentration of these compounds occurs.*

**Keywords**— *Vitis spp., byproducts, functional properties.*

## I. INTRODUCTION

The search for foods capable of helping reducing oxidative process rates in the organism has been subject of numerous researches. This protective effect comes from substances found in some foods, as grapes, also highlighted as source of several polyphenols. This group includes a heterogeneous set of substances from several classes, with antioxidant activity (Vargas et al., 2008).

Grapes present different characteristics, such as flavor and coloring, which is directly related to their polyphenols composition and content, as function of the cultivar group (Vedana, 2008). The phenolic content of raw grape fruits exerts strong influence on the quality of derived products such as juices and wines (ABE et al., 2007).

Grapes and their by-products are rich in phenolic compounds, aromatic substances commonly found in foods of plant origin. Several studies have demonstrated that these substances have anticarcinogenic and antioxidant action (Pimentel et al., 2005).

According to Law No. 7,678, dated November 8, 1988, wine is the beverage obtained by alcoholic fermentation of the simple grape must, healthy and fresh, while the grape juice is the unfermented beverage, obtained from the simple, sulphited or concentrated grape must.

In addition to the *in natura* grape, its by-products such as grape juice and wine also contain various combinations of phenolic compounds (Torres and Bobet, 2001). Regular consumption of products derived from grapes, as well as fresh fruits, brings benefits such as chemo-preventive activity and cardiovascular protection (Pezzuto, 2008).

As a result of the "French Paradox" (Goldberg et al. 2003), stilbenes as resveratrol and trans-pterostilbene were identified in *Vitis vinifera*. The French paradox motivated research on the presence and effectiveness of resveratrol because, through the MONICA program, an organized system of data on coronary heart disease (CHD) of the World Health Organization (WHO), it was observed a low incidence of CHD, even with a high-fat diet, smoking and alcohol consumption, by the French population (Castelli, 2001). This fact was partially elucidated by the discovery of high concentration of phenolic compounds present in the wine, as well as resveratrol, described as natural antioxidants (Melzoch et al., 2001).

Being a biologically active substance classified as phytoalexin, resveratrol (3, 5, 4-trihidroxi-trans-stilbene) is a metabolite produced in the secondary plant metabolism; in part as a response to bacteria, fungus or virus infection, as well as to mechanical damages and ultraviolet radiation (Oliveira, 2010).

According to Freitas et al. (2010), the amount of resveratrol found in wine is supposed to be lower than that found in grape juice. In general, significant concentrations of resveratrol are found in wines and grape juice, but these concentrations vary according to grape origin and type, vinification or juice extraction processes, and fungal infection occurring in vines.

Considering the assumptions previously described, this study aimed to evaluate the effects of the vinification process in comparison to the effects of the grape juice

manufacturing process, on the variation of resveratrol content in the wine and grape juice, respectively.

## II. POLYPHENOLS: FUNCTIONAL PROPERTIES OF GRAPES

Functional foods are part of a new food concept, launched in Japan in the 1980's, through a government program that aimed to develop healthy food for a population that was aging and had a long-life expectancy (Anjo, 2004). In addition to the basic nutritional properties of foods, relevant results obtained in recent years attribute the influence of secondary compounds on human health. For example, high concentrations of polyphenolic compounds with biological activity are found in alcoholic and non-alcoholic fruit products, classifying them as nutraceuticals or functional foods (Machado, 2010).

Thus, the antioxidant capacity of phenolic compounds is due to the ease with which a hydrogen atom of the aromatic hydroxyl group can be donated to a free radical and the ability of the phenolic group to support an unpaired electron (Pimentel, 2005). This action reduces the oxidation, for example, of LDL by free radicals decreasing the possibility of atherogenicity. *Vitis labrusca* grapes, used for the production of commercial juices and wines, are rich in polyphenolic compounds (Ashraf-Khorassani and Taylor, 2004).

Chemopreventive activity and cardiovascular benefits resulting from regular grapes and their products consumption, are highlighted in several studies (Pezzuto, 2008). According to Signorelli and Ghidoni (2005), there are also protective effects against the occurrence of Alzheimer's disease associated to consumption of phenolic compounds, due to the occurrence of a potential cholinesterase activity, since the disease is associated with cholinergic deficiency.

The performance of wine in different pathologies, such as atherosclerosis, LDL reduction has already been verified by several authors. The beverage decreases the formation of free radicals and increases the resistance of the collagen fibers (Souza et al., 2006).

The antioxidant activity which characterize the grape and its derivatives as functional foods, as already mentioned, is directly related to the presence of phenolic compounds. The generic term "phenolic compound" encompasses all phenolic core substances, and phenols are compounds that contain a single aromatic ring with one or more hydroxyl groups, while those with multiple phenolic rings in their structure are called polyphenolic (Silva, 2010).

## III. CLASSIFICATION OF PHENOLIC COMPOUNDS

Flavonoids and derivatives of benzoic acid and cinnamic acid are the two major groups of phenolic compounds. Flavanols (catechin, epicatechin and epigallocatechin), flavonols (kaempferol, quercetin and myricetin) and anthocyanins, are part of flavonoids, while phenolic, hydroxybenzoic and hydroxycinnamic acids belong to the group of benzoic acid and cinnamic acid derivatives. Another class is that of the stilbenes, to which the polyphenol resveratrol is framed (Abe et al., 2007).

Grape is one of the largest fruit sources of phenolic compounds. According to Malacrida and Motta (2005), the main concerned components of grape are flavonoids (anthocyanins, flavanols and flavonols), stilbenes (resveratrol), phenolic acids (derived from cinnamic and benzoic acids) and a wide variety of tannins.

### 3.1. Stilbenes

Stilbenes make up another class of phenolic compounds, among which the cis- and trans-resveratrol and cis- and trans-piceid monomers stand out. Compounds named phytoalexins, precursors of viniferous oligomers, are synthesized by the grapevine plant in response to stress, as previously stated (Gris, 2010).

### 3.2. Resveratrol

Compound originating from a family of molecules including glycosides and polymers called viniferins, resveratrol exists in the cis- and trans- configurations (Figure 1). According to Copelli (2005), this component is included in the class of antibiotics known as phytoalexins, since it has the capacity to inhibit the progression of infections caused by fungi.

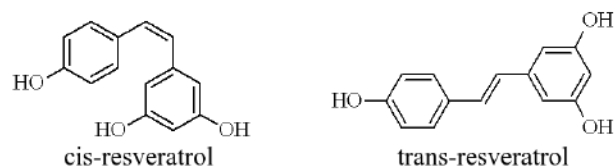
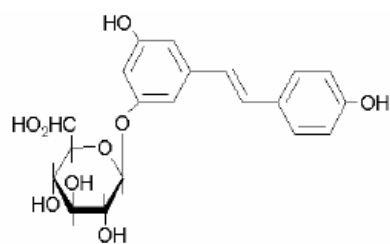


Fig.1: Chemical structure of cis- and trans-resveratrol.

Source: Adrian et al. (1996).

According to Sautter (2003), resveratrol can be found in nature in glycosidic or aglycosidic forms, and the former can be found under several denominations according to the glycone involved and the isomeric form, as shown in Figure 2.



*trans-resveratrol glucosideo*

Fig.2: Structure of a glycosidic form. Source: Adrian et al. (1996).

Resveratrol was found by Tyukavkina (1972), in *Pinus sibirica* bark, while looking for the presence of another stilbene, the pinitilbene. Langcake and Pryce (1976) for the first time reported the presence of the trans-resveratrol isomer in *Vitis vinifera* and other species of the Vitaceae family, and in 1977 they synthesized  $\epsilon$ -viniferin in vitro, and after two years identified the trans-pterostilbene.

As early as 1995, Jayatilake et al. (1995) identified a new stilbene derivative, which was named resveratrol triacetate (3, 4', 5-triacetohydroxy stilbene, 1) in a Porifera species of the Anchinoidae family, *Kirkpatrickia varilosa*.

#### IV. PHYSICO-CHEMICAL PROPERTIES OF RESVERATROL

The Index Merck (Merck, 2001) describes the physico-chemical properties of the standard trans-resveratrol, as follows:

- Presentation: crystals as amber powder
- Fusion point: 253 - 255 °C
- Composition: C = 73.67%; H = 5.30%; O = 21.03%
- Molecular formula: C<sub>14</sub>H<sub>12</sub>O<sub>3</sub>
- Molecular weight: 228.247 g
- Solubility: soluble in DMSO, acetone, ethanol or acetonitrile
- Storage: - 20 °C, protected from light, in inert gas, stable for 3 years.

##### 4.1. Biosynthesis

According to Dixon (2001), resveratrol is produced strictly by 31 genera of plants, and is usually not present in large quantities. Although resveratrol is toxic to plant pathogens, some parasites such as fungi can resist this toxicity by transporting the compound out of the cell compartment due to proteins in its membranes (Nakaune et al., 2002).

In addition, the production of resveratrol in grape berry begins primarily in the peel and is non-existent or found in minimal concentration in the fruit pulp. According to Jeandet et al. (1991), with grape ripening,

resveratrol content decreases drastically, which hinders the detection of the compound. However, the compound is present throughout the vine plant and not only in the fruit, although in different concentrations. A study developed by Melzoch et al. (2001), with wines from the "Mikulovská" region in the Czech Republic, shows significant concentrations of resveratrol in leaves and especially in engage (Table 1).

The concentration of resveratrol in the grape berry is higher in the peel than in the pulp or seed, since the peel suffers mechanical, chemical or metabolic disorder damage by sun radiation (Jeandet et al., 1991).

Malonyl-CoA, one of the precursor coenzymes to the synthesis of resveratrol, is derived from a combination of the acetyl-CoA units formed from phenylalanine, a compound synthesized in plants from sugars via the chiquimic acid route (Copelli, 2005). This occurs through oxidative deamination catalyzed by phenylalanine ammonia biase, which converts phenylalanine to cinnamic acid which is subsequently enzymatically hydroxylated to p-coumaric acid; in the final step, p-coumaril CoA is then formed by free coenzymes.

The biosynthesis of resveratrol occurs through the repetitive condensed decarboxylation of the p-coumaril residue of p-coumaril-CoA with 3 units of malonyl-CoA, these reactions being catalyzed by stilbene synthetase (Dias, 2009). Subsequently, reactions combine native resveratrol, which can give rise to chalcone, glucosyl or sulfate residues in position 3 of the biphenolic ring, the first form of resveratrol being susceptible to oxidation degradation, while the piceid form or glycosylation is resistant (Signorelli and Ghidoni, 2005).

In the formation of chalcone, the chalcone synthase converts the unstable molecule, called native resveratrol to the respective compound, and during the process of resveratrol formation the release of 4 molecules of carbon dioxide for each mol of said synthesized compound (Sautter, 2003).

Environmental factors, such as mineral nutrition, may influence the synthesis of phytoalexins, modifying the expression of the genetic characteristics of the plant (Copelli, 2005). This author also reports the effects of the main macronutrients as nitrogen and potassium, showed that when the grapevine is fertilized with high potassium compared to nitrogen, resveratrol synthesis is increased in both viniferous and hybrid varieties.

Table.1: Resveratrol distribution on grapefruit plant and wine at Mikulovská region, Czech Republic.

Wine Type	Resveratrol Content					
	Leaves mg Kg <sup>-1</sup> dry			Engage mg Kg <sup>-1</sup> dry		
	mass			mass		
	Total	Trans	Cis	Total	Trans	Cis
Cabernet	5.0	1.3	6.3	7.0	-	7.0
Pinot noir	1.6	1.2	2.8	13.	-	13.0
Laurot	4.4	1.6	6.0	15.0	2.0	17.0
Tintet	3.6	-	3.6	440	6.8	446
Neronet	9.9	-	9.9	209	2.3	212
Merlot	7.1	3.0	10.1	15.0	1.8	16.8
Erilon	44.2	2.2	46.2	482	9.9	491
Rubikon	14.6	2.6	17.2	6.0	-	6.0
Hibernal	5.4	1.3	6.7	63.0	3.4	66.4
	Fresh Fruit mg Kg <sup>-1</sup>			Fresh Wine mg L <sup>-1</sup>		
Cabernet	0.72	-	0.72	3.19	0.94	4.13
Pinot noir	2.34	-	2.34	10.5	4.87	15.4
Laurot	5.80	-	5.80	5.21	2.28	7.49
Tintet	0.30	-	0.30	3.85	1.54	5.39
Neronet	0.70	-	0.70	0.67	0.65	1.33
Merlot	0.70	-	0.70	1.31	0.61	1.93
Erilon	0.44	-	0.44	0.48	0.09	0.57
Rubikon	0.20	-	0.20	0.16	0.06	0.22
Hibernal	0.32	-	0.32	0.71	0.22	0.93

According to Boliani et al. (2008), the production of resveratrol and other stilbenes is also induced by solar radiation. In order to evaluate the production capacity of different grape varieties, irradiation methods applied in the post-harvest period allowed the detection of varieties with potential for producing wines with higher contents of these compounds (Bertagnolli et al., 2007).

In order to increase resveratrol content in white wines, a pilot study was conducted to investigate the feasibility of developing yeasts with the ability to produce resveratrol during wine fermentation by altering the metabolic pathway of phenylpropanotes in *Saccharomyces cerevisiae*, since red wine has much higher levels of resveratrol compared to white wine, as the peel of red grape berries is much richer in resveratrol compared to peel from white grape berries (Becker et al., 2003).

## 4.2. Functions

Resveratrol is known mainly for its antioxidant, anti-inflammatory and antitumoral properties (Soleas et al., 1997; Baxter, 2008). The compound acts on an enzyme called lipoxygenase, which has independent activities, which are dioxygenase related to oxidation induction and hydroperoxides, involved in xenobiotic detoxification (Sautter, 2003). According to Pinto et al. (1999), resveratrol acts inhibiting the dioxygenase activity of lipoxygenase, however, without interfering with the hydroperoxidase activity of this same enzyme.

Studies by Fuhman et al. (1995) have shown that the consumption of grape juice and wine is able to reduce lipid peroxidation (Halliwell and Gutteridge, 2000). Resveratrol, in addition to other biological properties previously mentioned, have been reported by Baxter (2008) and David et al. (2007), as reducing symptoms of menopause due to the structural similarity of stilbene to synthetic estrogen; improves tolerance in diabetics to glucose, protects against osteoporosis, cancer and Alzheimer's disease.

Regarding its anti-inflammatory action, resveratrol inhibits the transcription and activity of cyclooxygenase 1 and 2 (COX-1 and COX-2), responsible for the catalysis of the oxidative pathway of arachidonic acid, thus interrupting the production of prostaglandins, inflammatory agents, besides interfering with the cascade of arachidonic acid and the genesis of tumors (Subbaramaiah et al., 1998).

Resveratrol can act as an anti-proliferative agent, promoting apoptosis in tumors in a controlled manner in some types of tumors (Sautter, 2003). Apoptosis or programmed cell death, requires energy and protein synthesis for this to occur (Sautter, 2003); in this process, there is no release of the cellular content to the interstitium, so there is no inflammation around the dead cell, thus differing from necrosis. Resveratrol exhibits antitumoral activity due to its ability to induce apoptosis. It inhibits cell transformation, inducing tumor cells to apoptosis (Soleas et al., 1997).

Resveratrol does not exhibit toxicity at concentrations present in foods, acting in a beneficial manner as previously described. Resveratrol is a competitive antagonist of dioxin and other AhR ligands, having low toxicity and high potency as a prophylactic agent against aryl hydrocarbon-induced pathologies (Casper et al., 1999).

## 4.3. Bioavailability

Several studies aim to elucidate the metabolism and physiological effects of different forms of resveratrol (Frémont, 2000); however, its bioavailability has not been fully elucidated. There is a possibility that resveratrol



glucoside may be absorbed from grape juice by the small intestine, such as flavonoid glucosides, in sufficiently biologically active amounts. In *in vivo* experiments, Kuhnle et al. (2000) and Andlauer et al. (2000) observed that resveratrol is absorbed as resveratrol glucuronide in the small intestine at a ratio of 96.5 % and 16.8 %, respectively.

Despite all the benefits to human health promoted by resveratrol, reported in numerous researches, bio-availability and metabolic pathways should still be more deeply studied, in order to draw conclusions about its real effect of this compound (Frémont, 2000; Bhat et al., 2004).

Pinto et al. (1999) state that resveratrol can be used as a natural lipid antioxidant in foods, influencing the formation of desired aroma and flavor in animal and vegetable products; however, the authors remarks that off-flavors can be generated.

Gambini et al. (2015) state that resveratrol presents antioxidant properties and ability to bind to organic compounds such as hormone receptors and enzymes; this interaction with biological molecules confers to resveratrol beneficial effects against tumors and cardiovascular issues. Paiva (2018) remarks that flavonoids, flavonols and anthocyanins, associate to non-flavonoid compounds as resveratrol and phenolic acids to improve the efficiency on health improvement and conservation.

## V. COMPARATIVE – RESVERATROL LEVELS

All food goes through physico-chemical modifications that can be beneficial or not to nutrients maintenance during the process of transformation, industrialization or even during the simple home food preparation.

During the winemaking process, there is increase in the extraction of phenolic compounds, while in the production of grape juice, the concentration of these compounds occurs. Thus, a comparison on the levels of resveratrol in grape wine and juice are significant to guide consumers on the decision of using alcoholic or non-alcoholic beverages regarding the consumption of adequate levels of resveratrol for its benefits to the organism.

### 5.1. Grape Juice

Depending on the production method, the final chemical composition of the wine or juice will be influenced. In grape juice production by the pressing method, there is great effect on the extraction of resveratrol, although the cultivar has a significant influence on resveratrol concentration (Sautter et al., 2005). According to Freitas et al. (2010), in wine the amount of resveratrol is usually lower than that found in grape juice, because the juice

passes through cooking and hot packing, which promotes the concentration of several compounds, including resveratrol.

In a study developed by Sautter (2003), which aimed to quantify the levels of resveratrol (Table 2 and Table 3) in grape juice, it is observed the presence of trans- and cis-resveratrol, varying according to juice type and processes used for formulation, such as dilution of the juice and type of packaging.

Table.2: Trans-resveratrol contents in distinct grape juice types.

Juice Type	Trans-resveratrol (mg L <sup>-1</sup> )				
	Min	Max	Mean	SD <sup>1</sup>	CV <sup>2</sup>
Integral	0.39	0.44	0.41	0.035	4.26
Reprocessed	0.61	0.90	0.75	0.205	13.5
Reconstituted Sweetened	0.19	0.32	0.25	0.053	84.0
Nectar	-	-	0.41	0.0004	0.97

<sup>1</sup> Standard deviation of the mean; <sup>2</sup> Coefficient of variation around the mean (%). Source: Sautter (2003).

Table.3: Cis-resveratrol contents in distinct grape juice types.

Juice Type	Cis-resveratrol (mg L <sup>-1</sup> )				
	Min	Max	Mean	SD <sup>1</sup>	CV <sup>2</sup>
Integral	0.07	0.26	0.16	0.134	40.71
Reprocessed	1.22	1.59	1.40	0.261	9.31
Reconstituted Sweetened	0.07	0.67	0.38	0.330	86.84
Nectar	-	-	1.24	0.001	0.08

<sup>1</sup> Standard deviation of the mean; <sup>2</sup> Coefficient of variation around the mean (%). Source: Sautter (2003).

Among the types of grape juice evaluated, reconstituted and sweetened grape juice presented the highest coefficient of variation for trans-resveratrol (CV = 84.0%), due both to the type of cultivar and processing method. Grape nectar had higher trans-resveratrol concentration than simply extracted juice, because nectar, according to the Ministry of Agriculture and Livestock (MAPA) Regulation 1, is obtained from the dilution in drinking water of the edible part of the vegetable or its extract, holding 51% of juice, while the extracted juice is in its natural concentration, not added with sugar. According to Sautter (2003) this can be explained by the processing of the nectar, which undergoes smaller losses of the trans-resveratrol, since in extracted juice processing, there is filtration and stabilization.

Sautter (2003) reports that hot processes such as pasteurization, pressure and maceration increase the concentration of trans-resveratrol, as they also favor the

extraction of these compounds besides its concentration in the final product. This information is corroborated by Ali et al. (2010), Krikorian et al. (2012) and Paiva (2018).

However, the variation of cis-resveratrol (CV = 86.84%) in the reconstituted and sweetened grape juices, may be associated with juice exposure during industrial processing, since the product was in a protective packaging, not exposed to light. High concentration of cis-resveratrol in the reprocessed juice were also observed, and according to Sautter (2003), this is due to the shelf life of the elaborated juice packaged in a PET-type package, being more exposed to light. The consequence of this exposition is the transformation of the isomer trans-resveratrol into cis-resveratrol (Melzoch et al., 2001).

## 5.2. Red Wine

The phenolic compounds are extracted during the maceration of the grape in the vinification process, transferring them to the must. However, most of these substances remain in the grape residue at different concentrations, depending on the process applied or the variety of the raw material (Campos, 2005).

According to Roggero (1996), the cis- isomer, which is not detected in grape peel, is formed from the isomerization of trans-resveratrol or from the breakdown of resveratrol polymers during wine fermentation. According to Soleas et al. (1995), the predominant form of resveratrol in wine is trans-, the cis- form being found in lower concentrations, which is probably formed during vinification.

According to Frankel et al. (1995), during wine manufacturing, when grapes are crushed with stalk, peel and seed, more phenolic compounds are incorporated in the wine. Jeandet et al. (1995) and Roggero (1996) verified that both plant diseases caused by *Botrytis cinerea* (grey mould), as well as the wine aging, modify the concentration of resveratrol in wines. The authors found that resveratrol is relatively stable in wine, and even in older wines, these may have higher concentrations compared to young wines.

The difficulty in identifying most of the factors responsible for the variation in resveratrol concentration in wines, is mainly associated to problems in the execution of controlled experiments with alcoholic fermentation. These factors need specific investigation, because during the processing a range of interferences occurs (Trevisan, 2003).

According to Frémont (2000), variations in the concentration of resveratrol were detected in red wines from countries such as the United States, France, Spain and Japan. These variations depend on plant infection by gray mould, grape variety, geographical origin and

winemaking process. However, subsequent studies have shown that a high contamination by gray mold is not favorable to the formation of resveratrol, since grapes with 10 % infection originates wines with high resveratrol contents, but wines obtained from grapes with 40 % or 80 % infection resulted in wines with lower resveratrol concentration. This result lead researchers to believe that high levels of contamination by *Botrytis* causes resveratrol degradation by the fungus enzymes (Frémont, 2000).

Evaluating the content of resveratrol in Japanese white and red wines, it can be verified that the former presented  $0.027 \text{ mg L}^{-1}$ , while the latter resulted in  $0.175 \text{ mg L}^{-1}$ . Wines from Spain showed average values of  $0.13 \text{ mg L}^{-1}$ , and Portuguese wines  $0.21 \text{ mg L}^{-1}$  for white and  $1.25 \text{ mg L}^{-1}$  for red wines (Trevisan, 2003). Due to the alterations caused by vinification on resveratrol concentrations, studies were conducted to understand the influence of the steps of maceration, fermentation and clarification on the content of this important wine component (Copelli, 2005).

The extraction of resveratrol is strongly influenced by the maceration process. When comparing wines that underwent longer maceration with those that went through the same process during a shorter time (short maceration), they presented  $1.84 \text{ mg L}^{-1}$  and  $0.81 \text{ mg L}^{-1}$ , respectively (Trevisan, 2003). Most significant concentration is in red wines in part because they remain for a longer time in contact with the berry peel, whereas in white wines, the peel is separated at the beginning of the process. However, too much maceration may lead to the extraction of phenolic compounds that provide undesirable characteristics in wines, such as excessive astringency and bitter taste, which can be removed later (Copelli, 2005).

A study reported by Copelli (2005) revealed that the maximum level of resveratrol in the must was found between three and eleven days after maceration, where the extraction of resveratrol from the peel is facilitated by the production of ethanol during fermentation, since the compound is more soluble in ethanol than in water, and is consequently more easily extracted from the peel during fermentation, which do not occur during juice production.

Phenolic compounds have their values frequently reduced during clarification, through the addition of clarifying agents that aid in wine clarification and stability (Copelli, 2005). The use of bentonite, egg albumen and diatomaceous earth as clarifying agents exert no influence on resveratrol content of wines, and non-significant amounts of resveratrol are removed by using gelatin and silica gel. However, the addition of high levels of activated carbon reduces resveratrol content by about 50 %, while its isomers are reduced in about 80 %,

and the use of PVPP (polyvinylpolypyrrolidone) reduces resveratrol levels by 33 % (Trevisan, 2003).

According to Bertagnolli et al. (2007), trans-resveratrol content increases during fermentation, regardless of the vinification technique used. Samples of wines from carbonic maceration resulted in slight decline due to the atmosphere rich in CO<sub>2</sub> where the must was stored, which inhibited the route of formation of resveratrol at the end of the main alcoholic fermentation.

## VI. CONCLUSION

In grape juice, the variation of cis-resveratrol in the reconstituted and sweetened grape juices, may be associated with juice exposure during industrial processing. High concentration of cis-resveratrol in the reprocessed juice were also observed due to the shelf life of the elaborated juice packaged in a PET-type package and the consequent transformation of trans-resveratrol to cis-resveratrol.

In red wine, phenolic compounds have their values frequently reduced during clarification, through the addition of clarifying agents. However, bentonite, egg albumen and diatomaceous earth as clarifying agents exert no influence on resveratrol content of wines, and non-significant amounts of resveratrol are removed by using gelatin and silica gel. However, the addition of high levels of activated carbon or PVPP reduces resveratrol content.

During the winemaking process, there is an increase in the extraction of phenolic compounds, while in the production of grape juice, the concentration of these compounds occurs.

Overall, the resveratrol content, and its isomers, tend to be similar in grape juice and wine, although with large variation ranges in both of them, depending on the manufacturing procedures. These differences are mainly attributed to the juice processing or reprocessing procedures; the clarifying agents for wine; grape variety, edaphoclimatic and cultivation conditions; and harvesting and post-harvesting procedures. The interferent factors on resveratrol level that are controllable, need to be correctly adjusted to maximize resveratrol levels in the final product.

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# Analysis of Dynamic Loading on Automatic People Mover System (APMS) Bogie Frame According to UIC Standard

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**Abstract**— The purpose of this research is to conduct numerical analysis and verification of APMS bogie frame to withstand maximum dynamic loading with finite element analysis and to conduct design modification if bogie is not achieving safety criterion and infinite life cycle. Stages of this research was collecting data and APMS bogie drawing from PT. INKA Madiun, then conduct identification of bogie model structure, which included quality validation of Solid CAD model and mesh quality validation, then determination of boundary conditions for dynamic loading to acquire simulation of fatigue loading analysis or fatigue of material due to dynamic loading. From 3rd load step simulation showed that alternating stress result was 75.813 MPa which is under the limit of High Cycle Fatigue, 97,36 Mpa, and safety factor 1.25 so that until this stage was still safe. Limit of material SM 490A toughness used for bogie frame manufacturing on cycle  $10^6$  or High Cycle Fatigue (HCF) was 97.36 MPa.

**Keywords**— bogie frame, dynamic load, fatigue analysis.

## I. INTRODUCTION

APMS manufactured by PT. INKA basically using monorail as a basis, which developed by adopting technology and latest design, however those APMS bogie design need to be verified for its safety and ability to withstand standard working load or crush load.

Purpose of this structural analysis was to determine and assure the limit of bogie frame strength in order to fulfill requirements prior to the testing, or generally said as design verification stage. Static analysis represents bogie frame structure behavior in certain conditions, such as cruising, side wind, braking and maneuver, whereas maximum loading in short period on frame structure from vertical load, lateral load, or longitudinal load so that we can identify critical area due to maximum strain/ stress and deflection.. The result of this static analysis can be used as reference for strain gauge attachment during static test of APMS bogie prototype.

Dynamic load can be defined as time-load function. One of the result of dynamic load is fatigue load, because it can cause fatigue to material even if load is not achieving maximum limit of material yet. Most common fatigue analysis method used in railways structure is limit of endurance using nominal stress with maximum dynamic load. Saurabh et.all [1] during bogie lifetime several external forces act in the normal service loads on the bogie frame. These forces are coming from the wheel-rail contact points and from the interfaces with the car body and are generated from:

- 1) double sprung masses, including payload;
- 2) track irregularities;
- 3) lateral accelerations caused by curve riding;
- 4) longitudinal accelerations caused by traction and braking;

Kiim et al. [2] evaluated the static structural safety and durability of two composite bogie frame models using a finite element analysis. Based on the Tsai-Wu failure criterion under ten different loading conditions, durability of bogie frame were researched using Goodman diagrams. Han et al. [3] evaluated experimentally fatigue strength for bogie frame of an urban maglev train and researched fatigue and damage. Moskvitin et al. [4] studied the effect of fatigue crack growth under overload situation. Kumar et al [5] the acceleration response of front and the rear bogie with time is presented, initially the wheels of the front bogies comes in contact with the track irregularity and the vibration starts in the front bogie and latter these vibrations are shifted to the rear bogie. The amplitude of the vehicle vibration also increased with vehicle speed.

This research focused on numerical fatigue analysis on main frame of the bogie monorel to discover dynamic loading condition at the most dominant direction-vertical translation-which will effect fatigue strength of material on APMS bogie structure according to infinite fatigue life criterion, more than  $10^6$  cycle of dynamic loading .

## II. RESEARCH METHOD

First step of dynamic load of bogie frame is preparing 3D solid model and assembly for validation of structural model.

Next is calculation of dynamic load according to UIC due to rollingstock movement on the track to get loading value received by bogie structure.

To represent static and dynamic load on the bogie model, the boundary conditions and free body diagram was defined.

Then making prediction of S-N diagram for bogie material as input of fatigue analysis. Fatigue simulation is runned using ANSYS software [6][7].

According to regulation of Ministry of Transportation Republic of Indonesia: PM. 37 year 2014 about Technical Specification Standard of Monorail, Bogie is a construction entity which support monorail while moving on arches railway or straight railway for stability and comfort [8].

Bogie frame is a constructuin designed to support coach from loadings. Frame must meet some requirements such as having strength and high rigidity to vertical, lateral and longitudinal without having permanent deformation and defect (crack) on the critical point of loading.

Bogie is supported on two main wheel which is wheel to support vertical direction load (z-axis fixed) and railway mover on longitudinal direction (x-axis fixed) and six side wheel as support for lateral direction (y-axis fixed). Material used for this bogie is SM 490A (JIS G3106). Steel SM490A is rolled steel commonly used in engineering, specifically on welded structure. SM 490A is having equality on the classification of JIS G3106 standard and ASTM A 572. Mechanical properties of the material as follows [9] :

Modulus young	: 210 GPa
Elongation	: 17%
Yield strength	: 325 MPa
Ultimate tensile strength	: 490 MPa
Poisson Ratio	: 0.3

## III. RESULT AND ANALYSIS

Dynamic load can be defined as load-time function. Dynamic load can be classified as two kind of loading, which is impact and fluctuating/ alternating load, or can be named fatigue load, since it can cause fatigue on material even if the load is yet to achieve maximum limit of material strength. Fluctuating load is a load working on an object/ material with constant, variable and random amplitudo.

Fatigue analysis conducted to discover structural strength to cyclic or repeated loading so that remaining life of the structure can be obtained. A structure can be considered safe if service life from the calculation is longer than

design life planned. Design life of a component or product is a period of time of a component or product is expected by designer to work on parameters defined; or in another words life expectancy of a component or product. Design life can be adjusted during the stage of design planning.

### 3.1. S-N Diagram

S-N Curve is a fatigue characteristic which generally used from a material that suffered repetitive stress with the same value. This curve is obtained from stell speciment test that given repetitive load with N cycle until failure occured. "N" is inversely proportional to span of stress "S". According to Juvinal, S-N Curve of a material can be predicted by calculate some of correction constant factor such as Loading constant ( $C_L$ ), Dimension constant ( $C_D$ ), Surface condition constant ( $C_S$ ), Stress Concentration factor Cycle  $10^3$  ( $K'_f$ ) and Stress Concentration facto on cycle  $10^6$  ( $k_f$ ). S-N diagram for material SM 490A can be predicted by calculating values for  $S'_n$  ,  $K_f$  ,  $K'_f$  , *alternating stress* on cycle  $10^3$  and cycle  $10^6$ .

Value of  $S'_n$  :

$$S'_n = 0,5 S_u \\ = 0,5 \cdot 490 \text{ MPa} = 245 \text{ MPa}$$

Value of  $K_f$  :

$$K_f = 1 + (K_t - 1)qC_s \\ = 1 + (3 - 1)0,4 \cdot 0,68 \\ = 1,54$$

Value of  $K'_f$  :

$$K'_f = r(K_f - 1) + 1 \\ = 0.1(1.54 - 1) + 1 \\ = 1,054$$

Alternating stress on cycle  $10^3$  :

$$S = 0.9 \times S_u / K'_f \\ S = 0,9 \times S_u / K'_f \\ = 0.9 \times 490 / 1,054 \\ = 418.40 \text{ MPa}$$

Alternating stress on cycle  $10^6$  :

$$S_n = S'_n \times C_L \times C_D \times C_S / K_f \\ = 245 \times 0,9 \times 1 \times 0,68 / 1,54 \\ = 97.36 \text{ MPa}$$

After obtained result of calculation for endurance limit at Cycle  $10^3$  or limit Low Cycle Fatigue (LCF) as big as 418.40 MPa and cycle  $10^6$  or limit High Cycle Fatigue (HCF) 97.36 MPa, the result can be plotted to S-N Curve. Those S-N Curve prediction can be seen below:

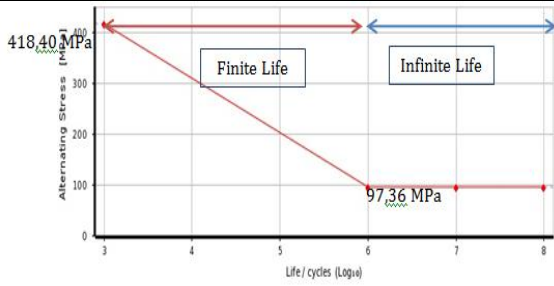


Fig.1: SN Curve Prediction for Material SM 490 A

**3.2. Fatigue Loads**

On conducting analysis, the most important thing is material definition used and forces assumption and boundary condition assumption which represent actual condition in a structure. Bellow is a modelling of forces and boundary condition for simulation:

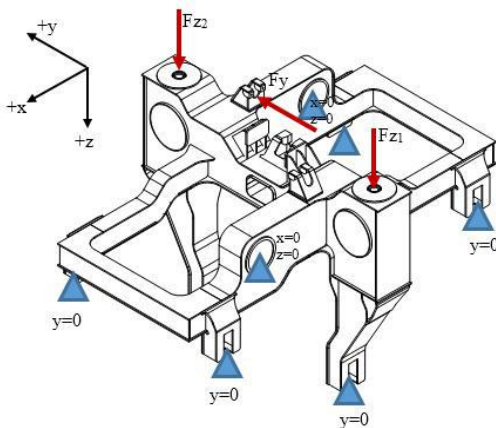


Fig.2: Forces Modelling and Boundary Condition of APMS Bogie

Definition of working loads based on UIC 615-4 while trainset is running:

- Vertical test load per bogie:

$$F_z(N) = \frac{g}{2n_b} (m_v + 1,2C_2 - n_b m^+)$$

- Transverse test load per bogie:

$$F_y(N) = 0,5(F_z + 0,5m^+ g)$$

Notation and definition of load above:

- $n_b$  = number of bogies = 4
- $n_e$  = number of wheelset per bogie=2
- $m^+$  (kg) = bogie weight = 1000 kg
- $m_v$  (kg) = empty weight of vehicle = 12,000 kg.
- $C_2$  = loading weight = 17,897 kg.
- $g$  = gravitation

According to UIC 615-4, calculation of forces for fatigue test can be conduct using formulas and step as follows:

1) Vertical Forces:

- Static Component:  
 $F_{zs1} = F_{zs2} = F_z = 36145.43 \text{ N}$
- Quasi static component:  
 $F_{zq1} = F_{zq2} = \pm \alpha F_z = 3614.54 \text{ N}$
- Dynamic component:  
 $F_{zd1} = F_{zd2} = \pm \beta F_z = 7229 \text{ N}$

2) Transverse Forces:

- Quasi static component:  
 $F_{yq} = \pm 0,25. (F_z + 0,5m^+ .g) = 10262.61 \text{ N}$
- Dynamic component:  
 $F_{yd} = \pm 0,25. (F_z + 0,5m^+ .g) = 10262.61 \text{ N}$

3) Testing can be conduct in 3 stages, according to the increase of loading level as showed in figure 3, as follows:

- Loading stages 1 :  $2 \times 10^6$  cycles;
- Loading Stages 2 :  $2 \times 10^6$  cycles, with loading factor multiplied with 1.2;
- Loading Stages 3 :  $2 \times 10^6$  cycles, with loading factor multiplied with 1.4;

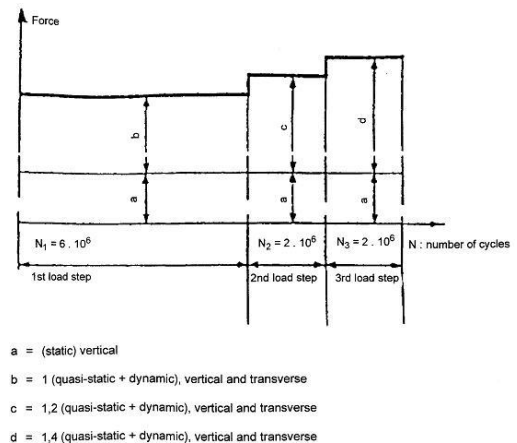


Fig.3: Fatigue Test Procedure

So can be obtained:

- 1<sup>st</sup> load step:
  - Vertical load: 46989.07 N
  - Transverse load: 20525.22 N
- 2<sup>nd</sup> load step:
  - Vertical load: 56386.88 N
  - Transverse load: 24630.26 N
- 3<sup>rd</sup> load step:
  - Vertical load: 65784.69 N
  - Transverse load: 28735.3 N

**3.3. Fatigue Strength Simulation**



Fatigue strength on this test evaluated using Goodman mean stress correction theory, because Goodman theory is empirically considered closest to the actual condition if compared to Soderberg Theory which is conservative as well as Gerber Theory. Loading type used in this simulation is zero based.

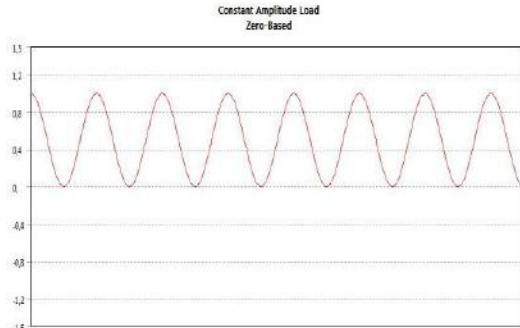


Fig.4: Zero Based Loading Type

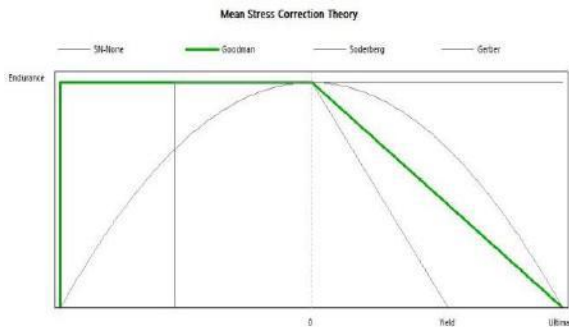


Fig.5: Goodman Mean Stress Correction Theory

These following figures is the result of fatigue test using ANSYS, and can be obtained data as follows:

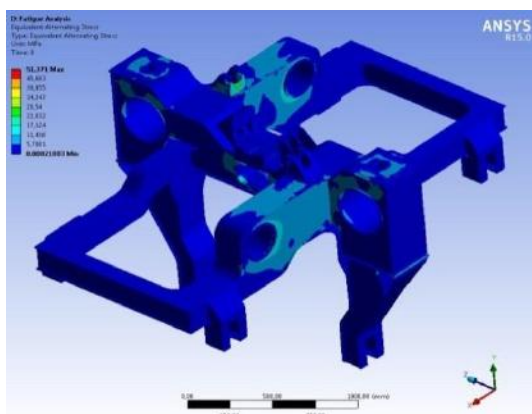


Fig.6: Alternating Stress on 1<sup>st</sup> Load Step

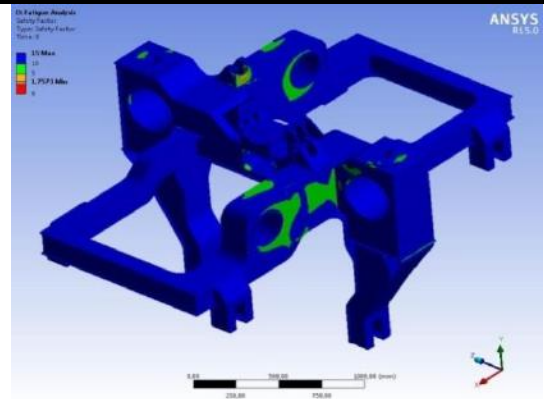


Fig.7: Safety Factor on 1<sup>st</sup> Load Step

From 1<sup>st</sup> load step simulation result, can be obtained result of alternating stress is 51.371 MPa which is still below limit of High Cycle Fatigue (HCF) 97.36 MPa, and safety factor 1.75, thus on this stage can be considered safe and can be continued to 2<sup>nd</sup> load step with multiplier for vertical load dan transverse load is 1.2.

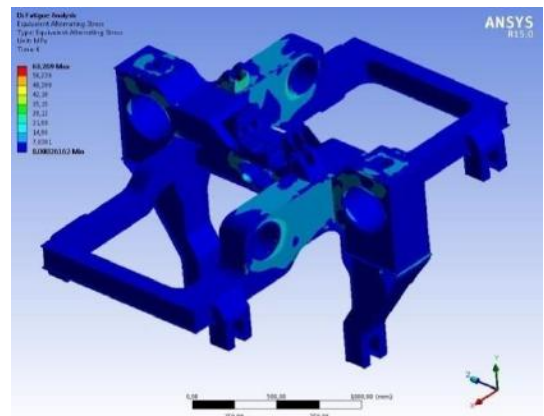


Fig.8: Alternating Stress on 2<sup>nd</sup> Load Step

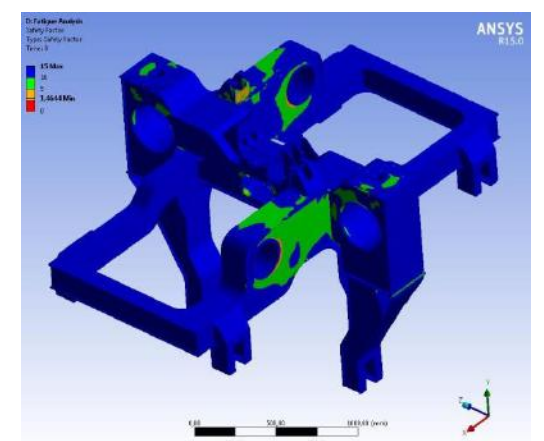


Fig.9: Safety Factor on 2<sup>nd</sup> Load Step

From the simulation of 2<sup>nd</sup> load step, can be obtained result of alternating stress is 63.269 MPa which is still below limit of High Cycle Fatigue (HCF) 97.36 MPa, and safety factor 1.46, thus at this stage still considered safe,

and can be continued to 3<sup>rd</sup> load step with multiplier factor for vertical load and transverse load is 1.4.

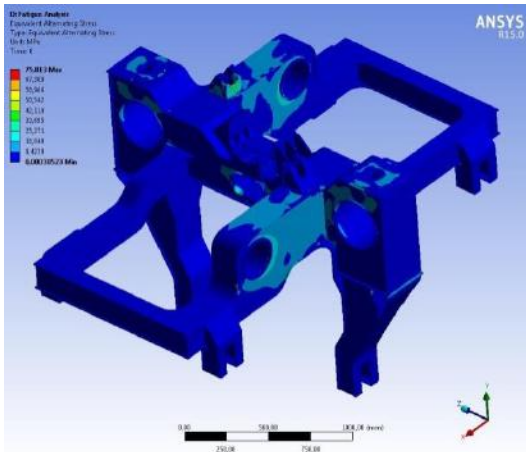


Fig.10: Alternating Stress on 3<sup>rd</sup> Load Step

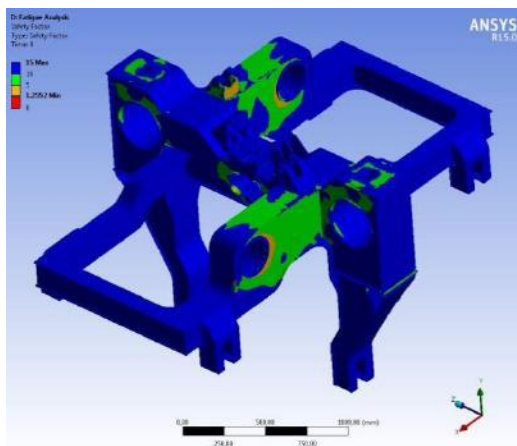


Fig.11: Safety Factor on 3<sup>rd</sup> Load Step

From the simulation of 3<sup>rd</sup> load step, can be obtained result of alternating stress is 75.813 MPa which is still below limit of High Cycle Fatigue (HCF) 97.36 MPa, and safety factor 1.25, thus at this stage still considered safe. Following table is summary for the fatigue test above:

Table.1: Result of Fatigue Test

Load Step	Cycle	Alternating Stress (MPa)	Safety Factor
1	6 x 10 <sup>6</sup>	51.371	1.75
2	2 x 10 <sup>6</sup>	63.269	1.46
3	2 x 10 <sup>6</sup>	75.813	1.25

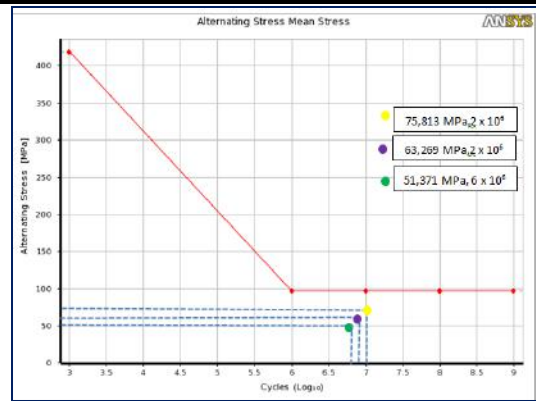


Fig.12: Fatigue Life APMS Bogie

From the result of fatigue test above, if the result of alternating stress is plotted to S-N Diagram prediction of material SM 490A, can be concluded that bogie frame was able to withstand loading according to UIC 615-4 Standard, until life cycle above 1e<sup>7</sup>, so can be considered having infinite life.

#### IV. CONCLUSION

Endurance limit of SM 490A used for bogie frame manufacturing on cycle 10<sup>3</sup> or limit for Low Cycle Fatigue (LCF) is 418.40 MPa and on cycle 10<sup>6</sup> or limit for High Cycle Fatigue (HCF) is 97.36 MPa.

From 1<sup>st</sup> load step simulation result, can be obtained result of alternating stress is 51.371 MPa which is still below the limits of High Cycle Fatigue (HCF) 97.36 MPa, and safety factor 1.75, thus until this stage is still considered safe.

From the 2<sup>nd</sup> load simulation step, can be obtained alternating stress is 63.269 MPa which is still below the limit of High Cycle Fatigue (HCF) is 97.36 MPa, and safety factor 1.46, so until this stage is still considered safe.

From the 3<sup>rd</sup> load simulation step, can be obtained alternating stress is 75.813 MPa which is still below the limit of High Cycle Fatigue (HCF) is 97,36 MPa, and safety factor 1.25, so until this stage is still considered safe.

APMS bogie frame able to withstand loading according to UIC 615-4 Standard, until lifetime above 1e<sup>7</sup> cycle, thus can be considered having infinite life.

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# Transaction Security in Energy Trading System using Block chain

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**Abstract**— *Transaction Security (TS) is a framework that intercepts real-time Sales force events and applies appropriate actions and notifications based on security policies we create. In the earlier system of transactions all the nodes in the network are connected using centralized approach in which a node act as a server and all other nodes are connected to it. It is similar to client server model. All the information are stored in the centralized node. When the centralized node is been hacked by the hacker then it provides entire details about the transaction and doesn't provide enough security. Since the privacy of these data is very less we proposed to have more secured system. The proposed system uses a decentralized network that doesn't rely on a central point of control. A lack of a single authority makes the system fairer and considerably more secure using block chain and multi signature. A block chain is a public ledger of information collected through a network that sits on top of the internet. It is how this information is recorded that gives block chain its ground breaking potential and it is extremely important that the information being stored is honest and accurate. The main aim of this system is to provide transaction security without using a trusted third party since it reviews all the critical transaction communications between the parties, based on the ease of creating fraudulent digital content. This system provides high security and the hacker meets the difficulty level to retrieve the data..*

**Keywords**— *Block chain, Centralized node, Decentralized network, Multi signature Transaction Security, Trusted third party.*

## I. INTRODUCTION

A block chain consist of growing list of records called blocks, where each block contains cryptographic hash of previous block, timestamp and data which are connected to each other using cryptography. In general block chain doesn't allow the modification of data. It is a system that facilitates the transaction between two parties [1]. The introduction of the block chain for bitcoin solved the double-spending problem without the need of a trusted authority [2]. There are two types of block chain i)

Public block chain ii) Private block chain where the private block chain is proposed for business use. The drawbacks faced in the existing system are as follows:

1. Capture the entire data- In the existing system all the details regarding the ownership of the transaction are stored in the database. Once the hackers enters the database he would capture the entire details.
2. High timestamp- Since for each transaction the nodes checks their previous history of stored transactions timestamp is merely high.

To overcome these drawbacks we proposed a system in which the transaction details stored in the database expires once the transaction gets completed. High security is employed in this system so that hacker meets difficulty level to retrieve the data.

## II. RELATED WORKS

Sidharth Quamara[3] proposed the system to overcome the limitations associated with the conventional approach of bitcoin based electronic financial transactions. But this system had a drawback of inability of doing non-reversible payments for non-reversible services. Exploratory Simulation Models for Fraudulent Detection in Bitcoin System was proposed by Vincent Lee[4]. Their main objective is to identify one of the possible method of double spending under the circumstance that the network connection status is not stable. The main drawback of this system is that it is expected to replace the traditional currencies among online transactions. Building on that, we believe that the security issues during Bitcoin payment must be put in high priority.

An improved approach has been put forth by Haozheng Wei[5] called Coin Express which aimed to achieve outstanding payment acceptance ratio with low routing overhead. This system failed because all transactions via a channel are stacked, and will be jointly published to the public block chain upon channel expiration. The next approach proposed by Ravi Vatrappu[6] aimed in using supervised learning techniques for appropriate classification of the Bitcoin entities. The main drawback faced by this system is pseudo-anonymity. Krishnan Kanoorpatti[7] designed a new

system to analyze the complete process of transaction of Bitcoins and anonymity that lies in that process. This approach failed because while downloading the Bitcoin wallets to the devices, they install software which is either a web wallet that is found in the host or a mobile wallet that is found in smart phone devices

Filip Caron[8] described a system that operate a diverse set of payment systems that facilitate these transfers of funds according to formal arrangements and standardized rules. This failed to meet the specifications of guaranteeing an orderly and timely settlement of wholesale payments is crucial for the wellbeing of financial markets. Dimaz Ankaa[9] Wijaya revised this system and put forth a system to extend the functionality of asset management systems which are limited to a maximum of 80 bytes data. This system faced a limitation where there is no central controller in Bitcoin as in fiat monetary system and therefore it employs cryptographic technique to verify the validation of the transaction.

An advanced system that facilitated single-fee micropayment protocol that aggregates multiple smaller payments incrementally into one larger transaction needing only one transaction fee was put forward by H.Robert[10]. This system failed because many low-value payment applications will suffer from the high transaction fee currently present in the bitcoin network. To reduce the complexity in purchase between customer and the traders a new system called BPCSS was introduced by Chia-Hui Wang[11] where all the details were stored in the cloud database for easy retrieval. But this system too failed because storage space is high. All these drawbacks has been overcome and Nurzhan Zumbabekuly Aitzhan[12] proposed a system that provides transaction security without using trusted third party. But this system faced the drawback of having high timestamp and when the hacker hacks 50% of the network the entire details will be known to the hacker. The modified password generation and storage method paved the way for providing high transaction security in the energy trading system.

### III. PROPOSED SYSTEM AND CORE COMPONENTS

#### 3.1. Proposed system

The earlier system using block chain were developed to overcome the security issues related to the traditional transaction processing system. The cryptographic proof of work has been introduced to provide basic security to the system. But it failed in providing non-reversible payment for non-reversible services. Later the system developed doesn't meet the user specifications it was able to find only the cause of double spending attack but couldn't find a perfect solution to it. Few years later system with supervised learning techniques were developed.

Unfortunately due to the inclusion of these additional features they failed to meet major issue of pseudo anonymity.

Then a cloud database has been setup to store the details of the customer who perform the transaction. Keeping this as a scratch Aitzhan designed a system in which each time when a transaction enters the network all other nodes in the network checks the previous available history of the transaction which resulted in high timestamp. And when the hacker successfully enters the network he could capture the entire transaction details of all the user. So there is no transaction security. To overcome all these above problems we have designed a system that provides high transaction security without using a trusted third party and multisignature. The timestamp is highly reduced in the system since there is no need of accessing the database each time when transaction enters into the network. The password stored in the database expires once the transaction is completed.

#### 3.2. Core Components

The proposed system is implemented in such a way that it has four important modules:

i) Fragmentation of the transaction ii) Signing of packets by all the nodes iii) Hacker identification and notification iv) Reassembly of packets.

Our system constitutes of 4 nodes and 1 server. The overall project is implemented using Net beans Integrated Development Environment (IDE). We have also used MySQL as backend to store the passwords that are created by the user. The Graphical User Interface (GUI) is created in such a way that the transaction can be selected by the user. First the connection has to be established. As soon as the sender browses the transaction the path of the transaction is displayed and the user sets the password for the entire transaction. Then it is fragmented into packets using file hashing algorithm. Then a key is generated using AES algorithm in which the length of the key is 4.

Once the transaction is fragmented it is sent through the router. The fragments are signed by all the nodes in the network implementing the concept of multi signature using DSA algorithm. After the completion of this process the number of packets and the encrypted format are displayed in the side pane. The fragments passing through each node can be viewed if the right password is entered. The user is given 2 attempts if he enters the wrong password. If it is repeated for the third time then the user will be identified as a hacker and notified to the sender. This will be acknowledged to the user by turning green to red light. This information passes through all the nodes in the network.

At the destination node the total number of packets reached the destination is displayed. Also the number of packets flowed through each node is also displayed in the overall window where the active nodes and hacker nodes

are displayed. Then finally reassembly occurs at the destination node using sequence number and when the right password is entered the entire file will be retrieved. We provide a webpage in which a button is displayed.

Once the button is clicked the entire path through which the packets travels from source to destination is displayed. The entire proposed system is designed as shown in Fig 3.2.

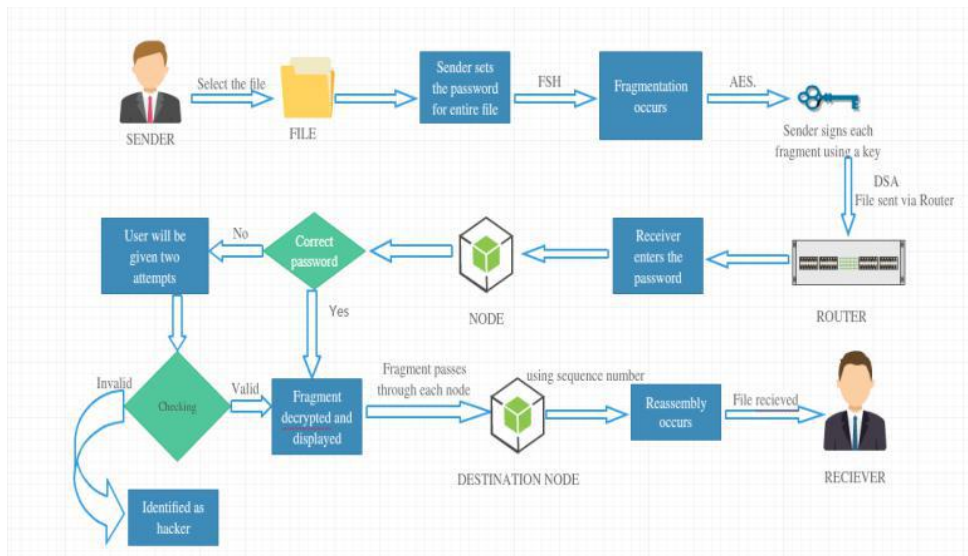


Fig. 3.2: Architecture Diagram

**3.3. Algorithms Implemented**

**3.3.1. Fragmentation of transaction**

Once the sender browses the transaction it is divided into fragments using file hashing algorithm. The algorithm is explained below

**File Hashing Algorithm**

File hashing module generates two random keys from the main key. It divides the key bits into half i.e. if key is of length n then the generated random two keys will be of length n/2. The pseudo code is given below:

- Step1: Select the input as n bit key
- Step2: Key1 and Key2 is set as n/2 bit value and it is initialized to 0
- Step3: Random function is initialized with seed value. 323
- Step4: Initialize length as n, x=0, y=0, flag=0.
- Step5: While (length != 0)
  - 5.1: If Flag==0 then
    - Find a randomly unused bit position.
    - Find out the value at that bit position in main key.
    - If value at that bit position is 1 then
      - The x'th bit of key1 is set as 1 and x value should be incremented
    - else
      - The x'th bit of key1 is set as 0 and x value should be incremented
    - Set Flag=1, Set the above found bit position is used.
    - Go to Step 5.3
  - 5.2: Else

Find a unused bit position.

Find out the value at that bit position in main key.

If value at that bit position is 1 then

The x'th bit of key2 is set as 1 and y value is incremented.

Else

The x'th bit of key2 is set as 0 and y value is incremented.

Set Flag=0, Set the above found bit position is used.

Go to Step 5.3

5.3: Decrement the Length;

5.4: Go to step 5

Step6: Return the keys key1 and key2 of size n/2.

**3.3.2. Key Generation**

To encrypt all the fragmented packets a key is generated using Advanced Encrypted Standard Algorithm. The algorithm is explained below in Fig 3.3.2

**AES Algorithm**

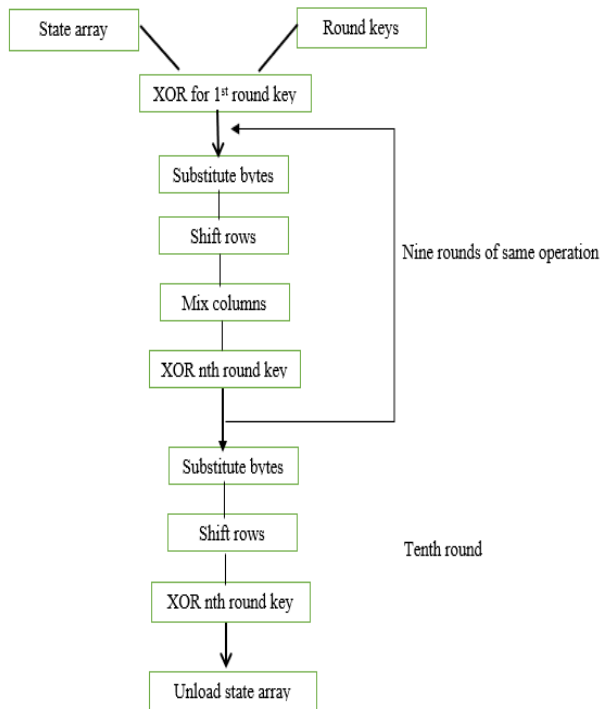


Fig 3.3.2: AES Algorithm Steps

Step1: A set of round keys should be obtained from the cipher key.

Step2: State array is initialized with the plain text.

Step3: Initial round key is added to the starting state array.

Step4: Nine rounds of state manipulation is performed.

Step5: Finally tenth and final round of state manipulation is performed.

Step6: Encrypted cipher text is the contents of final state array.

### 3.3.3. Signing of packets

Once the key is generated it is signed by all the nodes in the network using Digital Signature Algorithm. Now all the packets remain in encrypted form. The algorithm is explained below in Fig 3.3.3

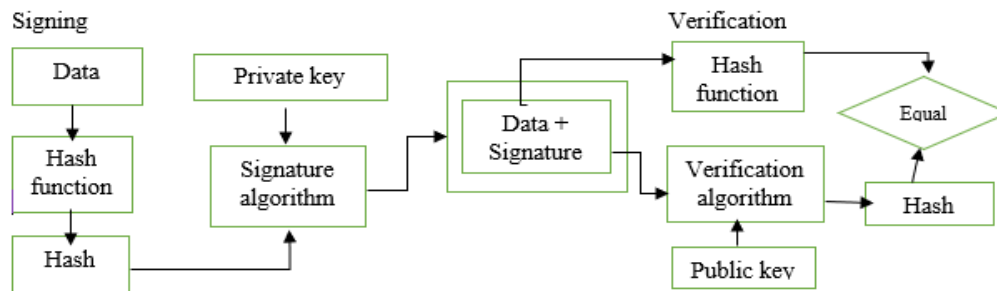


Fig.3.3.3: Digital Signature Generation and Verification

### Digital Signature Algorithm

#### Signature Generation

INPUT: Global parameters (p, q, g); sender's private key a; message M,  $h = \text{Hash}(M)$ .

OUTPUT: Signature (r, s).

- Step1: Choose a random integer k in the range  $[1, q - 1]$ .
- Step2: Calculate  $X = g^k \text{ mod } p$  and  $r = X \text{ mod } q$ . If  $r = 0$  go to step 1.
- Step3: Calculate  $k^{-1} \text{ mod } q$ .
- Step4: Compute  $h = \text{Hash}(M)$ .
- Step5: Compute  $s = k^{-1}(h + ar) \text{ mod } q$ . If  $s = 0$  go to step 1.
- Step6: Return (r, s).

#### Signature Verification

INPUT: Global parameters (p, q, g); sender's public key A; message, M, with message digest  $h = \text{Hash}(M)$ ; signature (r, s).

OUTPUT: "Valid" or "Invalid".

- Step1: Verify that r and s are in the range  $[1, q - 1]$ . If not then return "Invalid" and exit.
- Step2: Calculate  $w = s^{-1} \text{ mod } q$ .
- Step3: Compute  $h = \text{Hash}(M)$ .
- Step4: Calculate two components  $x_1 = hw \text{ mod } q$  and  $x_2 = rw \text{ mod } q$ .
- Step5: Compute  $X = g^{x_1} A^{x_2} \text{ mod } p$  and  $v = X \text{ mod } q$ .
- Step6: If  $v = r$  then return "Valid" else return "Invalid".

### IV. IMPLEMENTATION

This system is implemented using NetBeans IDE. It is depicted using 4 nodes that are connected in the block chain and 1 server from which the instructions are passed

to the network. MySQL acts as a backend which is used to store the passwords for the particular transaction. The hacker can be identified in at node at a time. The implementation of modules are discussed below:

**4.1. Connection Establishment**

This is to ensure that whether all the nodes in the network are connected to the server. Initially connect the server and all the nodes in the network using its IP address. To ensure this all the active nodes are represented using green light as shown in Fig 4.1.



Fig 4.1: General structure of all nodes

**4.2. Fragmentation and Signing of Packets**

Once all the nodes are connected the sender determines the transaction and it is divided into fragments using file hashing algorithm. The sender selects the destination. Once the destination is selected the sender sets the password for overall transaction. Keys are generated for each fragment using AES algorithm. After the key is

generated all the nodes in the network signs the fragment with the key generated using Digital Signature algorithm implementing the concept of multi signature. As a result all the packets will remain in encrypted form. Once the transaction reaches the destination successfully tick mark appears as shown in Fig 4.2.

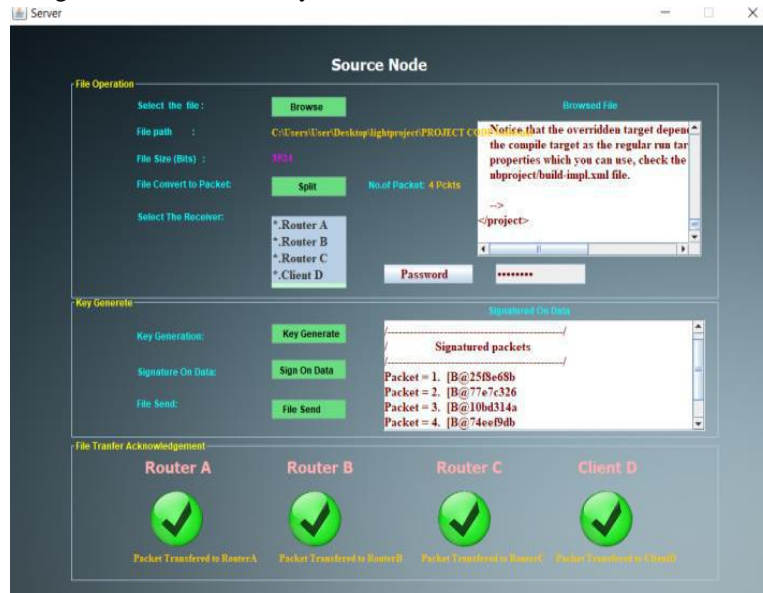


Fig 4.2 : Fragmentation and Signing of packets

**4.3. Privilege provided to the user**

In each node the receiver should enter the password to see the particular fragment flowing through it. When the receiver enters the right password the fragment will be displayed as shown in Fig 4.3 else the user will be given 2

attempts for the wrong password. If the user enters wrong password for the third time the user will be identified as hacker and will be notified to the sender by changing the colour of active node from green to red as shown in Fig 4.3.1.





Fig 4.3: Node represented when right password is entered



Fig 4.3.1: Representation of node when hacker is identified

**4.4 Receiving of packets:**

Once all the packets are received at the destination and the receiver enters the right password the entire transaction will be received at the destination node and the total number of packets received is also displayed as shown in Fig 4.4.

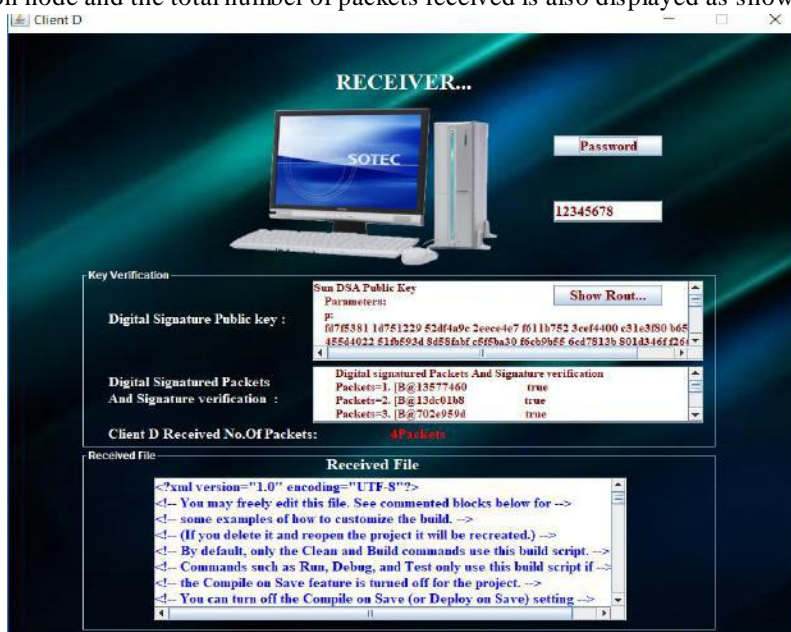


Fig 4.4 : Destination node structure

#### 4.5 Displaying the path

Once the file is received we need to start the server to view the path in which the packet is transferred.

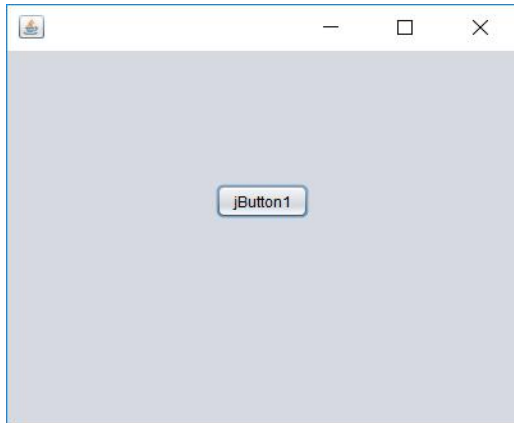


Fig 4.5: Graph button

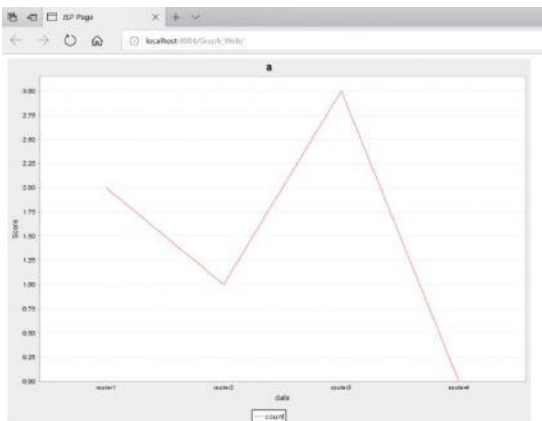


Fig 4.5.1: Path in which the packet is transferred

#### V. RESULTS AND DISCUSSION

It is found that in the existing system of block chain the transaction security is very less and the probability of hacking is extremely high. The key generated for the transaction are stored in the database and this paved the way for the hacker to completely steal the data. Most of these systems were not decentralized and hence central node failure causes the entire system to be collapsed. In our proposed system the chance of hacking is completely avoided since their entry is identified and reported to the sender so there is no way for the hacker to enter into the network. All the passwords for the particular transaction stored in the database expires after the completion of the transaction. Also it doesn't limit the amount the data to be transferred. It protects against the overflowing of data. Since the hacker entry is detected it is immediately notified to the sender thus this system provides high transaction security without using trusted third party.

#### VI. CONCLUSION AND FUTURE

##### ENHANCEMENT

In this paper, we have proposed a energy trading system that provides high transaction security without using trusted third party. The technique efficiently combines AES and DSA to sign the packets to exploit their complementary strengths. It consists of four main elements: password generation, fragmentation and signing, Password attempts and Reassembly. The overall password for the entire transaction is set by the sender. The experimental outcomes advised that an overall password and hacker notification gives high security because all the data is in encrypted form and will be decrypted only when the receiver enters the correct password and if number of attempts increases by 2 the user will be identified as hacker and notified to the sender. As a result of accuracy comparison proposed method have 98% accuracy, that is it have 6% more than existing method. Thus this system is proved to be the best method adopted for secured electronic transactions.

For future work, we plan to work towards various directions. In the future mode of project we have planned to combine Artificial Intelligence (AI) in which the number of packets that can be split will be estimated before. The arrival of any unauthorized user will be automatically detected by intelligence without the attempts provided when the user enters the wrong password.

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# Antimicrobial activity of Mamica de Porca (*Zanthoxylum rhoifolium* Lam) Extract against Gram-positive and Negative bacteria

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**Abstract**— Mamica de porca (*Zanthoxylum rhoifolium* Lam., Rutaceae) is a native medicinal plant of occurrence in the Brazilian Cerrado Biome, the most diverse and rich savannas worldwide. It's present in the states such as Tocantins, Roraima, Amapá, Pará, Amazonas, Acre, and Rondônia. The leaves are used to treatment of microbial infections and parasitic diseases, conferring alternative for health promotion and recovery. However, little is known about the action against Gram-positive and negative bacteria, expanding the knowledge about the potential of the antibacterial. To analyze the antimicrobial activity of leaf crude extract of *Z. Rhoifolium* L. front the standard strains Gram-positive *Staphylococcus aureus* and Gram-negative *Escherichia coli*. The ethanolic extract was obtained in the Natural Products Laboratory (UAP) of the University UnirG, Gurupi-TO, Brazil, allotted to Muller Hinton Agar plates, in triplicate, inoculated with bacterial strains Standard American Type Culture Collection (ATCC): Gram-Positive *S. aureus* ATCC<sup>®</sup> 29213 and Gram-Negative *E. coli* ATCC<sup>®</sup> 25922, with the technique of wells for depositing 50 µL saline (negative control) and extract, with Gentamicin<sup>®</sup> on disk 10µg for positive control. The plates were incubated in a greenhouse at 35 ± 1 ° C for 24 hours, microbiology laboratory, measuring the diameter of the growth inhibition halos. The crude leaf extract of *Z. Rhoifolium* showed biological activity against Gram-positive bacteria *S. aureus* and Gram-negative *E. coli*, with moderately sensitive response and growth inhibition halos ranging from 14 to 16mm and 10 to 10.3mm, respectively. The antimicrobial potential of the crude leaf

extract *Z. Rhoifolium* was checked against microorganisms of different cellular structures, expanding the possibilities of antimicrobial action, especially Gram-negative bacteria, being incipient studies in this perspective and not commonly identified for other medicinal species.

**Keywords**— Medicinal Plants, Antibacterial Agents, Natural Products.

## I. INTRODUCTION

The medicinal plants traditionally used confer an alternative for health promotion and recovery, recommended the safe and effective use according to the World Health Organization and National Policy of Medicinal Plants and Phytotherapy. Considering the chemical and biological diversity of Brazil, this review highlights the Brazilian natural products that were successfully used to develop new products and the value of secondary metabolites from Brazilian biodiversity with potential application for new products and technologies [1]. The therapeutic properties are attributed to the presence of bioactive constituents, many of which are employed in the development of drug production [2]. Although research in the field of complementary and alternative medicine has revealed the mechanisms of action and efficacy of this type of treatment, many extracts vegetables yet comply with research to be properly used for therapeutic purposes [3]. This is one of the ways to the rational use of this drug alternative antimicrobial therapy and combating bacterial multidrug resistance, a worldwide problem that persists in the area of hospital health.

The phytotherapy characterized by the use of medicinal plants in its different pharmaceutical forms was implanted, being widely used effectively in primary health care, with the purpose of preventive or curative of pathologies [4, 5]. In Brazil, as an integrative therapeutic option, it is extremely useful in primary health care programs, due to its efficacy, low operational cost and great potential for the development of this therapy, since it is the Country with the highest plant diversity in world, possess broad biodiversity and studies linking traditional knowledge technologies to scientifically validate this knowledge [6]. It is estimated that 75-80% of the entire population uses this practice, especially in developing countries where it also requires very often primary health care, greater cultural acceptability, and accessibility to treatment, in addition to the safety treatment, due to better compatibility with the human body and less adverse effects deleterious [7, 8]. It was verified in studies evaluating Methanol extracts of *Colocasia esculenta* (Araceae) an activity against several Gram-positive bacteria, highlighting the *S. aureus*, with MIC of 250 µg/mL; among Gram-negative bacteria, the emphasis was on the MIC of 500 µg/mL against *Pseudomonas aeruginosa* [8]. The Mamica de porca (*Zanthoxylum rhoifolium*) other is a percent plant species the order Sapindales, Family Rutaceae, being native of occurrence in the Cerrado Biome, Brazil, the most diverse and rich savannas worldwide. It's present in the north of the Country, in States such as Tocantins, Roraima, Amapá, Amazonas, Acre, Rondônia [9,10]. The extracts of this vegetal species have been used in the treatment of microbial infections and parasitic diseases. In Recent studies, the antileishmanial effect induced by ethanolic extract of stem bark from *Z. Rhoifolium* and its n-hexane fraction in the infection and infectivity of murine macrophages by promastigotes forms of *Leishmania amazonenses*, where the antileishmanial effect was significant in the reduction of macrophage infection, probably underlying the activation of defense mechanisms in these cells, evidencing the potential application of this species in the treatment of parasitic diseases such as leishmaniasis [11].

There are few studies with *Z. Rhoifolium* and there are unknown investigations that evaluate its biological activity both against Gram-negative and Gram-positive bacteria, which would indicate certain ease or not of the extract acting through microorganisms of different cellular structures. It is justifiable to broaden the scientific search for the biological action of plant species of the genus *Zanthoxylum* spp. due to its wide ethnobotany and biological importance, therefore, a promising source of substances with different biological activities [10]. In view of the above, the study aims to

analyze the antimicrobial activity of the crude leaf plant extract of Mamica de porca when subjected to contact with Gram-positive and Gram-negative microorganisms, respectively *Staphylococcus aureus* and *Escherichia coli*.

## II. MATERIALS AND METHODS

The collection of Leaves of *Z. Rhoifolium* was held in the Legal Reserve Area (ARL) of the Vale Verde Settlement, municipality of Gurupi-TO, Brazil, located between the coordinates S 11 52,582 W 048 ° 58,913, identified by comparison accessing *Zanthoxylum rhoifolium* Lam. in GBIF/Checklist dataset <https://doi.org/10.15468/39omei/HUTO-Herb`Optareo> from University of Tocantins – Version 1.45 [11]. The confirmation of the occurrence of the species and conference of the scientific name was also carried out on the site Flora do Brazil 2020 [12].

The foliar extract of *Z. Rhoifolium* it was obtained from the Natural Products Laboratory (UAP) of the University of UnirG, Gurupi-TO, Brazil, from the collection and drying of the leaves in a greenhouse at a temperature of 40 °C (± 0.5) for 03 days, followed by milling in Willey knife Mill (EDB-5), weighing 100 g of the FO powder and subsequent extraction in 500 ml of ethanolic solution (ethanol dynamic brand) at 95% for 07 days.

The ethanolic filtrate was concentrated in a rotational evaporator model 801 (Fisaton) under reduced pressure (temperature up to 50 °C) and then weighed. This concentrate was dried in a greenhouse for 24h at 50 °C and weighed again in order to obtain the ratio between the mass (g) of the concentrated extract (m) and after its drying (m), presenting for the *Z. Rhoifolium* the yield (M/m) of 8.5%.

The crude leaf extract was tested at the concentration of 50ml front the bacteria pattern strains Gram-positive *Staphylo-coccus aureus* ATCC® 29213 e Gram-negative *Escherichia coli* ATCC® 25922.

Four 140x15 mm plates containing Muller Hinton Agar (MH) were used at room temperature. For inoculation, we used the good technique of 12mm diameter and Agar perforation with a sterile and, distally 2.4 cm from each other following the recommendations Clinical and Laboratory Standards Institute – CLSI, 2006 [13]. Bacterial eyeglasses with Mac Farland scale 0.5 turbidities (1 a 2 x 10<sup>8</sup> UFC/mL) were evenly distributed on the plates on the agar surface using sterile Swab [13]. For positive control, we used standard chemotherapeutic, Gentamicin in Disk 10µg, being allocated to the wells in order to allow contact with the surrounding surface of the medium containing the bacteria. The plates were

incubated in a greenhouse at  $35 \pm 1^\circ\text{C}$  for 24 hours. The tests were performed in triplicate, thus, every 4 MH plates the same microorganism was tested 4 times before the extract, to the positive control group (Gentamicin  $10\mu\text{g}$ ) and the negative control group (saline). The antibacterial activity was verified from the growth inhibition halo, in millimeters, using the graduated halometer.

The evaluation of the antibiotic response was made from the comparison against the biological chemotherapeutic reference standard (positive control) and the zone or halo of growth inhibition, being measured starting from the circumference of the well following the margin where there is the growth of microorganisms [13,14]. The sensitivity of Gram-negative and Gram-positive bacteria against antimicrobials was verified from the dimension of the halo formed, according to the classification: sensitive, when the diameter of the inhibition zone was greater or not more than 3 mm less than the Positive control; moderately sensitive, with a halo greater than 2 mm, but less than the positive control of more than 3 mm; and resistant, where the diameter was equal to or less than 2 mm [15, 16].

### III. RESULTS AND DISCUSSION

In the evaluation of the present study, the extract leaf crude *Z. rhoifolium* presented antimicrobial effect for Gram-negative and positive, with the formation of the largest halos of inhibition of bacterial growth when compared with negative control, being effective to antibacterial action through the dilution technique in wells against Gram-positive bacteria *S. aureus* and Gram-negative *E. coli*, with moderately sensitive response and growth inhibition halos ranging from 14 to 16mm and 10 to 1mm, respectively. The answer was considered moderately sensitive, given that his halo was greater than negative control but less than positive control [17]. This result is relevant through the antimicrobial potential, also, in the face of Gram-negative bacteria, being more common scientific evidence of action only against Gram-positive bacteria. Was verified a higher antimicrobial potential against Gram-positive bacteria to the detriment of Gram-negative, from the dimension of the formed halo, although such results still do not overcome the action evidenced against the positive control (Tables 1 and 2).

Table.1: Antimicrobial activity of *Z. rhoifolium* front of gram-negative bacteria, assessed by the size (mm) of inhibition of bacterial growth. UnirG/Gurupi-TO, 2019.

<b><i>Escherichia coli</i> (Gram-negative )</b>					
<b>Surrounding Halo (mm)</b>					
Test number (n)	1	2	3	4	Average of the Halo (mm)
<i>Zanthoxylum rhoifolium</i>	12 mm	10 mm	10 mm	10 mm	10,5 mm
Positive control (Gentamicina $10\mu\text{g}$ )	24 mm	24 mm	24 mm	24 mm	24 mm
Negative control (Sterile saline )	Absent	Absent	Absent	Absent	Absent

Table.2: Antimicrobial activity of *Z. rhoifolium* front Gram-positive bacteria, assessed by the size (mm) of inhibition of bacterial growth., UnirG/Gurupi-TO, 2018.

<b><i>Staphylococcus aureus</i> (Gram positive)</b>					
<b>Surrounding Halo (mm)</b>					
Test number (n)	1	2	3	4	Average of the Halo (mm)
<i>Zanthoxylum rhoifolium</i>	16 mm	12 mm	12 mm	14 mm	13,5 mm
Positive control (Gentamicina $10\mu\text{g}$ )	24 mm	24 mm	24 mm	24 mm	24 mm
Negative control (Sterile saline)	Absent	Absent	Absent	Absent	Absent

The antimicrobial activity of plant extract front *E. coli* Gram-negative bacteria (Figure 01) and *S. aureus* Gram-positive (Figure 02) was flagged from the formation of the halo.

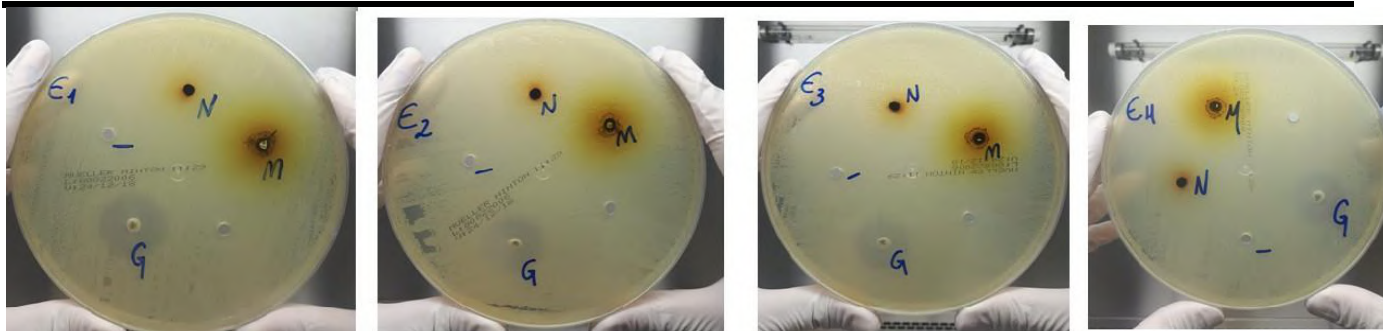


Fig.1: Formation of halo (mm) inhibition of bacterial growth of *E. coli* (E-Gram-negative) by the effect of leaf extract of *Z. rhoifolium*., UnirG/Gurupi-TO, Brazil. 2019. N = negative control; G-positive control; M-mamica of the porca/*Z. rhoifolium*.



Fig.2: Formation of halo (mm) inhibition of bacterial growth of *S. aureus* (S-Gram-positive) by the effect of leaf extract of *Z. rhoifolium*, UnirG/Gurupi-TO, Brazil. 2019. N = negative control; G-positive control; M-mamica of the porca/*Z. rhoifolium*

O antimicrobial potential of volatile oil from leaves of *Z. Rhoifolium* was confirmed in previous studies, being highly virulent against 6 species Gram-negative bacteria, being *Proteus mirabilis*, *Serratia marcescens*, *Klebsiella pneumonia*, *Escherichia coli*, more efficiently in front of *Shigella sonnei* e *Salmonella enteritidis* and negative inhibitory effect in front of *E. coli* [18]. More recent studies have shown the antimicrobial potential within the genus Gram-negative bacteria, the ethanolic extract, ethylacetate, acetone and methanol of *Z. bungeanum* presented activity in front of *Cepa E. coli*. [19]. In relation to the characteristic of the body, from the MIC tests, studies point out that extracts from *M. linifera* showed more effective action only against Gram-posit bacteria, and that this is must, probably. The differentiated cellular structure of Gram-negative bacteria once these have a cellphion wall air composed of peptidoglycan and an external membrane containing lipopoly Saccharides, which confers protection against environmental substances, plant extracts, and antiobióticos [20].

The efficiency of plant extracts has been better evaluated against the Gram-positive bacterias [6, 18, 21]. The extracts polar *Clusia burlemarxii* were evaluated and the only verified against Gram-Positive, among them *S. aureus*, where the ethanolic extract of the leaves inhibited the microbial growth with a CIM (Concentration of the Minimum inhibitory) 62,5 µg/ML,

although you have not observed Gram-Negative activity [22]. The extract ethanolic leaves of *Clusia nemorosa* G. Mey. (Clusiaceae) was shown to be effective against gram-positive multidrug-resistant bacteria *Staphylococcus aureus* and non-effective against gram-negative *Escherichia coli* [23].

It is understood as positive the findings of this study, since the existing medicinal use of this species as well as potential for bacteria, consistent with the national policy of medicinal plants and phytotherapy, regarding the results of research to foundation The safe and effective use of native species in the treatment and complementary practices of Brazilian Single Health System- SUS. Although They do not overcome the antimicrobial action of allopathic drugs, as in the present study, there are alternatives with resolution ability in the presence of bacteria, especially Gram-negative, and positive. Such evidence does not always occur, because it is microorganisms whose cellular structures are different, certainly conferring different barriers to the attack of antimicrobial agents.

The action of plant extracts against bacteria is also intrinsically related to the secondary components present. Keskin et al. (2001) [24] verified that propolis extracts showed antibacterial activity against Gram-positive bacteria (*Streptococcus aureus* and *Streptococcus*) and weak activity against Gram-negative bacteria (*Escherichia coli* and *Pseudomonas*

*aeruginosa*) and that this effect may be related to the chemical composition of propolis concentrates, with the phase-in flavonoid content [25]. Identified the most representative active principles, such as alkaloids, coumarins, terpenes, flavonoids are present in the secondary metabolites of the genus *Zanthoxylum*, although faced with the difficulty still in the greater understanding of extract specialization, antimicrobial analysis, and pathogens [26]. There is empirical use of the *mamica porca* with medicinal direction. Two of the specimens of this genus (*Rhoifolium*, *Ekmanii*) are used for the treatment of cancer and malaria, pain relief in the teeth and reduction of microbial processes by the inhabitants living on the banks of the Madeira River in the state of Rondônia [17, 27]. In French Guiana is used the bark of *Z. Rhoifolium*, with antimalarial remedies due to their curative and preventive cities, where boil in water to shell, alone or mixed with other ingredients [28]. The therapeutic indications of Brazilian folk medicine prioritize oral administration as teas and infusions against various diseases, where the medicinal properties of this species may be related to its alkaloid composition [17].

There are other factors influencing the biological activity, if not the potential of the plant extract, and also attributed to the inoculation technique used, even though the good technique is one of the most recommended for bioactivity studies with Leaf extracts. Depending on the substance, whether natural or artificially obtained, it is different diffusion capacities and dissociation in agar, with causes associated with: the presence of bacterial enzymes; composition of the medium; the substance in the middle; Inoculum density; incubation period; Temperature and finally stability of the substance in use [29]. O Agar diffusion method has a higher efficiency for water-soluble substances, enabling the diffusion of these through the culture medium. However, the molecular weight and the presence of particulate matter in the sample can also hinder the diffusion in the culture medium [30]. In this sense, it is plausible report that the extract of *Z. rhoifolium*. In the present bioassay showed to be poorly disseminated in the medium in the culture medium when using antibiogram technique in wells, and this fact may have its antimicrobial potential masked and forming inhibition halos smaller than the standard positive control. This suggests the verification of the physicochemical characteristics of the extracts in correspondence to the respective extractors, diluents and even methods used.

Research with medicinal plants and phytotherapy allows detecting vegetables with an active microbial and therefore a number of plants has been investigated for the You can medical, in view of the growing problem of

bacterial resistance front synthetic antimicrobials. However, still, there is a lot of discussion as to the validity and feasibility of the reported information about plant extracts activity, mainly due to the diversity of techniques used in research because of the lack of standardization [31].

#### IV. CONCLUSION

The antimicrobial potential of the crude leaf extract *Z. Rhoifolium* was checked against microorganisms of different cellular structures, which is unusual for other medicinal plant species. This extends the efficacy against Gram-negative bacteria, being incipient studies in this perspective. There was little diffusion the extract of *Z. rhoifolium* in this bioassay when using the antibiogram technique in wells, and this fact may have compromised the antimicrobial potential. Observed inhibition halos lower than the standard positive control. This suggests the verification of the physicochemical characteristics of the extracts of this species in correspondence to the respective extractors, diluents and even methods of inoculation used.

The existing medicinal use of this species as well as the potential for bacteria, consistent with the national policy of Medicinal plants and phytotherapy in Brazil, in relation to the results of research to increasingly underfloor the safe and effective use of the species Therapies and complementary practices of the Unified Health System. Although It does not overcome the antimicrobial action of allopathic agents, there are alternatives with resolution ability in the face of bacteria, especially the Gram-negative and positive. Such evidence does not always occur because they are microorganisms with different cellular structures and, for this reason, differ in response to the attack of antimicrobial agents.

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#### CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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# Facial Recognition with Mobile Application and Artificial Neural Network

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**Abstract**—This work presents the implementation of a facial recognition system with mobile application for the identification of people/faces. For this, haar-like object detection techniques, filters of luminosity, contrast and grayscale are used. In order to abstract the characteristics, the discrete cosine transform (DCT) and the Laplacian filter were used. In the classification stage it was used the Multi-Layer Perceptron Neural Network (MLP) and Self-Organizing Map (SOM). The interaction flow between the application steps and the classifier has been linked to a web services set. The results reached an accuracy of up to 97%, reaching the objectives proposed for the work.

**Keywords**—facial identification; neural networks; image processing; mobile app; features extractor; facial segments.

## I. INTRODUCTION

Falsification of identity is a crime against the public faith with the intention to gain an advantage over a third party to result in a gain or cause harm [1]. To avoid this crime, different computational techniques are proposed. One particular technique is biometrics, which aims to extract and define characteristics of an individual in a way that makes it unique, or in other words, more easily identifiable. In this context, one aspect of biometrics is facial recognition, which uses knowledge in the area of artificial intelligence, computer vision and image processing.

Facial recognition can be defined as a technique to identify patterns in physical characteristics such as mouth shape, face, distance of the eyes, etc [2]. The human being recognizes easily a family person, even with obstacles preventing their perfect vision. However, for a machine, this process is not trivial, requiring multiple procedures to detect and recognize specific patterns capable of labeling a face as a known or unknown, for example.

Unlike other biometrics models, facial recognition does not require the use of specialized equipment and can use simple hardware (mobile cameras, for example), allowing

the identification of more than one individual simultaneously in a single unit. Thus, in order to take advantage of such features, this paper presents the development of a personal recognition system using a mobile application for support.

Thus, a few steps were taken, such as personal image capturing by the device, characteristic segments extraction (face, mouth, eyes and nose), the segments normalization through filters, significant features extraction in segments found and the segments classification in relation to the training images found on the base.

## II. RELATED WORKS

Several facial identification models can be found in the literature. Each variant differs according to the approach type to detection, extraction, classification features, besides the application.

In [3], is proposes a face recognition method based on higher order statistics (HOS) applied to public security. This work aimed to identify individuals with criminal bond, previously registered in a database. HOS is used to create compact face signatures in addition to Fisher's Discriminant Ratio (FDR) and linear correlation to eliminate redundancies. The results showed a detection and classification rate above 70%.

In the work of [4], a multi-purpose algorithm was implemented for: face detection, face alignment, pose estimation, gender recognition, smile detection, age estimation and facial recognition, simultaneously, using a simple deep convolutional neural network. Because it is a multitasking problem, it was necessary to use a learning framework in order to facilitate synergy between different domains and application tasks. According to the authors, several experiments have shown that such networks presented better results for understanding faces and achieved satisfactory results for most tasks.

In [5] is shows a three factors authentication system of face recognition, gestures and location. Due to the users gestures and location being time series, the authors used a

recurrent LSTM (Long Short-Term Memory) type with unsupervised learning. The work has promising partial results, demonstrating the method viability.

Finally, [6] uses a Support Vector Machine (SVM) to classify human emotions. Facial expressions recognition to extract human emotions is a growing field in computer vision. In this work, the proposed system combines the cloud model with the traditional model. Facial Landmarks and Center of Gravity (COG) algorithms are used, which generate training and test data sets that contain expressions of anger, disgust, fear, happiness, neutrality, sadness and surprise. The proposed system was tested on CK+, JAFFE and KDEF databases, reaching a prediction rate of 96.3%.

### III. METHODOLOGY

For this work, it was proposed a system implementation composed of a mobile application integrated with a facial identification method. This structure can be divided into three parts: a mobile application, responsible for capturing the faces and presenting the results of the captured image identification; a communication channel between web services that organize the personals basis to be registered and establish communication between the application and the identification method; and an identification method, responsible for centralizing the personal base registered and transform into a learning base.

The segmentation process corresponds to the stages of normalization and detection of facial segments characteristic. The segmentation criteria used in this paper correspond to the morphology facial nature. The proposed segmentation methodology consists of samples normalization through luminance, contrast and color filters and the facial segments detection such as face, eyes, mouth and nose through classifiers based on Haar-like features [7]. The segmentation phase is very important in the identification process and should be as efficient as possible, for lack of accuracy undertake the subsequent processes of identification.

For comparative purposes, two identification system methodologies were modeled. Both methods process the extracted face region by the Haar cascade detector. The first method extracts the most significant pixels of the face by a DCT (Discrete Cosine Transform), in order to reduce its dimensions to feed a multilayer perceptron network, which classifies the individual. The second model extracts the segments characteristic shapes using a Laplacian filter, and identifies the individual using networks of self-organizing maps.

#### 2.1. Mobile Application

The mobile application acts as a terminal interaction between the user and identification systems. This

application allows the user to do three operations: capturing image from the device camera, checks that there is a face in the image, and query the identity of the individual by the verification system. No significant transaction or processing charge is made in this application, aimed at saving of mobile resources and to allow a more fluid running even on devices with more modest hardware.

#### 2.2. Web Services

In order to communicate with the mobile application, a set of web services has been implemented: a public, which provides operations and data that do not change the identification data set; and a private one, which implements the personal registration operations, as well as others that influence the system recognition capacity.

Images of person registered by the web service will be stored and indexed in the database. These are handled by the identification system with the normalization and segmentation processes for the facial features extraction. Later they are transformed into knowledge base for identification.

#### 2.3. Identification System

In this paper, a set of steps were implemented to process and generate knowledge for identification. These steps are presented in the Fig 1.

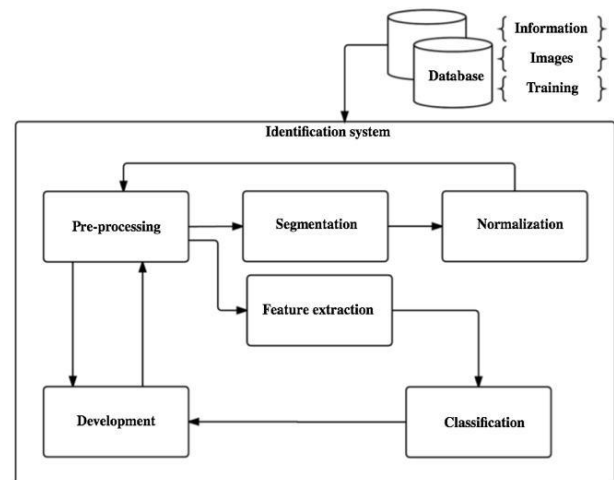


Fig. 1: Identification system and its respective operations.

The first step of the network input processing consists in image normalizing. This step aims to improve the morphological aspects in order to increase the chances of success of the following steps [8]. To realize the normalization was applied three filters: grayscale, luminance and contrast. Grayscale filter converts the images in RGB format to grey scale. The luminance filter adjusts the brightness intensity using linear filters. Finally, the contrast filter uses the histogram equalization technique resulting in constant levels of brightness in each pixel of the image. The result of the application of

the filters can be seen in the Fig2, where they are presented by the original image and adjustment in grayscale, luminance and contrast, respectively.



Fig. 2: Normalization filters. (a) Grayscale (b) Luminance (c) Contrast.

After normalization, the segmentation stage consist in the extraction of facial characteristics like eyes, mouth and nose [9] by classifiers based in Haar-like features [7]. In the proposed segmentation stage was used four public haar-like representation models for segmentation. Such models are presented in the Table 1.

Table. 1: Public haar-like models used.

Model	Size	Author
Mouth	25x15	Santana et al. [10]
Nose	25x15	Santana et al. [10]
Front Face	24x24	Lienhart et al. [9]
Pair of eyes	45x11	Santana et al. [10]

The Fig3 shows the operations performed in the segmentation process: quantization, detection and cleavage.

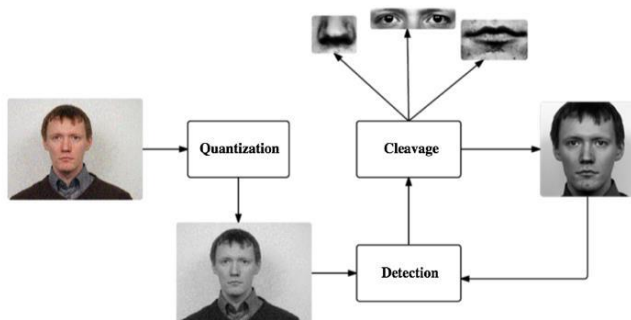


Fig. 3: Normalization filters. (a) Grayscale (b) Luminance (c) Contrast.

- **Quantization:** performs the image preparation process, that is, adjustment of the pixels intensity variation present in an image. The lower the pixels intensity present in an image, faster and accurate will be the detection operation. For the quantization, 8 bits was used per pixel intensity;
- **Detection:** in the first instance the detection uses a type of haar-like model for looking for a specific image area. This model corresponds to the delimitation of an object similar to a human face. After we found the segment by detecting, the same will suffer the process of cleavage;

- **Cleavage:** physically delimits a specific part, that is, performs the division of certain characteristics. To find the other characteristic segments, the face cleaved of the image suffer another detection process, using models haar-like corresponding to the pair of eyes, mouth and nose. At the end of the process, characteristic facial segments will be highlighted from the input image.

For the characteristic extraction step, two different methodologies were modeled, which are the image compression by transform DCT and the application of laplacians filters for edge detection. Two-dimensional DCTs were used to extract the image DC coefficients, along with the application of a ratio between the extracted coefficients and a highlight matrix (luminance or chrominance). Each DCT coefficient was mapped to a finite levels number determined by the compression factor. Compression factors are defined by the subdivided blocks number for DCT application ((4x4); (8x8); (16x16); (32x32); etc) and the quality factor defined by an enhancement matrix. At the end of the method the IDCT(Inverse Discrete Cosine Transform) was applied for image reconstruction. In this work was applied 8x8 blocks and the matrix used for the quality factor was the luminance, in which defines the color spectrum levels resulting in the image.

The second method used a Laplacian and morphological filters. The combination of these filters aims to highlight contours and edges, which correspond to the facial features extracted from the segmentation stage. The morphological filter highlights the edges obtained by the Laplacian filter. Through the image-opening operation, the noise will be removed and the edges found by the Laplacian filter will be highlighted.

Finally, in the classification stage, two models were used: one supervised and one unsupervised. The supervised model is represented by a MLP network with Resilient Back-Propagation (Rprop) learning algorithm. This methodology was based on the method applied by [11] on facial recognition based on neural networks combined with transform in the images domain. Thus, the input samples for learning the MLP network go through a characteristic extraction step based on the discrete cosine transform (DCT). This step serves to represent the more compact image, to reduce the amount of computational effort required for training and classification of MLP.

Already proposed unsupervised network is represented by a SOM based on the competitive learning method. This methodology was based on a concept published by [12] on the use of the SOM classifier to optically recognize certain types of characters. Thus, the input samples for the SOM network use the sum of Laplacian and

morphological filters to extract forms belonging to the facial segments.

At the end of the classification the set of characteristic segments (face, mouth, eyes, nose) was applied to training. The training process resulted in four respective knowledge bases to the sets extracted from the previous stages of the identification system. The knowledge generated was stored in a database, it will be later read to the identification phase carried out by the application.

**IV. RESULTS AND DISCUSSION**

In this work a facial identification system was implemented based on two classification methodologies: MLP with DCT and SOM with Laplacian filter. Both using the basis of facial images of Denmark and

Nijmegen universities. The Denmark is composed only of male individuals. Despite being a relatively small base, the samples have a nice quality. Already, the Nijmegen base has a lower quality than Denmark, but has a large variety of individuals in relation to gender, age and ethnicity.

**4.1. MLP classification methodology with DCT**

For this methodology a total of 42 tests were performed, varying the number of neurons in the hidden layers, the number of hidden layers, the size of the images, the error and the number of cycles. For one hidden layer the results are presented in the Fig. 4 and for two hidden layers in the Fig. 5, both for the Denmark database. For the Nijmegen database, for one hidden layer the results are shown in the Fig. 6 and for two hidden layers in the Fig. 7

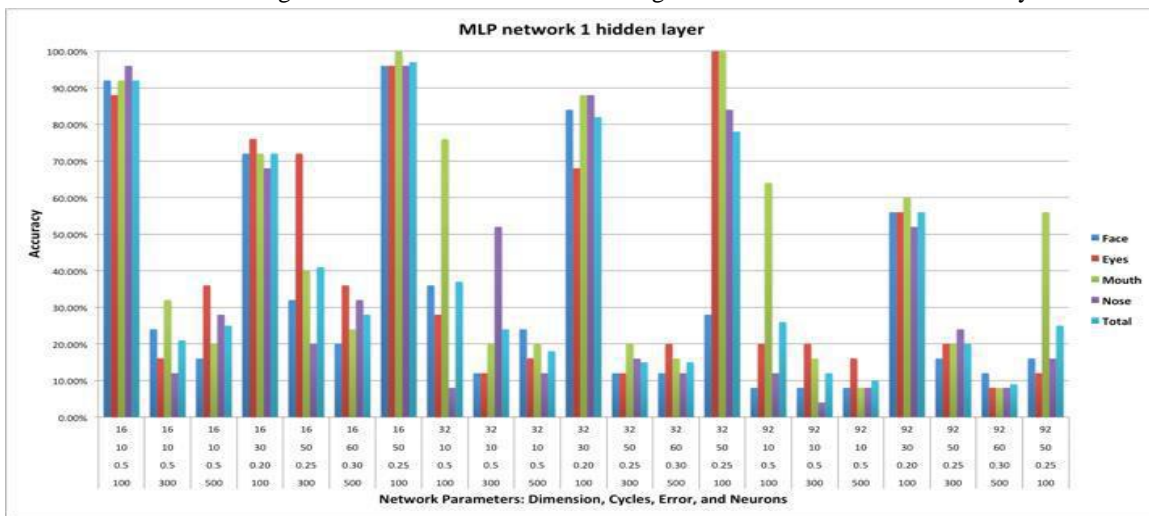


Fig. 4: Result of one hidden layer MLP network with the Denmark database.

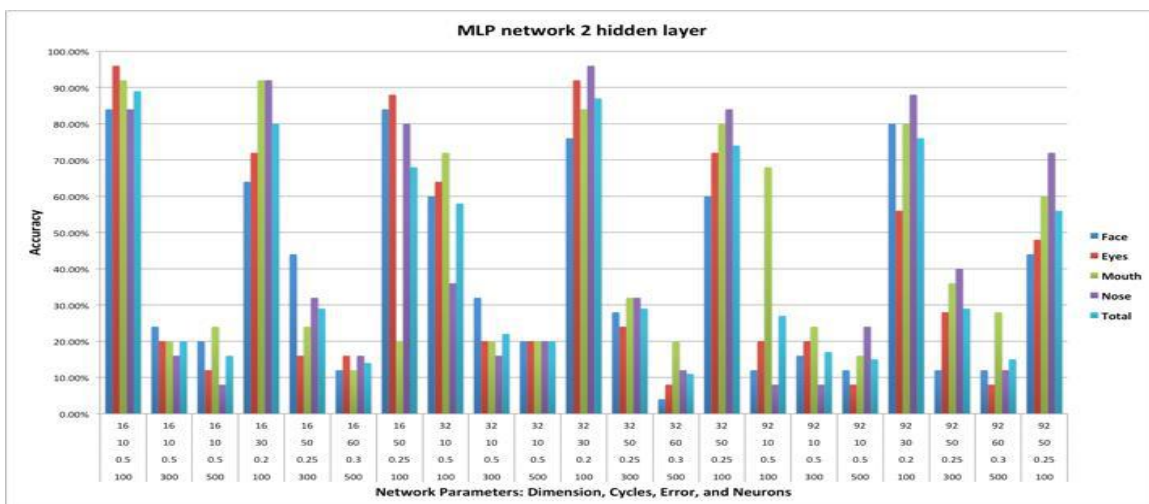


Fig. 5: Result of two hidden layer MLP network with the Denmark database.

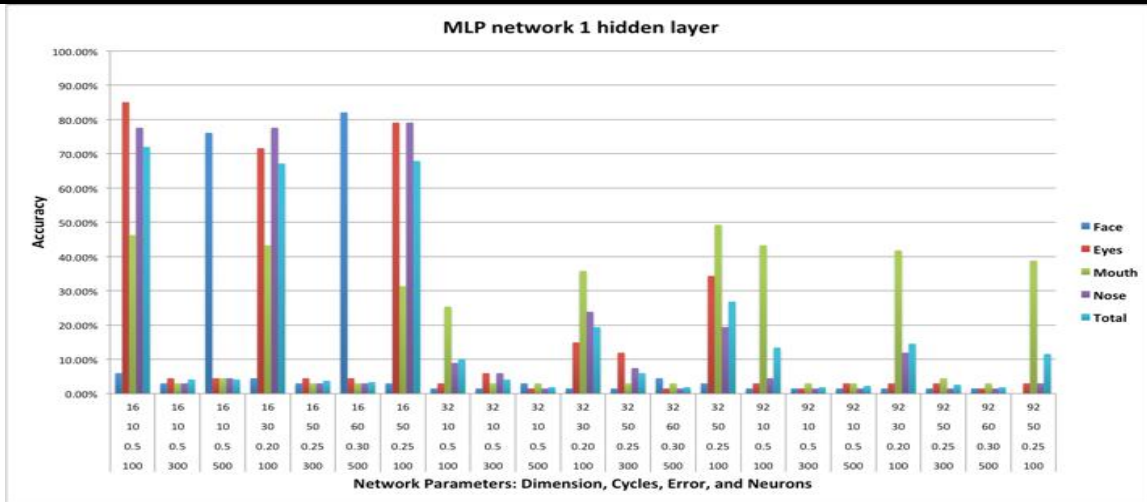


Fig. 6: Result of one hidden layer MLP network with the Nijmegen database.

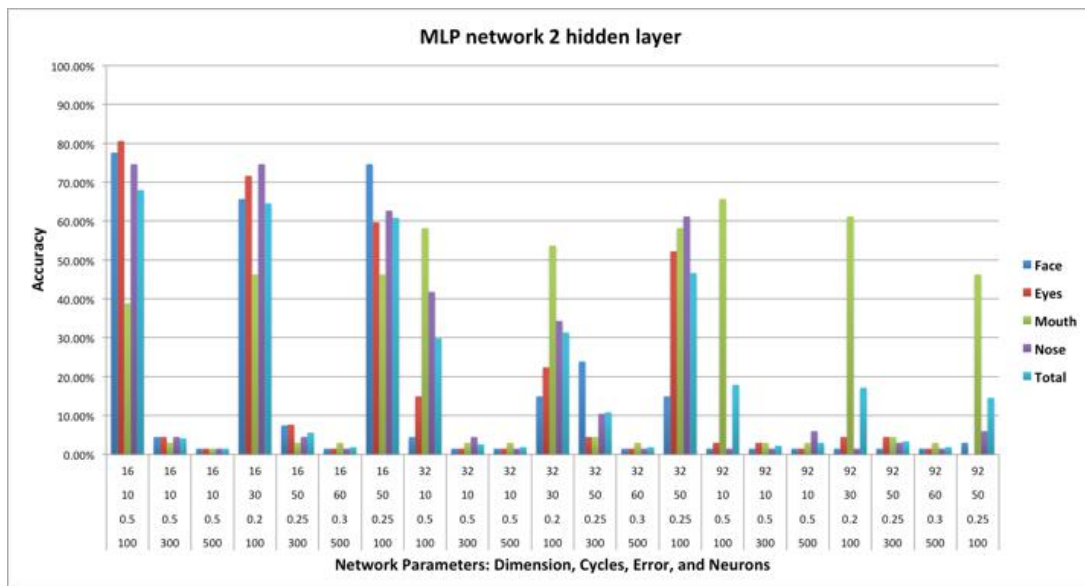


Fig. 7: Result of two hidden layer MLP network with the Nijmegen database.

It can be seen that the best results were observed in Denmark database, with the network composed of one hidden layer, with smaller amounts of neurons per layer and a minimum error rate ranging from 0.20 to 0.30. The best accuracy was obtained with the configuration: 100 neurons per layer, one hidden layer, an error of 0.25 and 50 cycles. For this configuration, the accuracy rates by characteristic segment were: 96% for the face, eye and nose, 100% for mouth and 97% of the total.

For the images obtained from the Nijmegen database, it is noted that the best results corresponded to the parameter of 100 neurons per layer and a minimum error rate that ranged from 0.5 to 0.25. As for the Denmark base, the best result had one hidden layer. The hit rate for this best result was 72,02%, where the eye characteristic segment contained 85,07% hit and the others had a margin of error of 33%.

Among the set of performed experiments some parameters achieved success. The image size 16x16 showed better results compared to other dimensions. One hundred (100) neurons per layer obtained the best accuracy in identifying the characteristic segments. The minimum error and cycle parameters obtained good adjustment intervals, ranging from 0.5 to 0.25 in the case of the minimum error and 10 to 50 in the case of the cycle.

**4.2. SOM classification methodology with Laplaciano filter**

For the SOM network methodology with Laplacian filter, three tests were performed varying according to the input images dimensions. Because it is an unsupervised network, it defines the number of neurons through the input vector (image dimension) and balances their weights randomly. In test 1 was used an input vector with 16x16 pixels, the test 2 an input vector with 32x32 pixels

and in test 3, a vector with 92x92 pixels. For the Denmark database, the results are presented in the Table 2 and for the Nijmegen database in the Table 3.

Table 2: Results of tests 1, 2 and 3 of the SOM network for the Denmark database.

Test Number	Face	Eyes	Mouth	Nose	Total
Test 1	40.00 %	52.00 %	28.00 %	36.00 %	39.00 %
Test 2	60.00 %	56.00 %	48.00 %	40.00 %	51.00 %
Test 3	56.00 %	56.00 %	48.00 %	60.00 %	55.00 %

Analyzing the data in Table 1 we can see that the thresholds belonging hit rates did not achieve good results for identification. This may indicate that the network training was not satisfactory, leading to stagnation. Regardless of the input vector (size of images) the characteristic segments obtained low success. The test 3 showed the best hit rate, 55%, where the nose segment contained 60% hit and the other segments had a margin error of 56%.

In the Table 3 for the Nijmegen database, it is also observed that the thresholds belonging to the hit rates did not reach expressive results for the identification, which leads us to deduce that the training was also not enough. The test 2 can be considered the most successful, where the hit rate has reached 51.92%, the mouth segment with 58.21% hit and the other segments with a margin error of 49%.

Table 3: Results of tests 1, 2 and 3 of the SOM network for the Nijmegen database.

Test Number	Face	Eyes	Mouth	Nose	Total
Test 1	31.34 %	25.37 %	38.81 %	34.33 %	32.46 %
Test 2	46.27 %	50.75 %	58.21 %	52.24 %	51.86 %
Test 3	49.25 %	53.73 %	56.72 %	46.27 %	51.49 %

**4.3. Quality Metrics**

In order to analyze the effectiveness of the classification models used in this work, metrics were used to calculate the recognition quality rates. The first metric used was the False Recognition Rate (FRR). The FRR described in the Equation 1, is an error measure that indicates the percentage of individuals present in the knowledge base, which are not recognized by the classifier. The lower the FRR rate, the higher the system hit rate.

$$FRR = (\text{Number of False Rejections} / \text{Total Number of Recognized Accesses}) \times 100\% \quad (1)$$

In addition to this, the False Acceptance Rate (FAR), Equation 2, was also calculated. The False Acceptance Rate (FAR) presents the individuals percentage not known by the learning base, which are presented as existing by the classifier. The lower the FAR the higher the system hit rate.

$$FAR = (\text{Number of False Acceptances} / \text{Total Number of Unknown Accesses}) \times 100\% \quad (2)$$

Finally, the Total Success Rate (TSR) was calculated, Equation 3, which presents an overall performance measure combining the FRR and FAR error measures to extract the classifier identification rate.

$$TSR = [1 - (FAR + FRR / \text{Total Accesses Number})] \times 100\% \quad (3)$$

The three proposed metrics were used in the best results obtained in the test phase. For the FAR calculation, individuals from the Denmark database were used to be identified in the training created by the Nijmegen database, and 25 individuals from the Nijmegen database to be identified by training created from the Denmark database.

The Table 4 shows the proposed metric rates for approach cited. It is possible to note that the MLP classifier appeared to have some superiority in relation to the SOM methodology due to the low rates of FRR and FAR. This performance difference can be explained due to its nature of learning, while the MLP is supervised by means of more than one adjustment parameter, the SOM, because it is unsupervised, the network itself tries to understand the input parameters and organize them for recognition.

Table 4: Quality metrics applied to proposed methodologies.

	FRR	FAR	TSR
MLP	26.86	9.25	73.05
MLP	4.00	2.00	88.00
SOM	47.76	32.90	39.80
SOM	44.00	29.00	46.00

**V. CONCLUSION**

This paper presented the development of a facial recognition system using mobile application. Thus, two classification methodologies were implemented, one of the MLP network with DCT and the other the SOM network with Laplacian filter. In addition, Denmark and Nijmegen facial image database were adopted.

Based on the results it is possible to conclude that in the classification stage the MLP network obtained better results when compared to the SOM network, reaching an accuracy of 97%. In addition, the SOM network presents FRR and FRA rates very closely demonstrating that the classifier will try to recognize an unknown



element. The characteristic segments corresponding to the nose and mouth, in both classification methodologies, obtained the best recognition rates.

It was concluded that the MLP network obtained the best results with the lowest input vectors (16x16) and with only one hidden layer. This can be explained as the more neurons in the hidden layer, the higher the convergence time and the probability of network stagnant. As for the SOM network, the topographic map of the same did not balance the distribution of the classes belonging to the input samples between the neurons.

The results were satisfactory, especially if we consider the difficulty of finding bases with facial images of high resolution. Most of these bases are found compacted, which makes the limited study. A greater number of samples could expand the results by obtaining a greater variety of interesting patterns, achieving a greater class of features.

#### ACKNOWLEDGEMENTS

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# Treatment of Effluent of the Cellulose and Paper Industry Using Aerobic Granular Sludge Thermophilic

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**Abstract**— Large amounts of effluents are generated in pulp and paper mills. In general, these effluents present temperatures above 40 °C, which may preclude biological treatment in mesophilic conditions (35 °C). For this, the present work aimed to produce aerobic granules in mesophilic conditions and, after their stability, leads them to thermophilic conditions. After the thermophilic granules were obtained, analyzes of their maintenance, treatment efficiency and verification of the production of the extracellular polymeric substances (carbohydrates, proteins and humic acids), present in the granules under these conditions were carried out. It was observed that the granules, generated from the biological sludge and the effluent of a pulp and paper industry, can act up to a temperature of 45 °C, presenting a removal rate of around 70%, without great loss of efficiency of the proposed treatment compared to that of mesophilic flocculent sludge.

**Keywords** — Aerobic granules, Paper, Sludge, Thermophilic, Treatment .

## I. INTRODUCTION

The pulp and paper industries use a large amount of water in their processes, around 60 m<sup>3</sup> of water per ton of pulp, and although they present modern and efficient operating techniques for the production of one ton of paper, In the generation of large volumes of effluent. The effluent from pulp and paper mills is the sixth largest polluter because it contains a variety of liquid and solid waste that is discharged into the environment[1].

The development of aerobic granule technology has been studied as a method to improve conventional activated sludge processes, mainly because of its greater efficiency in the removal of organic matter[2].

The low space requirement, simplicity and operational flexibility of granular aerobic sludge systems make it

possible to apply this technology in the treatment of sewage in communities and industries that have little availability of physical space [3].

Aerobic granules have been developed with mixed cultures (such as activated sludge) or defined cultures. Aerobic granulation has been observed in reactors fed with various organic substrates (phenol, ethanol, glucose, acetate, etc.) and industrial wastewater. The microbial structure of the granules is dependent on the inoculums, chemical composition, dissolved oxygen concentration (OD) and the size of the granules. A conceptual granule is composed of three microbial communities, aerobic bacteria that grow on the outside, bacteria that oxidize ammonia in the medium and facultative / anaerobic in the center of the granules [4; 5 and 6].

The microbial community of aerobic granular mud can range from species limited to extremely diverse species and are strongly affected by substrate composition or wastewater, inoculums, and environmental and operational factors [3].

The size of the aerobic granular sludge may influence the distribution of the microbial community structure in the granules. The OD concentration also influences the microbial structure of the granular sludge. OD deficiency favors the growth of different filamentous bacteria during granulation. Different temperatures result in different dominant microorganisms. The microbial community structure at 25 ° C exhibits less similarity to those at other temperatures [7].

The process of formation of the aerobic granules is determined by the presence and action of the extracellular polymeric substances (EPS), which act as an important factor in the characteristics of microbial aggregates in effluent treatment processes [8].

The formation of aerobic granules in effluent treatment processes has been the subject of studies, although there

are controversies in the literature on the ideal conditions for their formation. Another aspect not yet well clarified has been the characterization of the microorganisms that aid in the aggregation of the granules.

Few studies exist on the capacity of formation of aerobic granules under thermophilic conditions (temperature between 40 and 60 °C). The search for microorganisms able to aggregate in the form of granules under these temperature conditions can constitute an important advance for the treatment of industrial effluents. The pulp and paper industries generally discharge an effluent stream that is relatively warm (50 °C) when compared to effluents from other industries. Some researchers have attempted to treat pulp and paper effluents at the thermophilic temperature (in which they are discharged) in an attempt to reduce energy costs for treatment. [3; 6 and 9].

Based on this, the objectives of this work were: To produce thermophilic aerobic granules, used in the effluent treatment of the Pulp and Paper Industry; determine the microbial diversity in aerobic granules and quantify the major chemical components of the EPS produced in the process.

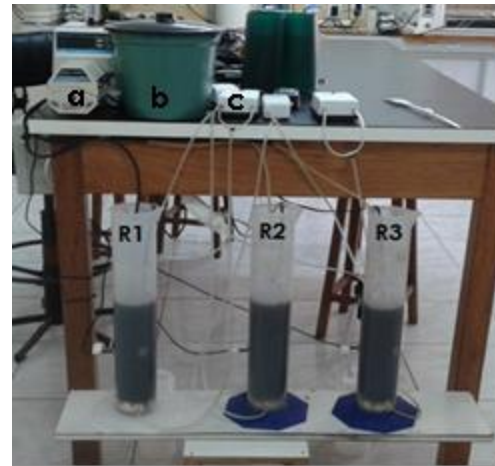
## II. MATERIAL AND METHODS

### 2.1. Production of thermophilic aerobic granules

Three reactors (R1, R2 and R3) with a useful volume of 2 liters were used, each reactor was initially fed with 800 mL of effluent and same volume of biological sludge from the Effluent Treatment Station (ETE) of the Pulp and Paper industry. Papel Celulose Nipo-Brasileira S / A (CENIBRA®). One of the reactors (R1) was maintained under typical process conditions with activated sludge to form flocculent sludge, and the other two reactors (R2 and R3) were operated with parameters that favored the formation of aerobic granular sludge [10].

Initially all reactors were maintained at 35 °C under aeration in order to maintain the dissolved oxygen content (OD) above 2.00 mg.L<sup>-1</sup>, with reaction cycles of 12 hours, where each cycle 300 ML of treated effluent was withdrawn and 300 mL of new effluent were added. Before addition, the effluent was supplemented with nitrogen and phosphorus to maintain the COD: N: P ratio of 250: 5: 1. After the addition, the aerators were reconnected, starting a new cycle. The pH of the reaction mixture was corrected to maintain in the range of 6.5-7.5. All reactors were operated with a settling time (ST) of 1 hour at the end of each cycle of 12 hours, initially. In the reactor operated for the formation of flocculent sludge (R1), this time was maintained until the end of the experiment. For the reactors operated for the formation of aerobic granular sludge (R2 and R3) the time was decreased, every three days, to 30, 20, 10, 5, 3, 2 and 1

minute (s), the latter being the time indicated for the formation and maintenance of aerobic granular sludge [10]. After the formation of the granules the time of 1 minute for decantation was maintained until the end of the experiment.



*Fig.1: Structure for the operation of the three reactors used to treat paper and pulp industry effluent via flocculent sludge (R1) and mesophilic /thermophilic granular aerobic sludge (R2 and R3). A) Peristaltic pump, for feeding the reactors to each cycle; B) Storage of the effluent to be added before the start of each cycle and c) Aerators, for maintenance of the DO.*

With the aerobic granules formed, the temperature of 35 °C was maintained in the reactors R2 and R3 for one week. After that, the temperature was increased at a rate of 1 °C per day until the next study temperature (40 °C), this temperature was maintained for one week and the increase was increased at the same rate until the Temperature reached 45 °C. The procedure was repeated for temperatures of 50 and 55 °C.

In order to verify the efficiency of the proposed treatment, samples of the treated effluent were collected daily from all three reactors, and chemical oxygen demand (COD) analyzes were carried out.

The analyzes were performed in triplicates, per cycle of each reactor, following the colorimetric method, after closed reflux (APHA method 5220D).

In order to verify the efficiency of the proposed treatment, COD analyzes were performed on the system as well as at the end of each cycle. The difference between the input COD and the treated effluent was defined in percentage values and indicated as a percentage of COD removal.

The processes of formation and maintenance of the granules, as well as the stages of temperature change in order to obtain thermophilic granular sludge, and the COD analyzes, were carried out in the Laboratory of Environmental Analysis of the Pulp and Paper Laboratory of the Federal University of Viçosa (UFV).

## 2.2. Aerobic granular sludge mesophilic

Fifteen samples were collected in each reactor, each sample was related to the target reactor temperatures for the production and analysis of thermophilic aerobic granules. Table 1 shows the relationship between collection points and associated temperatures. Taking into account the behavior of the organic matter removal efficiency (COD) at the temperatures studied in the reactors R2 and R3, those of interest were defined, since in the case of reactors R2 and R3, the target temperatures represent: Point 1 -Formation of the granules and start of treatment with aerobic granular sludge; Point 3-Apex of the treatment, indicated by the rate of removal of organic matter; And Point 5-Temperature in which there is a marked decay of the removal rate. From this definition, 09 samples were selected and submitted to analysis of the structure of the formed granules and analysis of the production and quantification of extracellular polymer substances at each target temperature during the proposed treatment.

*Table 1. Relationship between collect points and sample temperatures of each reactor during pulp and paper industry wastewater treatment by flocculent sludge (R1) and mesophilic and thermophilic granular aerobic sludge (R2 and R3).*

Collect point	Reactor 1 (flocculent)	Reactor 2 (granular)	Reactor 3 (granular)
1	35 °C	35 °C	35 °C
2	35 °C	40 °C	40 °C
3	35 °C	45 °C	45 °C
4	35 °C	50 °C	50 °C
5	35 °C	55 °C	55 °C

## 2.3. STRUCTURAL ANALYSIS OF AEROBIC GRANULAR SLUDGE

The nine samples (Table 1, 3 samples from point 1, 3 of point 3 and 3 of point 5) were submitted to the structural analysis step of the obtained granules, via scanning electron microscopy and confocal microscopy, performed at the Center of Electron Microscopy Of the State University of Santa Cruz (CME-UESC). For this purpose, the samples were fixed with respective fixative buffer for scanning and confocal electron microscopy, and then stored.

### 2.3.1. Scanning Electron Microscopy (SEM)

The granules were fixed in cacodylate-glutaraldehyde buffer (2.5%), followed by washing twice with 0.1M cacodylate buffer. The samples were dehydrated by a series of water-acetone (50-100%), then they were submitted to the critical point, for the removal of all the

water, being mounted in stubs using carbon double face tapes. The assembled samples were metallized by depositing a thin layer of gold through an evaporation system known as "sputtering" using the Sputter Coater SCD 050 (Bal Tec) apparatus. At the end, the samples were examined with Scanning Electron Microscope (SEM), model Quanta 250 (FEI Company), operated with an acceleration voltage of 20 KV.

### 2.3.2. Confocal Microscopy

The samples were stained in microtubes (1.5 mL) covered with aluminum foil and placed in a shaker rack (100 rpm, 15 min). The dyes used were fluorescein isothiocyanate (FITC) (0.01%), which is reactive to amines and binds all the proteins and amino sugars of cells and EPS. Concanavalin A (ConA) lectin conjugated with Texas red (100 µg.mL<sup>-1</sup>) binds α-mannopyranosyl and α-glucopyranosyl sugar residues. Syte 63 is a nucleic acid permeant dye of cells. After each staining step, the samples were washed with phosphate buffered saline. The samples were visualized in channels with corresponding excitation and emission wavelengths for each dye using the Confocal LSM 700 Microscope.

## 2.4. EXTRACTION AND ANALYSIS OF GRANULAR AEROBIC SLUDGES EPS

For the EPS extraction step, 1 mL of each sample was transferred to microtubes (2.0 mL), centrifuged (11200 g, 4 ° C, 15 min) and the supernatant was stored in a new microtube for further quantification of free EPS . The pellets were resuspended in 20 ml of phosphate buffer, the pH was adjusted to 11 by the addition of 1M NaOH, followed by heating in a water bath (80 ° C, 30 minutes). After this extraction step, the samples were centrifuged (11200 g, 4 ° C, 10 min) and the supernatant stored for further analysis of the bound EPS [5].

The chemical characterization of the extracellular polymeric substances produced was carried out through the analysis of carbohydrate contents [1] proteins and humic acids [12]. The analyzes were performed in triplicates.

## III. RESULTS AND DISCUSSION

### Efficiency of the proposed treatment

The mean values of COD removal were obtained in the R1 reactor (35 °C) at six collection points (Figure 2), each collect point at R1 was related to the collection point at each study temperature in the R2 and R3 reactors, 35, 40, 45, 50 and 55 ° C.

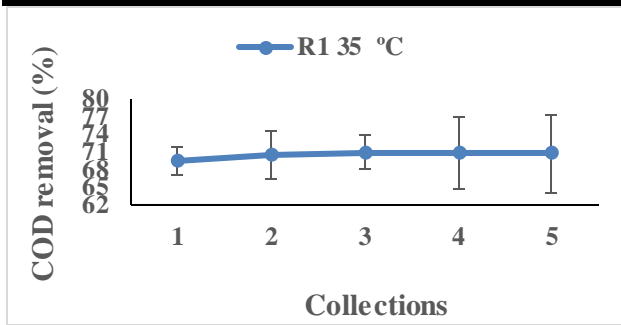


Fig.2: Averages (+ standard deviation) of the COD removal rate at the collection points of study in the reactor R1, with the temperature maintained at 35°C, during treatment of effluent from the pulp and paper industry using mesophilic flocculent sludge.

70%. It is noteworthy that, in the works mentioned above, the reactors were operated under mesophilic conditions.

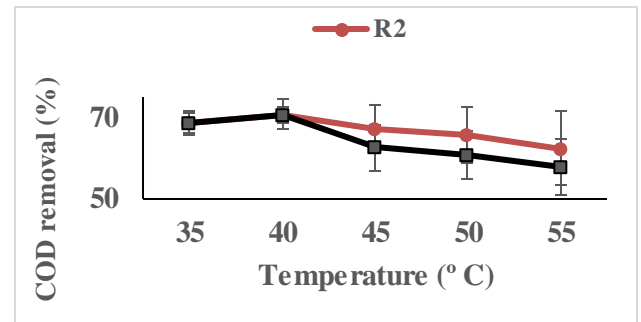


Fig.3: Averages (+ standard deviation) of the COD removal rate at the study collection points in the R2 and R3 reactors, with temperature change, during treatment of cellulose and paper industry effluent using mesophilic and thermophilic granular aerobic sludge.

Fig. 3 shows the results obtained from the analysis of the organic matter removal rate of the collected samples, at the study temperatures, in the reactors R2 and R3.

Based on the Figs. 2 and 3 it was found that there is a difference in efficiency between treatment with granular aerobic sludge and flocculent sludge. Although in the temperatures between 35 and 45 °C the reactors with granular aerobic sludge (R2 and R3) presented a removal rate close to or equal to that found in the treatment with flocculent sludge (R1).

In a study developed by Jungles *et al.*[3] a removal rate of about 75% was obtained using the granular aerobic sludge process in domestic sewage treatment in a sequential batch reactor. A removal rate between 70-75% was verified in an experiment performed by Liu *et al.* [6], during treatment with the same type of domestic effluent. Using the granular aerobic sludge technique in the treatment of effluent from the palm oil industry, Abdbullah *et al.* [11] obtained a COD removal rate below

Thus, in the case of effluent from the pulp and paper industry, which has a higher recalcitrant potential than the effluents studied above, the removal rate (45 °C) of COD between 65-70%, obtained during the execution of this experiment, can be considered as a parameter to prove the efficiency of the treatment with aerobic granular thermophilic sludge.

Above the temperature of 50 °C, the efficiency dropped by 10 percentage points and the final temperature of study (60 °C) decreased by 20 points, characterizing a very low rate for the execution of the process. Thus, the maximum temperature for treatment in thermophilic conditions, without losing much of the efficiency of the treatment, was 45 °C.

STRUCTURAL ANALYSIS - SEM

Samples submitted to analysis by scanning electron microscopy produced the following images (Figures 4 to 6).

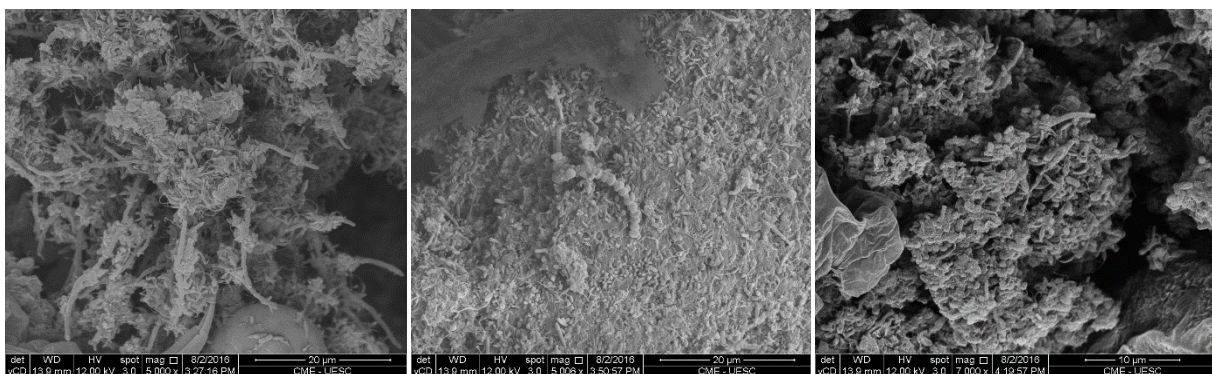


Fig.4: Microscopic structure of the flocculent sludge samples obtained from the reactor R1 operated at 35 °C using scanning electron microscopy.

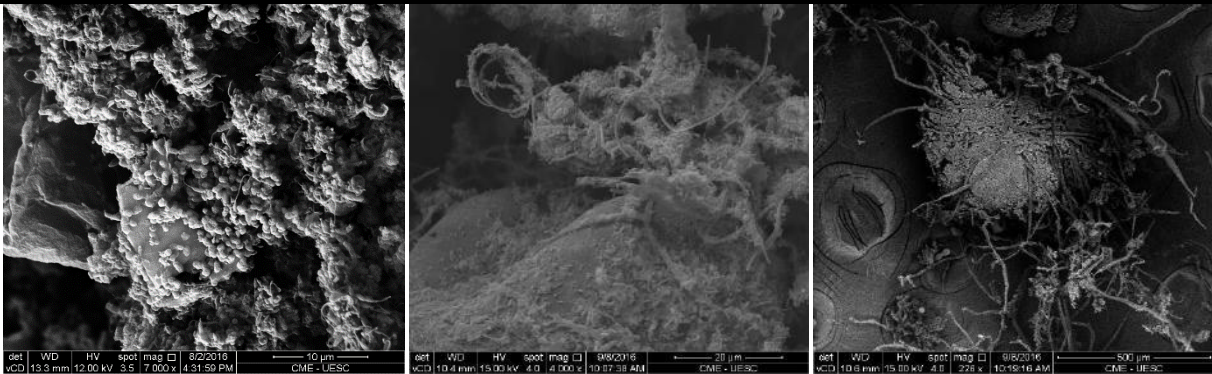


Fig.5: Microscopic structure, using scanning electron microscopy, of aerobic granular sludge samples obtained in reactor R2 operated at different temperatures for thermophilic conditions. a) at 35 °, b) at 45 ° C; And c) at 55 ° C.

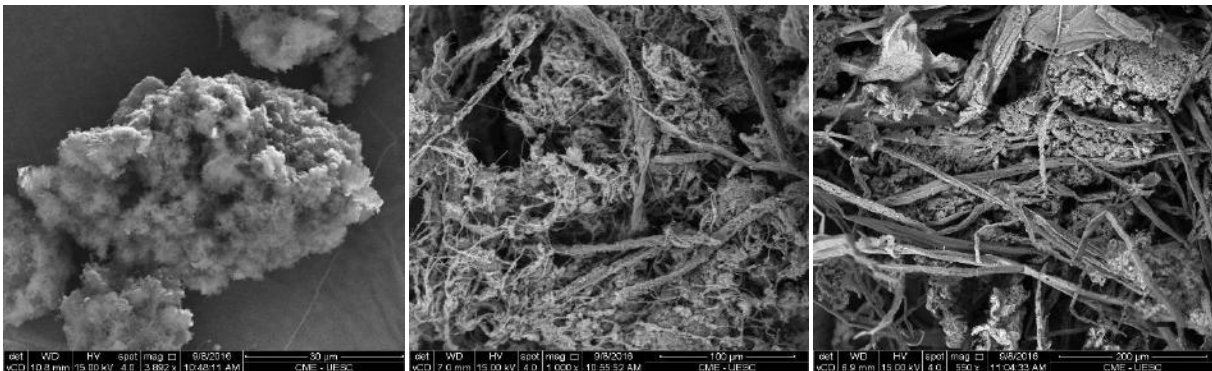


Fig.6: Microscopic structure, using scanning electron microscopy, of aerobic granular sludge samples obtained in reactor R3 operated at different temperatures for thermophilic conditions. A) at 35 °, b) at 45 ° C; And c) at 55 ° C.

In the reactor operated under conditions of flocculent sludge production (R1), maintained at 35 ° C during the experiment (Figure 4), it was observed that there was no change in the structure of the flakes produced and that they had the same configuration of aggregation during development of the experiment.

In the reactors operated under conditions for the production of thermophilic aerobic granules (R2 and R3), it was observed that in both, aerobic granules were produced at 35°C (Figures 5a and 6a). However, when raising the temperature, for operation in thermophilic conditions, it was observed that filamentous bacteria were produced, even on a small scale (Figure 5b and 6b). However, a high production of filamentous bacteria was observed (Figures 5c and 6c).

The behavior shown in the reactors that operated under conditions for the production of thermophilic aerobic granules (R2 and R3) indicate that the appearance and high reproduction of the filamentous bacteria may have contributed to the decay of the treatment efficiency through aerobic granular thermophilic sludge. One of the factors that may have led to such production is due to the change in temperature, as in the present study. With this,

there was also a change in the microbial population present in the formation of the granules.

The appearance of filamentous bacteria is not a problem in itself, as they aid in the initial stage of aggregation for the formation of thermophilic aerobic granules. However, their proliferation is extremely detrimental during treatment, since, in a high population density, these bacteria hinder the sedimentation process of the biomass or granules present in the reactors [13].

#### STRUCTURAL ANALYSIS - Confocal Microscopy

Taking into account that the FITC dye binds to proteins and other amino-compounds, in addition to being able to bind to groups of proteins and glycoconjugates associated with cell walls, Syto 63 was used as a counter-agent to distinguish cells of extracellular polymer substances [5 and 14].

During the observations in the confocal microscope LSM 700 it was verified that the images stained with the ConA dye presented the same behavior as the FITC, that is, the polysaccharides stained with ConA are also stained with the FITC, since it also has glycoconjugates besides Proteins [5 and 14].

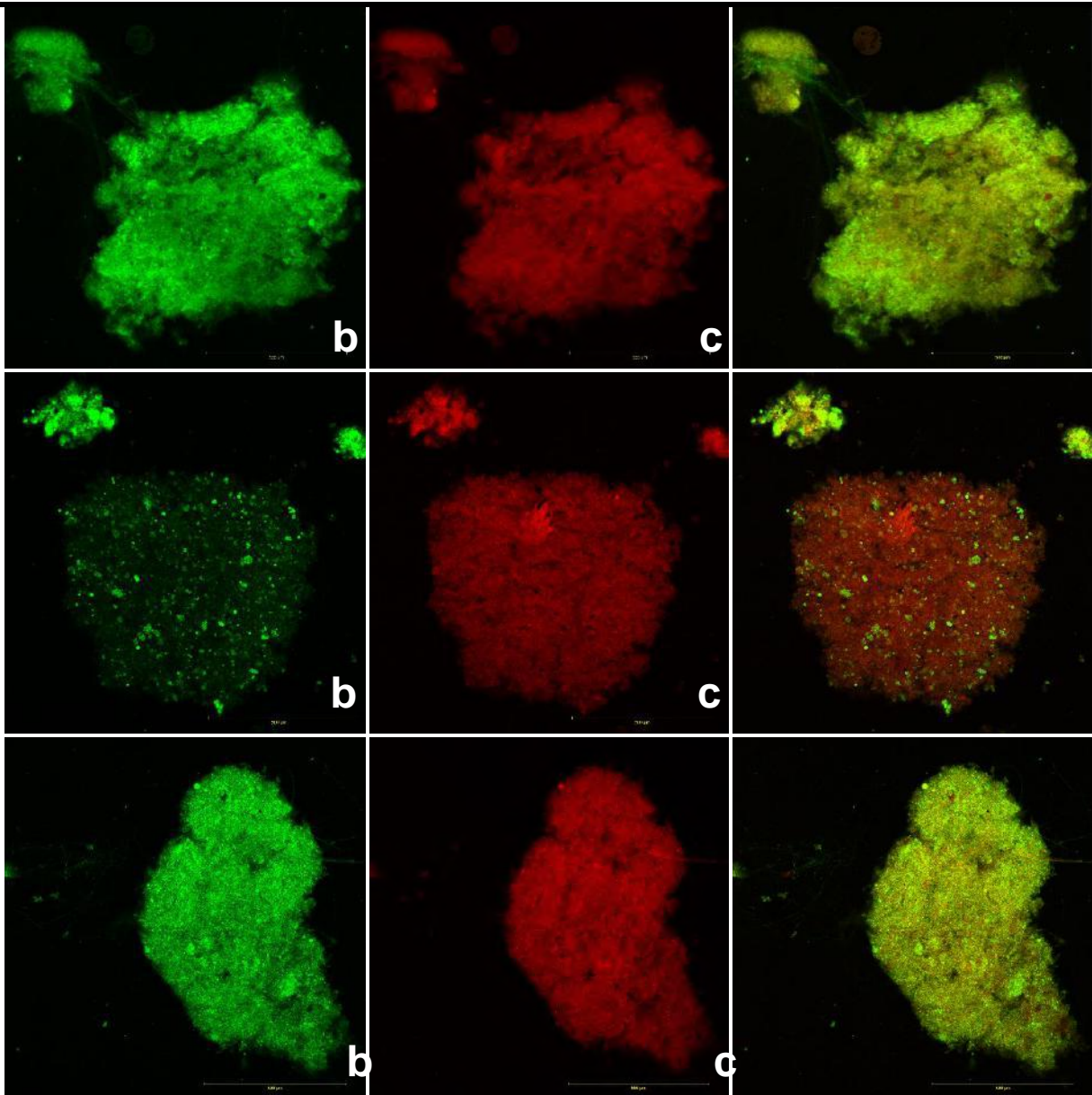
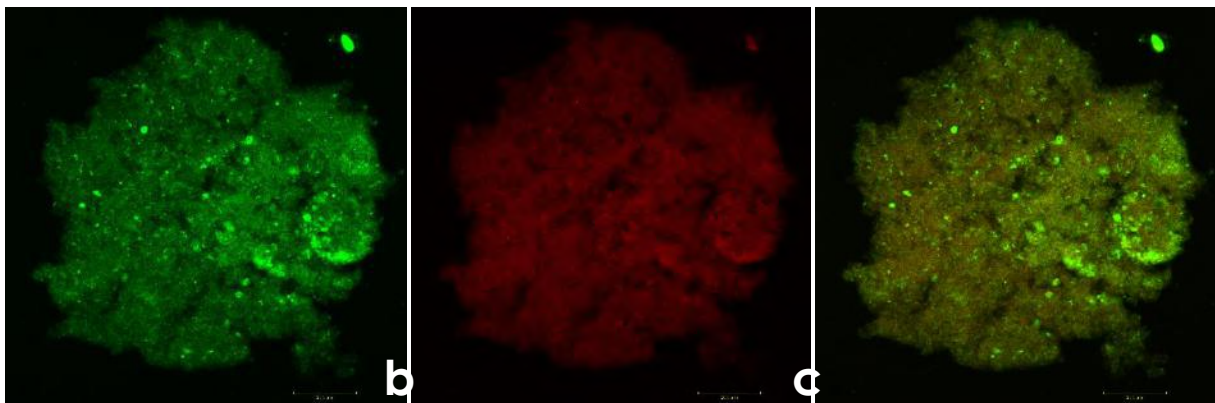


Fig.7: Confocal microscopy (500  $\mu\text{m}$ ) of aerobic granular sludge sample from reactor R2, operated at: 1) 35 ° C; 2) 45 ° C and 3) 55 ° C. (A) FITC dye-green colored beads, (b) red-colored Syto 63 dye; And c) Overlapping of FITC and Syto 63 dyes.



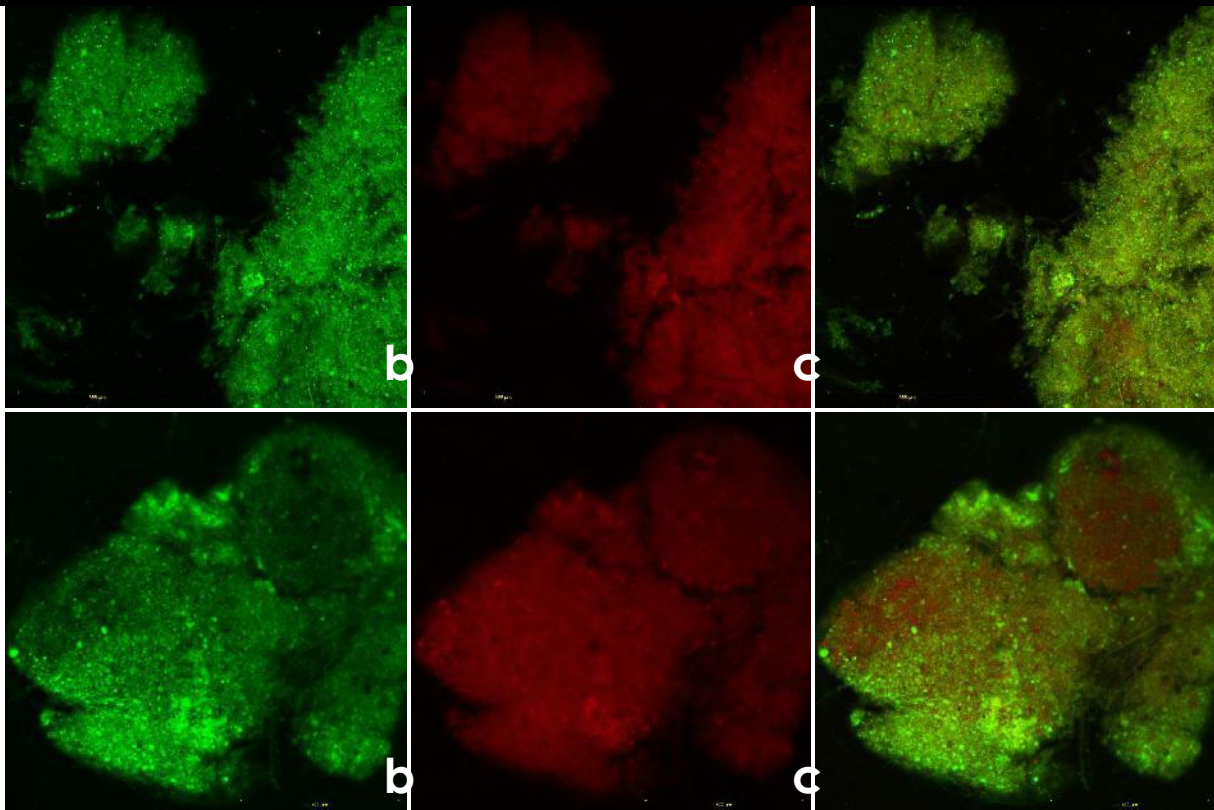


Fig.8: Confocal microscopy (500  $\mu\text{m}$ ) of aerobic sludge sample from reactor R2, operated at: 1) 35 °C; 2) 45 °C and 3) 55 °C. (A) FITC dye-green colored beads, (b) red-colored Syto 63 dye; And c) Overlapping of FITC and Syto 63 dyes.

On the basis of Figures 7 and 8, we can verify that both reactors (R2 and R3) behaved in a similar way, especially when the images obtained from samples of the same study temperature are analyzed.

There was also a decrease in the production / availability of proteins and glycoconjugates on the surface of the granules when comparing Figures 7.1 and 8.1 with 7.3 and 8.3, when the granules were at 35 °C and 55 °C, respectively.

In summary, we can define that the FITC dye stains the extracellular polymeric substances while Syto 63 blends only the cells, being permeable to the nucleic acids.

**EXTRACELLULAR POLYMERIC SUBSTANCES**

The nine samples, referring to the temperatures and points of study, were submitted to the analysis of carbohydrates, proteins and humic acids. The result is shown in Table 2.

Table.2: Quantification of the extracellular polymer substances in the sample samples of each reactor during the pulp and paper industry effluent treatment by flocculent sludge (R1) and thermophilic mesophilic aerobic granular sludge (R2 and R3).

Collect point/ Temperature	Carbohydrates ( $\text{mg.L}^{-1}.\text{g}^{-1}$ )	Proteins ( $\text{mg.L}^{-1}.\text{g}^{-1}$ )	Humic acids ( $\text{mg.L}^{-1}.\text{g}^{-1}$ )
R1 35 °C (1)	4,75 ± 0,46	0,38 ± 0,04	0,32 ± 0,04
R1 35 °C (2)	3,03 ± 0,01	0,37 ± 0,04	0,32 ± 0,04
R1 35 °C (3)	2,31 ± 0,43	0,39 ± 0,03	0,34 ± 0,03
R2 35 °C	3,11 ± 0,25	0,26 ± 0,03	0,31 ± 0,03
R2 45 °C	5,65 ± 0,22	1,02 ± 0,51	0,32 ± 0,51
R2 55 °C	5,10 ± 0,07	0,57 ± 0,19	0,30 ± 0,19
R3 35 °C	2,65 ± 0,75	0,34 ± 0,02	0,31 ± 0,02
R3 45 °C	4,59 ± 0,31	0,64 ± 0,22	0,33 ± 0,22
R3 55 °C	2,39 ± 0,27	0,37 ± 0,05	0,30 ± 0,05



The polymeric substances analyzed are of paramount importance for the formation and maintenance of granular aerobic granules [15].

The polymeric polysaccharides in EPS mainly serve as adhesives favoring the union of the bacteria forming a micro-colony. These polysaccharides under the surface of the small granular particles can serve as bridges or connect other smaller granules to form larger granules [16 and 6].

Proteins are hydrophobic constituents of EPS. The high-protein substances are responsible for the formation, structural stability of the granules and contribute to the reduction of scale in processes to membranes [4; 5 and 17].

Humic acids are related among the polymeric substances produced during the formation of aerobic granules. They act principally on the structural part of the granules [7].

Table 2 shows that, in the reactors operated under conditions of formation / maintenance of granular aerobic sludge (R2 and R3), there was an increase in the production of the three EPS when analyzing the quantification of 35 °C with that of 45 °C. At the temperature of 55 °C there was a reduction in the availability of these substances, in some cases being below that which had been quantified at the beginning of the experiment at 35 °C.

This behavior may be associated with the need for greater EPS action, since they act to maintain the structure and protection of the granules [6].

The values of the quantification confirm the observations made by confocal microscopy, namely, an increase in the EPS availability at 45 °C, in the reactors R2 and R3, with subsequent decay in the samples collected when the reactor was operated at a temperature of 55 °C.

The EPS values at 55 °C, associated with the proliferation of filamentous bacteria, as observed in scanning electron microscopy, indicate that the granule structure was lost and thus the loss of the treatment efficiency under thermophilic conditions above 45 °C.

#### IV. CONCLUSION

Aerobic granules were produced in reactors, which were operated for the production and maintenance conditions of the same. Such granules were initially produced under mesophilic conditions (35 °C) and subsequent raising of the temperature in order to obtain thermophilic operating conditions.

Under these conditions the granules were maintained, but the efficiency of the treatment presented decay in terms of the organic matter removal rate (COD). Microscopic and EPS data indicated that temperature increase, alteration of the microbial population and reduction in the production of EPS components may have influenced this decay.

Thus, the present work concluded that the aerobic granules, formed from the biological sludge and the Effluent of the ETE of a pulp and paper industry, can act in mesophilic conditions (at 35°C), as well as in thermophilic conditions, where the maximum temperature Not exceed 45 ° C, without loss of treatment efficiency.

#### ACKNOWLEDGEMENTS

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# Public Policies with users of Alcohol and other Drugs in CAPS AD III in Gurupi-TO

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**Abstract**—This article is the result of a master's thesis and has a general objective to know the actions and care practices carried out by the psychosocial program CAPS AD III-Gurupi/TO, with the families of users of alcohol and other drugs. This research is qualitative, having as the methodology the qualitative analysis of Bardin. Data collection includes participant observation, the Continuous Cursive Record Reporting technique (RCCC) and specific interviews with the multi-professional team, users and user families included in the program. The observations were made in activities developed in the psychosocial program and in-home visits. Therefore, four home interviews with families, five interviews with users and six interviews with professionals of the program are presented here. Through the analysis of data and results, it was possible to identify the points that make working with families difficult. The research found in the work of the CAPS, greater emphasis on harm reduction and medicalization, little emphasis on social reintegration. Thus, it is concluded that the CAPS ADIII-Gurupi presents relevant aspects in the accomplishment of the work as the commitment of the multi-professional team, the adequate physical space and the professional qualification.

**Keywords**—Psychosocial care, CAPS AD III, Public policy, The Tocantins

## I. INTRODUCTION

This article is the result of a master's thesis and aims to work on the theme of families participating in activities and actions in the CAPS AD III (Psychosocial Assistance Center for Alcohol and Drugs III), whose members are users of this program, and verify if the actions carried out cover the needs of the family members and if the assistance policies contribute to the optimization of the service.

The methodological procedure used by this article consisted of participatory research, based on research participant observation. In this sense, Rocha (2004) [1] considers that there is in the participant research a political component that makes it possible to discuss the importance of the research process with a perspective on intervention in social reality.

Mann (1983) [2] describes participant observation as an attempt to place the observer and the observed on the

same side, making the observer a member of the group, in order to experience what they experience and work within their reference system. The initial goal would be to gain the trust of the group and to make individuals understand the importance of research. Thus, Serva and Júnior (1995) [3] say that participant observation is in a face-to-face relationship between observer and observed, whose data collection process takes place in the environment of the observed, and it happens to be seen not as an object of research, but as the subject of it. The instruments used were interviews with the participating subjects, participant observation and continuous cursive recording report (RRCC). The sample of the following research consisted of 04 families, 05 program users, 1 psychologist, 2 nurses, 2 social workers, 2 administrative assistants. The study was carried out in CAPS AD III, in the municipality of Gurupi / TO, located in Sector Pedroso, Rua F, at the corner of Rua G s / quadra PMG R-3. As it research with human beings, the project was authorized by CAPS AD III Gurupi-TO, the Research Ethics Committee (CEP) and the subjects who participated in the research, according to the signing of the Free Consent and Oil Term (TECLE). The selection of the participating families was made through the home visits and also the family members to the program with the psychologist and social worker, moments in which the approach to these families was made until reaching the desired quantitative of ten (10), being the selection on a first-come, first served basis and upon acceptance to participate in the research at the institution. However, the number of ten families was not suppressed because they did not participate in the meetings on the scheduled days and some did not volunteer. Thus, the total was four (04) families interviewed during home visits. Together with the psychologist of the program and after explaining the purpose of the same was asked if the family member wanted to collaborate with the research.

The users' families, Gurupi-TO CAPS AD III users who participated in the program from 2016 to the second half of 2018 were included in the research, and the multi-professional team, composed of the coordinator of the program, two nurses, two psychologists, two social workers, and two administrative assistants, voluntarily. Users who enrolled in the program and their families prior to 2015 did not participate in this study. Users, family

members or professionals who did not agree to their free participation in the survey were excluded, as well as those who were absent on the date of data collection. Regarding the professionals, those who did not show an interest in participating were excluded from the study, after an invitation from the researcher in charge.

The methodology of data analysis focused on the qualitative analysis and content analysis of Bardin (2011) [4] which consists of a set of procedures and techniques that aim to extract meaning from the text through a unit of analysis that can be keywords, specific terms, categories and / or themes, in order to identify the frequency that appears in the text, making it possible to make replicable and validated inferences.

Thus, three stages were performed: 1.Pre-analysis of the material: floating reading, choice of documents, formulation of hypotheses and preparation of the material; 2. Exploitation of the material: operations of codification, through semantic cuts, and elaboration of recording and context units. The unit of record is realized from the themes that constitute nuclei of meaning and also by object or referent that corresponds "to the themes-axis, around which, the discourse is organized" Bardin (2011).

The context unit refers to "unit of understanding to encode the recording unit" Bardin (2011). For its formation, the enumeration rule is used that consists of the calculation of the frequency (presence and absence) of the units of registry 3. Treatment of the results: through the semantic organization, establishing categories, through the process of collection, that constitutes in the classification of the elements, [4] .

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3. Treatment of the results: through the semantic organization, establishing categories, through the process of collection that constitutes in the classification of the elements, [4] .

The interpretation was based on the theoretical reference of the area. The appropriateness of the categories was checked according to the following criteria: mutual exclusion (elements in only one category), homogeneity (single organization principle), relevance (belonging to the defined theoretical framework), objectivity and fidelity which compose a category) and productivity (index of new data), [4].

## II. MATERIALS AND METHODS

### Analysis of data and results

The participant observation technique made possible a personal contact of the researcher with the researched phenomenon, which evidenced a series of significant results such as the subjects' behavior, language, cognitive behaviors, life perspectives, coexistence with other individuals in the same situation, restlessness. In addition, it allowed the subjects to infer the needs of care, in what implies the users of alcohol and other drugs, and their relatives.

The description of the observation allowed defining the subjects in their behaviors, in the specific activities as the dialogues and weaving annotations of reflective form. This process facilitates for those who search, intuiting in the understanding of the phenomena from the detail of the observation in CAPS AD III of Gurupi-TO. It was then observed the dynamics of operation and group activities always with the focus on the relatives of the users. Thus, to organize the observations, the RRCC was used, where the important details observed were described in order not to lose important information.

In the field diary, all observations and impressions were recorded on the observed subjects. For Minayo (2001) [5] the field diary is an instrument that has information on informal conversations, behaviors, expressions, besides the impressions of those who observe the phenomenon. In order to get the job done, the first

contact with the field was made in 2016, at the old CAPS ADIII - Gurupi-TO facility located on Av. Amazonas, where he was interviewed by the institution's psychologist about the project. master's degree and the inclination to carry out research in the psychosocial program.

In conversation, it was reported by the psychologist of CAPS AD III - Gurupi-TO, the difficulties of working with the families of the users, and that, a job in this area, would help in the difficulties of the field. Subsequently, the proposal was submitted to the coordinator of the program, which provided the venue for the work. This led to bibliographical research for the preparation of the first draft of what would be the design and construction of the history of CAPS AD III of Gurupi-TO.

The project went through a second reformulation where the imperfections were corrected until a standard for submission to the CEP was reached. Initially indirect and freer observations were made, to the knowledge of the program team, establishing trust, informally visiting the program. After the acceptance of the CEP in October 2018, and with the authorized research project, the work had a more directive and formal character, and soon the researcher began to talk and establish greater contact with the users and family members inserted in the program.

From this, the meetings had a participatory profile, and the researcher inserted herself as part of the groups where she interacted with the participants and when a family member visited the program there were informal conversations in search of impressions that helped in the construction of the ideas.

On October 9, 2018, the CEP issued an opinion favorable to the execution of the research, and soon after the interviews began, on October 11, 2018, to collect the data and to link information to what had already been collected from the direct observations and participants.

The interviews were structured with the focus on what was intended to investigate the activities and actions carried out with families. After being collected, the interviews were transcribed verbatim, to guarantee the fidelity of the information. These were not previously scheduled but performed on a first-come, first served basis. Only with the multi-professional team can be made in the professional service rooms.

The work presented some obstacles such as time for the collection of data from the interview, the evasion of the families, which caused some households and compromised the desired number of samples, and of ten (10) families, only four (04) participated, many did not want to have to respond to an interview.

After the interview, the transcripts of the speeches and categorization of the data were analyzed.

#### **From the multi-professional team**

At the time of data collection CAPS AD III of Gurupi had about nine (09) professionals in the team. For the

purpose of this study were included all the professionals who agreed to participate in the research, by signing the Term of Free Consent and Acceptance. As an inclusion criterion for professionals working in the program at the time of data collection, an employment relationship was required, that is, not being an intern.

#### **Of the users of CAPS AD III Gurupi**

Of the existing users in the program, twelve (12) inmates and twenty-one (21) outpatients are currently assisted on a 21-hour and twelve-hour hospital stay basis. For this research interview was made with 05 users, all of them volunteers, who explained the reason for the research, and its importance. Two out of ten (10) volunteered without the researcher's initial approach, seven

(07) volunteered to participate in the research, following the researcher's initial approach. The interviews took place in the CAPS ADIII coexistence space, during the users' relaxation time. All were collaborative in answering the questions, there being no hesitation or resistance in the answers.

#### **From the CAPS AD III family of users - Gurupi-TO**

In relation to the families of the users, those included in the program were included and were older than eighteen years, with communication conditions, presenting no mental impairment or with any comorbidity. Four (04) families participated and the collection could not be made on a first-come, first served basis due to the evasion of families from the activities that were held on Wednesdays and Thursdays. Therefore, the researcher in question, together with the Social Worker (A1) and the psychologist, went to the families' house to collect the data. They did the interview only after the signing of the Free Consent and Acceptance Term.

Through visiting families, it was possible to get in touch with the local reality, seeing the difficulties and poverty to which they are inserted. There are many difficulties in both subsistence and health issues. All the families visited have their residences in the outskirts of the city of Gurupi, where the sectors are controlled by the drug factions (PCC and Comando Vermelho).

The lack of being assisted and the need to talk about the problem are present in all the families that have been visited, some have not lost hope, others are hopeless and very fragile.

#### **From the physical space of CAPS AD III – Gurupi-TO**

Regarding the new physical space, during the visit to the premises, it was reported by the social worker (A1), which is very well distributed and organized, which facilitates the team's work with the clinic's inmates, and the attendances each occur in his room, there being no disorder. The new facility is located in the sector Pedroso,

street F, corner with street G s / block PMGR-3. The social worker (A1) reported that there are currently 12 internal users, but that registered and active are approximately 21 users (internal and external). It was also reported in conversation that the assembly with users occurs once a week, activities with families twice a week, which at the moment is marked, but families do not attend. The meeting with the multi-professional team takes place once a week and the medical visit twice.

It should be noted that after the data collection, the method of qualitative analysis of Bardin (2011) [4] was used. According to the author, this method allows the extraction of meaning from the text through the unit of analysis that can be categories or themes, in order to identify the frequency with which they appear in the text, one has the possibility of making inferences about the speeches of the subjects.

Ordinance No. 2,841 / 2010 [6] regulates the technical team that should compose the operating system. In this sense, it can be seen that the CAPS AD III of Gurupi works with a number of professionals adequate to comply with the legislation. According to the report of the individuals who make up the multi-professional team, there is a commitment in the work of the team, which perceives the importance of the service, the need for professional engagement, but it is little recognized in the community and social context regarding the service provided. Thus data found in the IBGE census (2010) [7] point out that psychosocial programs, in order to be effective, must act with the councils and favor social and community functioning, ie to include local society more in public policy planning. For Silva and Abrahão (2016) [8], the repercussions of policies happen mostly in devices such as harm reduction teams, in specialized psychosocial care centers.

Thus, it can be seen in the report of the professional team that the lived experience causes anguish in the execution of the work. During the research the difficulty of operationalizing the service was observed, due to the bureaucratic obstacles of the system, since this speech is confirmed in the discourse of the subject interviewed: "Mental health networks sometimes run into the barriers of bureaucracy, which makes it difficult to achievement of certain collective and individual goals "(B, 37 years old).

Another important speech on the subject was: "The lack of instruments of work in the execution of the actions hinders the work" (A1, 27 years). This shows the fragility of the continuity of the system.

As it was seen that the service is geared towards harm reduction, actions such as prevention and promotion of alcohol and other drugs are on a secondary level, a fact that sometimes discourages the team because they do not know how to develop some actions, especially with families and the community.

On the positive and negative aspects of the work, it is noticed that there are divergences in opinions, but it is clear that bureaucracy and lack of operational resources are obstacles for professionals. It is necessary to emphasize a question concerning the profile of the professionals, who are young people with little time of action in the social service, and consequently they are in the process of institutional experience, fact that leads to a little communication in team and still turned to the normative questions and functioning of the CAPS AD III Gurupi-TO, not even realizing the humanization issue of the service. This could be detected in the assembly held with the users, where the conversations tended more on the rules and norms in force in the program and not on the situation or subjectivity of the user and his family.

Thus, Ramos and Brito (2015) [9] consider that there is a need for dialogue between health care professionals, staff and user, and their families. It indicates a fragility of the program towards the professional qualification, to recycle the team better, but this does not happen.

This shows that there is an investment in structure, palliative care, and harm reduction, aimed specifically at users. Thus, Silva and Abrahão (2016) [8] point out that the "care production devices of care programs should develop therapeutic projects that meet the demand of society in a preventive way." But these practices would only be possible by qualifying the professional to carry out the activities.

During the interview, it was noticed the difficulty of users to answer the questions due to existing cognitive disorders and to the comorbidity already caused by the disease (alcohol and other drug use). Even so, everyone was very collaborative. In some question, the answers were deficient due to the short time patients stay in the hospital, from one week to 45 days. When the user has more time in the house, it is around three months.

It was noted during the interview that the subjects are individuals who have difficulty in establishing a connection of their reality, it is also clear that being in that place means having support in which to be attended to and treated within the current needs and care. In this sense, public policy programs focused on situations of alcohol and other drugs have a relevant role for individuals at risk.

Regarding the social aspects and activities in groups, it is said to be fragile in the service, given that it is precisely possible to execute these actions. During the visits to the program and observation of the time of the activities, users stay idle, are distracted watching television or play cards with colleagues, and also some sleep on the benches of the living room and reception, many seek the smokehouse where they make it a living room and chat room.

It is understood that psychosocial programs should take into account the user's need not only in the harm reduction criterion, but also seek various mechanisms of

activities and actions that work together with the user's social life as a form of rehabilitation. The need for communication and leisure becomes evident, users seek a moment of relaxation in the time they are inside the institution.

It was verified that when talking about the family the difficulties on the part of the users are many, little communication with the familiar system is perceived. Even when the researcher tries another approach to better research on the family system the user has difficulty keeping short and vague answers.

The impression one can have about this situation is that the subject is given to neglect and abandonment in the care networks, often by their relatives. The person who does not fit within a socially oriented pattern ends up being inferior and stigmatized.

For Goffman (2004) [10], individuals with stigmas are marked by physical and psychological particularities, because socially these people are considered as different and inferior in relation to the majority of people, being exposed to daily struggles. Thus there was a questioning of the researcher with some professionals (psychologist and social worker), they reported that families do not want to commit to the problem leaving their members at the mercy of the program. In this sense, the answers found with the team reinforced that there was an evasion of the families. In this question, there was a complexity in the answers,

setting up contradictions between the user's and the professionals' speeches.

According to Duarte (2015) [11], the needs of family care should be investigated and an emotional climate for health should be enhanced in which reciprocity and cooperation result in co-responsibility in the acts, since there is bonding and trust and complicity, since the practice of care extends to the family system.

Thus, the need to work with the family in a welcoming way in psychosocial programs begins to be clear through the research, through specific care demands, understanding the particularities of each one.

Duarte (2015) [11] considers that welcoming and bonding with the family are procedures that should be used in the space of production to health. The team, despite developing active listening, welcoming and informing family members, reports that the families are not very involved in the service, they do not participate in the activities and meetings, they only want the hospitalization of their members, as if it were to solve the situation.

When the interviews and home observations were made with families, the difficulties they face in various aspects from the point of subsistence, chronic diseases, as well as social and shelter difficulties were evident. It was noticed that knowledge about the psychosocial service was through public health agencies that the family sought for

first making resources for its drug users members. In this sense, the lack of information becomes a relevant factor. It is noted that the community has little knowledge of what the CAPS AD III program is. During interviews, it is evident in the speech of families that incarceration, ie, leaving the user closed will help to stay drug-free. This fact is present in the mothers' statements when they report that the Gurupi CAPS AD III dependencies should be closed to be safer and the user would not have contact with the external environment. Thus, an anti-drug ideology is perceived in a repressive and punitive way, in which there is no space for the user in society, being condemned by the family itself to live far from social coexistence. A point that hinders the work of reinsertion of the user in society. Silva and Abrahão (2016) [8] found that "the repercussions of policies happen mostly in devices such as harm reduction teams, centers of specialized psychosocial care." The family remains needy in terms of help, put the issue of safety and control as a positive way of dealing with the situation since if users were closed, they would be free of drugs and treatment would be better. This is evidenced in the speech of mothers who keep their children under treatment in the CAPS observed: "More security, protecting to stay in here not to go outside, should have a grid to prevent them from passing out" (Mother, Family 01). "When they are in there the time they want to get out they have to have a more severe order, constant control" (Mother, Family 03).

The families interviewed are in a situation of social vulnerability and in the poverty line, so all the help these families can have becomes of great value. De Michelli and Formigoni (2002) [9, 12] present that the contemporary challenges increased the level of intrafamily stress, directly affecting family ties and causing family members because they could not deal with family problems consciously, began to do use of psychoactive substances. The authors present that, at the present time, families face challenges such as urban violence, unemployment, STDs, changes in the ecosystem and the use and abuse of psychotropic drugs, among other factors.

Thus it is noticed that the team assists the families and provides a welcoming service, a fact that was also verified in the domiciliary visits in the days of active searches. It is clear that even being a very new team and with little experience in the service of CAPS AD III, keeps a look at the family complexity and the risk situation that they experience.

With respect to data analysis, a point that appears in Arriagada's (2007) [13] and Medeiros (2000) [14] discourse on the role of women in the family system and its social representation, in which many are family members, maintain family economic subsistence, as well as education and affective aspects. This point becomes noticeable in the research on home visits and interviews

conducted. It can be seen that they are all women and mothers, and maintain the role of family support, take care of children, grandchildren, and families as sons-in-law and daughters-in-law. In this respect, the emotional aspect is left in the background in the family system, as there are more emergent issues to take care of.

As an impression of the researcher on this aspect, these women remain exhausted in solving problems and conflicts in the family environment, where all the help is necessary since the emotional aspect seems weakened.

The home visit and interview with the mother of the 02 families identify this issue well when in her report she says that "the whole family is a crack user, there are four with her son-in-law." "I am a widow, my husband died of an accident, I am hypertensive patient, diabetes, I take care of the grandchildren, money is just my retirement and today I am not well."

Another story that exposes this reality is the mother of the family 04: "It's just me and him, I work and earn a minimum wage, everything is with me".

According to the data presented in the analysis of the research, it is noted that the problem of alcohol and drugs for the individual and for the family system is related to the context of the life of each one. Also by a historical, cultural, social and economic construction, fact that in the context of the drugs one can not detach these aspects.

In this sense, Werner (2004) [15] considers the man as a subject that essentially is constituted by social relations, its social conditions, and its historical determinants. It emphasizes that man is a dialectical being and part of the assumption that this interaction is mediated by its importance in the social group.

From the observations and interventions carried out in CAPS AD III in Gurupi, this question of the social context of the user provides the entrance and dependence of drug use, since basically all the subjects surveyed come from a precarious social system, with a very large index of marginality, families with a weak social, economic and financial structure, dependent on the governmental aid of social programs, factors that collaborate with the iniquity of the subject, leading to total self-neglect, subordinated to physical and mental illness.

In the study carried out with the four families, the issue of inequality is visible where there are problems of low income, little schooling, without much assistance, financial resources and unemployment. Social determinants that lead to the entry into the world of drugs, marginalized, and criminal factions, as Comini studies (2016) [16] point out, social conditions such as low schooling, social exclusion restrict options and strengthen vulnerabilities.

The narrowing of contact with users through participant surveys, informal conversation, and the

interview pointed out that the present idea is to get out of addiction, have no inclination for the future and also do not know what they will do when they finish treatment and is charged. It presupposes that the consciousness is submerged in front of the facts and the reality, one lives the day-to-day, in perspective of remote future. When talking or commenting on drug addiction, the looks became passive and distant, the caution in saying something was always present in the conversations.

Goffman (2004) says that stigma inhibits personal growth and stigmatized people are viewed as inferior and different from others and their lives become a constant struggle.

When it comes to the struggle of users and families against the dread of drugs, these individuals forget that they are capable of seeking a significant change in themselves, but the difficulty of perceiving themselves capable makes them fragile, and they are waiting for greater care promoted by the health team, which is seen by them as professionals holding a knowledge for the supposed "cure" to be granted.

On the other hand, as a strengthening source, the multi-professional team of the psychosocial program is presented, qualified but deficient in qualification to attend a clientele so complex that it is the family and the user. These professionals, at certain moments, feel powerless in the face of the difficulties encountered with the demand to be treated.

It is understood that the family in our society is heterogeneous, mutant and complex. In order to work for the family the professional needs to understand this transformation and complexity in the family system. Arriagada (2007) [13] points out that there is a great variety of family arrangements, but these large variations will show that they are important in the perceptions of the family members and their effective connections. This speech of the author shows the evidence in the participation of the field activities with the relatives, since it was seen that the family when it presents an effective emotional structure with its members and is present in the assistance to the fuser member, there is adherence of this to the treatment, that makes it more intense, even with the difficulties of getting rid of addiction. "... the family has to help if abandoning gets worse, the family's help is important" (Mother, family 03).

When it comes to families in the context of poverty, the analogy that is made is directly linked to social inequalities, economic and institutional factors. Social Indicators demonstrated by the IBGE (2017) [17] proved that Brazil is one of the countries with the highest index of social inequality, mainly income.

Comini (2016) in speaking about institutional factors points out that impunity and corruption in high-ranking decision-making positions have an effect on the



enforcement of laws. Still, in this sense, the author states that there are children and adolescents who suffer due to the vulnerability and marginalization of their relatives, many of whom are used by criminals, some of whom have their parents in prison for trafficking and others have lost their families orphaned.

Thus, society faces a problem that is no longer seen in only large centers, since criminal factions also take care of small towns and drug-trafficking settlements, where communities of peripheral regions of the city live in sectors that are taken by groups that the region. Reality is lived by the families and youth of Gurupi, which can be confirmed in the reports of the subjects interviewed and in the visits in peripheral regions of the municipality. Consequently, very early on, children and adolescents come into contact with such groups, causing many of them to become soldiers of trafficking as a way of subsistence, where some who do not get meaningful help end up prematurely losing their lives or death by rival factions.

The issue of drugs and culture has always been related, says Comini (2016) [16] narco-culture where symbolic elements such as honor, protection, loyalty, status, prestige, revenge, and consumption are present in the life of the individual and of society.

The drug pathway is not only related to consumption but it also can not qualify or disqualify the user. In contact with the users of the CAPS III AD of Gurupi, it was evident that the people who are there have a history, some still have their families, others have lost because of the addiction and there are those who are without any contact with the family system, at first they are people and each in their own way seek an improvement attempt.

An important study by Velho (2000) [18] on the issue of low-income families, says that in the Brazilian context the demographic exploitation of urban populations as a result of rural exodus and processes of social segregation is the basis of low-income groups, with basic demands of health, housing, education, and work, where they end up exposed to abuses and also causing them. This fact is perceived in the inhabitants of peripheral regions of low income.

Regarding the State of family well-being, Medeiros (2009) [14] raises three important points. The first is that both family and state fill a market space in the capitalist economy, so they play an important role in the systemic development chain since they normalize the individual's life through property rights, duties, power, and social assistance. The second point described by Medeiros (2009) [14] relates to the "Welfare State", this affects the organization and structure of the family as the changes of values and the redivision of social work, expressing repercussions on the family hierarchies. The third and last point refers to the well-being of families, who must be stable and well organized.

Of the families surveyed the welfare issue is practically non-existent, since they have the minimum, and this must be multiplied so that the needs of its members are satisfied. The order of welfare is not established in these families by several factors: first that there is an imbalance in the homeostasis of the family system, according to which the subsistence conditions are minimal and precarious, third that the level of formal education is low (part of the families are half-illiterate), the fourth point, there is no division of labor and help.

Thus, in the case of these families, there is helplessness in relation to the model in the Welfare State. The economic crisis, the difficulty of a better insertion in the labor market and the low level of education, are factors that trigger instability in the welfare state. The woman is not only the one who takes care of the children and the house but becomes the one who often maintains the house, life becomes sedentary and there is a considerable change in food and maintenance of health. Of the families visited are practically the women who maintain the family's support and sometimes the cigarette, the drink, the medicine, and clothes. They are also the ones that keep the users' children enrolled in the program, hoping for an improvement and harmony in the family environment.

Regarding the Psychosocial Programs and Public Policies, it was verified in the field study the difficulty of maintaining the attention networks and the adherence of support networks. It is noticed that at the moment the CAPS AD III Gurupi walks alone and that there is an understanding between the roles of CAPS since in Gurupi there are CAPS I and CAPS AD III. What is reported is that when it comes to the clientele to be served, it is often confused the clientele that would have to be served by CAPS I and goes to CAPS AD III. With this, there is a need for a brief clarification on mental illness, alcohol, and drugs. CAPS I was designed for the treatment of individuals with mental disorders.

Regarding observations and conversations with users, there is evidence of cognitive ability is affected. Of the five (05) users only one (01) did not present the disorder. The four users who appear to have a picture of the cognitive capacity affected, it is possible to attribute this to the abusive use of drugs in a long time.

Individuals in the clinic who have specific clinical cases of schizophrenia and acute mental retardation, who should be treated by CAPS I, but who are in the CAPS AD III, were also perceived. In a conversation with the professional of the team was questioned this situation and the same answered that in a meeting with the professionals of the CAPS I, due to the patient make use of drugs, he would be treated in CAPS AD III.

In this sense, there is a need for a case study and communication with the teams to analyze the best way to deal with these issues, which can be a challenge in terms

of program progress.

An observed and verified condition in visits to the institution is that the main focus is on medicalization and harm reduction. This point was noticed in the speech of the users and also of a professional, in which they report that there is a great wait for the day of the consultation in which the discharge or permanence in the program is determined.

According to the research, the work with support networks and greater proximity to the community remains loose in the activities of CAPS AD III Gurupi. One can have an answer to this fragility the aspects already raised regarding the team, which has very young professionals with little experience in the area, without a specific specialization to deal with mental health, psychoactive drugs and the complexity of the family system.

In order for Gurupi's response to CAPS AD III to be positive and to develop activities and actions, the program must reach out to the communities, seek to clarify what the program is, to visualize the work developed, to participate in the activities and actions of the municipal councils, make frequent home visits, not only on days of active searches. To create conditions for users and families to meet, since it was notorious, in view of the observations made, the distancing of families and their members, regarding affective aspects.

Thus, to speak of policies in this respect constitutes a stage in which the democratic governments in the idea of Souza (2006) translate their intentions so that they have a change in the daily life and the life of the citizen.

### III. CONCLUSION

This article had as objective to know the activities and actions carried out in the CAPS AD III of Gurupi-TO with the families of the users. Qualitative research was carried out. Participant observation and interview with users, staff, and families have applied a methodology.

The research development process was carried out through the observations, the participation of the activities carried out, home visits and interviews, taking into consideration the positive and negative factors, as well as the issues of vulnerability presented. As positive factors can be perceived the physical structure that presents itself as broad, cozy, with capacity to accommodate users and families, appropriate space for the team to develop a good job within what is allowed.

As far as the multidisciplinary team is concerned, it can be recognized that the work of the team is carried out with seriousness and that all professionals define their roles well and execute them in the program. Regarding the service to the family and to the user of the system, a good performance of the team was also evidenced in relation to what is recommended in the ordinance No. 2 841, dated September 20, 2010.

The negative points are cataloged in the vision of the multi-professional team, in the issue of system bureaucratization, communication difficulty in the scope of actions to be developed, lack of qualification in the area of mental health, which is considered important for the accomplishment of the work. For the users of the program, the negative factors are in the fragility of the physical structure, in the attendance of the reception and in the medical attention. Often due to the demand, users of the 12-hour regime are left unattended, with the 21-hour regime being prioritized. The family highlights the issue of lack of security in the physical structure and the freedom with which users stay when they are in the CAPS AD III Gurupi, in the view of these people there should be more control, space would need to be closed with grids.

In the analytical category of the family, according to the interpretation of the researcher, there is the care with the family, through active listening, orientation, information and the accomplishment of activities twice a week and more home visits.

With regard to public policies, many challenges at the national level are to be addressed. One of the important points would be the de-bureaucratization of the system, so that the projects carried out by the technical professionals are approved and executed, and that the planning, execution and evaluation organs of the program's dialogue with each other with the objective of improving and improving the community/society.

The community and social benefits would be the implementation and optimization of the services and actions pertinent to

the psychosocial system, available to families, user's members, and multidisciplinary team. Depending on the activities carried out in the CAPS ADIII, intervention actions are proposed, together with other assistance programs existing in the municipality, in this case the NASF (Social Support to the Family), as work in the form of support networks in Primary Care constituting the search Prevention and Promotion of Health in the Family System.

The research contributed in a significant and effective way in order to have more favorable conditions in the development of activities and actions with families so that they understand their importance in the process of rehabilitation of the user family member.

There are many challenges, but optimism is needed in building improvements in public policy. The participation of social actors is necessary for the whole process since this process is understood as dialectical.

With regard to the public policy work cycle, it was verified that the execution and evaluation part of the work in the program remains deficient, due to the vulnerability presented and the evaluation that does not occur, in order to remedy the deficiencies. But the relevance of the program lies in serving the poor communities and society

as a whole, as it becomes the only means that families can receive, helping their members at risk and need for protection.

Thus, the program needs to be more widely disseminated in society in general, so that there is a perception of the relevant work for communities that are at risk with their users who are ill with alcohol and other drugs. As a humanitarian process it is observed that the community/society does not use stereotypes like "drugged", "pothead", "pinguço" or "vagabundo" and to see these individuals as beings capable of a transformation. This fact was experienced by the researcher when in the interview with users who were volunteers, in which they reported that the day of the services was very good. There for, one should have a non-stigmatized look, both for the user and for his family.

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# Children's Evasion in a Public Program of Early Dental Attention

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**Abstract**—In order to evaluate children's oral health related to frequency in a public program of dental attention early, this research conducted a study retrospective cohort which reached 252 assessment children, between 36 and 60 months of age, in the city of Gurupi, Legal Amazon region, Brazil. Three groups of children were analyzed: G1: effective participants of the program since birth; G2: children no longer participate for more than 24 months of the program, and a control group G3: children who never participated in prevention project. The evaluation was conducted in two stages: interview mothers and clinical examination in children for analysis of caries, gingivitis, and malocclusion. The index of caries in deciduous teeth (dmft) presented different data between groups  $G1 = 0.05$ ,  $G2 = 1.96$  and  $G3$  was 3.30. Oral diseases were statistically more common in children who have never attended an oral health program ( $p = 0.025$ ). The main reason cited by 54% of mothers who have left the program, was the oblivion of the scheduled day. Thus, children who effectively attended the oral health program showed the best results in relation to caries, gingivitis, and malocclusion, when compared to those who have left or have never participated.

**Keywords**—Pediatric Dentistry, primary prevention, oral health.

## I. INTRODUCTION

Education and access to information about preventive methods to avoid oral diseases such as dental caries, gingivitis, and malocclusion in children, should begin as soon as possible. The early dental world attention reached to be a way to prevent and control oral diseases, from guidance to pregnant women in prenatal period [1] [2]. Information on oral health care must be directed to pregnant women to increase your knowledge about the care of pregnancy, oral and General implications and to prevent problems that may occur both in their own mothers and in the future kids. [3] [4]

Several authors [5] [6] [7] agree with the implementation of preventive programs for babies since they claim that oral education parents get great benefits. A systematic review of the literature identifying risk factors during the first year of life has shown that maternal early intervention can reduce the likelihood of early caries criança [8]. Children from 0 to 5 years still aren't mature enough psychological and motor skills to perform all the activities and education and motivation of the nuclear family are important to promote the oral health of children, especially in the early years of life [9].

In order to verify if the evasion of scheduled consultations in public attention early dental program could present different results in relation to oral diseases when compared to the group that frequents and the other who never participated in a program of health.

## II. MATERIALS AND METHODS

This study was a retrospective cohort study conducted in the Legal Amazon, covering the northeast of the Bananal Island, within the public health network of Gurupi (TO), with an area of 1,836,091 square kilometers and a population total of 76,755 people (IBGE 2010), in which 20% are children aged 0 to 5 years of age. The study was approved by the Committee of ethics in human Research at the University of Gurupi UnirG, protocol number 455422215.8.0000.5518.

A local study [10] has shown the great demand in this municipality for dental care of children aged 2 to 5 years of age, with the presence of pain and consequences of oral diseases. Thus, the public attention early dental program called "baby's Mouth" was implemented in 2010 in the town of Gurupi, in Tocantins State, in partnership with the city Hall and University of Gurupi UnirG. This program operates from the gestation of the child up to the age of 5 years. The children are enrolled in this program from the public and the professionals carry out examinations and care in children still toothless with quarterly control. The project directs the mothers about the diet and provides a

program card with the return appointment date. The professionals followed the child's dental eruption, occlusion stabilization until five years of age, if changes are detected during this period, the team operates in accordance with the guidelines of the American Academy of Pediatric Dentistry [11]

The program works on all basic health units (BHU), featuring educational lectures on oral health for pregnant women in prenatal care, focusing on the importance of breastfeeding, sucrose consumption control, warning about habits harmful to the formation of dental arch (use of pacifier and bottle) and encourages the oral care. Children can be enrolled from 0 to 12 months in any one of the BHU. Hygiene, intraoral examinations are carried out, and often have a maximum interval of 6 months. In the visit, every child with teeth receive an oral hygiene kit with infant toothbrush and toothpaste with fluoride wire. The visits are also to monitor the development and stomatognathic growth, dental eruption, breathing, swallowing and oral correct posture.

**Inclusion and exclusion criteria:**

Ages 36 to 60 months and both sexes were accepted for all groups. The age of 3 to 5 years was selected to allow assessing the effect of activities carried out by this dental health program since 2010, therefore, it was stipulated that the study reached results of the program with a minimum of 30 months of frequency for G1 and 12 months of escape to the G2.

In 2015, of the 1,303 enrolled in the program from 0 to 6 months in the period from 2010 to 2014, there was evasion of 423 children (52%) after the first query, the second was 171 (21%), and 89 (11%) after the third consultation, absent without justification, the other quitters occurred after the fourth query. Therefore, during the study period of 2015, had 488 completed records of children from 0 to 5 years of age who participated effectively in the program.

To obtain homogeneity of the sample quantity in the groups, the basic number established was the amount of Group 1.

Group 1 (G1): of the total sample of 488 children 0 to 5 years, those who attended the program regularly, were chosen for the study of children with biannual frequency cohort and entered in the program from birth (0 to 3 months). This sample consisted of 106 children with 3 to 5 years of age, using a sample calculation with the possibility of error of 5%, 95% confidence level, resulting in 84 children. In Group 2 (G2), including children who attended the program from birth (0 to 3 months) that remained at least 18 months in the program and who have left for more than 24 months. Obtained phone records, of which 145

were randomly invited to participate in the study until the number of 84.

Group 3 (G3) was composed of a similar number of children with spontaneous demand, which sought the vaccination in UBS and never participated in any oral health promotion program (control group).

Exclusion criteria of G1 were incomplete records. The G2 was the lack of telephone contact or if the child has migrated to a different prevention program, and G3, if these children do not live in the region studied.

A total of 252 were evaluated 3 children 5 years to March 2015 period to December 2016. The G1 was attended in the routine queries, G2 with a prior schedule to attend the clinic at the date and time set, and the G3 invited for participation in the study after vaccination in BHU. Three children of the G1 were replaced, because the drawn lacked, so the number of 84 participants. In G2, 14 children did not attend the scheduled consultation and new additions were made to the number of 84. On the G3, the first 84 tests were held permits to study in ten UBS.

The responsible signed an Informed Consent Form (ICF). All examinations and interviews were carried out in an appropriate room of UBS for the attendance in the program. The survey was divided into two stages, the first consisted of an interview with mothers, containing twelve closed questions. The mother was questioned about the maternal information, such as age, household income, education, employment, marital status, number of children, habits, oral hygiene, and also related to the frequency of the program. The children of the G2 and G3 with oral amendments (caries, periodontal disease or malocclusion) detected during the study were forwarded to the public service pediatric dental of UBS.

In the second stage, the child has received a specific clinical examination of the oral cavity, by a single examiner for this study. All examinations were performed by one examiner trained and previously calibrated (Kappa intraexaminer index = 0.86). 10% of the total sample was reviewed during data collection (Kappa = 0.89). This examiner was responsible for all the tests of children in the dental office, which after brushing and in the light of the reflector, used instruments such as a periodontal probe, dental mirror, and gauze.

The index of the caries disease was (dmft), decayed teeth, with extraction indicated and closed recommended by the World Health Organization (who), in that values exceeding 6.6 have very high prevalence; between 4.5 to 6.5 show high prevalence; between 2.7 to 4.4 are indicative of a moderate level of caries; and between 1.2 to 2.6 are indicative of low prevalence; the values less than 1.1 reflect a very prevalence baixa [12].

The indicator used to measure changes in gingival mucosa was the Gingival Index Modified (GIM) proposed by Lobene et al. [13], with criteria set: 0-absence of inflammation; 1-mild inflammation: when there is slight change of color and texture changes of any portion of the marginal gingiva or the gingival papilla; 2-inflammation: criterion above, but involving completely or almost all portions of the marginal gingiva and gingival papilla; 3-moderate inflammation: marginal gingiva and gingival papillae bright, red, swollen and/or hypertrophic; 4-severe inflammation: redness, swelling, and/or gum hypertrophy marginal or gingival papillae, spontaneous hemorrhage, congestion and/or ulcerations.

Tests were carried out to detect signs of malocclusion, as Overbite, cross bite and overjet. The overjet was examined by measuring the horizontal proportion between the upper and lower incisors with the teeth in occlusion. The distance between the incisal edge of the prominent upper incisors and the lower incisor labial corresponding face was measured with the periodontal probe parallel to the occlusal plane. This distance was considered: normal for values up to 3 mm; overjet values greater than 3 mm; and anterior cross bite, when the incisors were at a distance of negative incisal edge lower occlusion of the incisal edge to top vestibular. The Overbite was obtained by measuring the vertical distance between the edges of the upper and lower central incisors with the teeth in occlusion. This distance was considered normal when the upper incisors

covering up to 3 mm from the bottom; and deep overbite for values greater than 3 mm; and open bite when there was no overlap between the upper and lower incisors with a minimum space of 1 mm between the incisal edges. The posterior crossbite was considered present when, in occlusion, the vestibular of molar cusps are displaced to the buccal cusps of the maxillary molars. Just your presence or absence was considered, regardless of the side.

The clinical data and information obtained through the questionnaires were described and the variables subject to the Chi-square test ( $p < 0.05$ ).

### III. RESULTS AND DISCUSSION

Family profile, results of these children showed family income of 1 to 2 minimum wages and the age of the evaluated groups with mean values and standard deviation corresponded to G1 ( $3.662 \pm 0.753$ ), G2 ( $3.698 \pm 0.711$ ) and G3 ( $3.714 \pm 0.743$ ). The educational level of mothers, in all groups, prevailed the completion of high school. By analyzing the percentage of program components in table 1, there was statistical significance in groups, with or without partners, and in G1 and G2 most was married. The number of children for each mother prevailed two children on the G1, a child in the G2 and three or more children in the G3, with a significant difference between the groups.

Table 1: Distribution in number and percentage of the sample profile (mothers and children).

Table.1: Distribution in number and percentage of the sample profile (mothers and children).

Children	G1		G2		G3		Total		p value
	n	%	n	%	n	%	n	%	
<b>Age</b>	$3.66 \pm 0.75$		$3.69 \pm 0.71$		$3.71 \pm 0.74$				
<b>Gender</b>									
<b>Female</b>	33	39.2	41	48.8	48	57.1	122	48.4	0.06
<b>Male</b>	51	60.8	43	51.2	36	42.9	130	51.6	
<b>Mothers</b>									
<b>Age</b>	$29 \pm 6.26$		$22 \pm 4.06$		$20.5 \pm 3.95$				
<b>Marital status</b>									
<b>married/</b>	59	70.2	57	67.8	38	45.3	154	61.1	*0.001
<b>single</b>	25	29.8	27	32.2	46	54.7	98	38.8	
<b>Number of children</b>									
<b>1</b>	29	34.5	33	39.2	17	20.3	79	31.3	*<0.001
<b>2</b>	42	50	26	30.9	29	34.5	97	38.4	
<b>&gt;3</b>	13	15.5	25	29.9	38	45.2	76	30.3	
<b>Total</b>	84	100	84	100	84	100	252	100	

\* Chi-square test with a significance level of  $p < 0.05$ .

Table 2 presents the distribution of the data collected for the information of the interview of the three groups. The women of the G1, G2 and G3 reported about "oral health guidelines during the prenatal period" in which there was a significant Association of adherence to the program and the information received ( $p = 0.0002$ ;  $X^2 = 16.8$ ). On breast feeding, the groups presented significant statistical data regarding frequency ( $p = 0.021$ ;  $X^2 = 14.9$ ). The

children of the G1 had the lowest use of bottle- feeding and nutritional habit was significant between the groups ( $p = 0.0001$ ;  $X^2 = 23.48$ ). In relation to non-nutritive sucking habits, there is evidence that belongs to groups that had a lower frequency, or lack of participation in the program, meant to increase finger sucking/pacifiers ( $p = 0.002$ ;  $X^2 = 11.69$ ).

Table.2: Distribution in number and percentage of mothers' perceptions and knowledge about oral health care in early childhood in all groups.

QUESTIONS	ANSWER	G1		G2		G3		p value
		N	%	N	%	N	%	
Did you have any information about oral health for your baby during the pregnancy?	Yes	25	30%	37	44%	14	7%	* $<0.001$
	No	58	70%	43	52%	70	83%	
Until which age have your child breastfed?	> 6 months	16	18%	4	5%	10	12%	
	6 months	5	6%	7	8%	8	9%	*0.021
	< 6 months	58	70%	73	87%	61	72%	
	Never	5	6%	0	0%	5	7%	
Does your child use a baby bottle?	Never	51	60%	25	31%	27	32%	
	>1 year and stop	21	25%	38	45%	29	34%	* $<0.001$
	Always	12	15%	20	24%	28	34%	
Does your child suck finger or pacifier?	No	78	92%	76	90%	64	76%	
	Yes: Suck finger	1	2%	1	2%	7	8%	*0.002
	Yes: Pacifier sucking	5	6%	7	8%	13	16%	
How many times per day do you brush your child's teeth?	1 time	4	5%	14	16%	20	24%	
	2 times	34	40%	40	48%	51	60%	
	>3 times	46	55%	18	36%	13	16%	9.87
	Not answer	1	2%			1	2%	
Do you use toothpaste?	Yes: fluoride tooth paste	76	90%	80	95%	68	81%	7.64
	Yes: tooth paste without fluoride	7	8%	4	5%	14	19%	

\* Chi-square test with a significance level of  $p < 0.05$ .

As for the use of fluoride toothpaste ( $p = 7.64$ ,  $X^2 = 74.21$ ) and the number of times that children received daily brushing ( $p = 9.87$ ;  $X^2 = 38.281$ ), there was no statistically significant difference in frequency between groups. Mothers G1 and G2 signed up their children in the program of prevention, while mothers of G3 intended to take them to the dentist only when the treatment of caries or pain were needed [10].

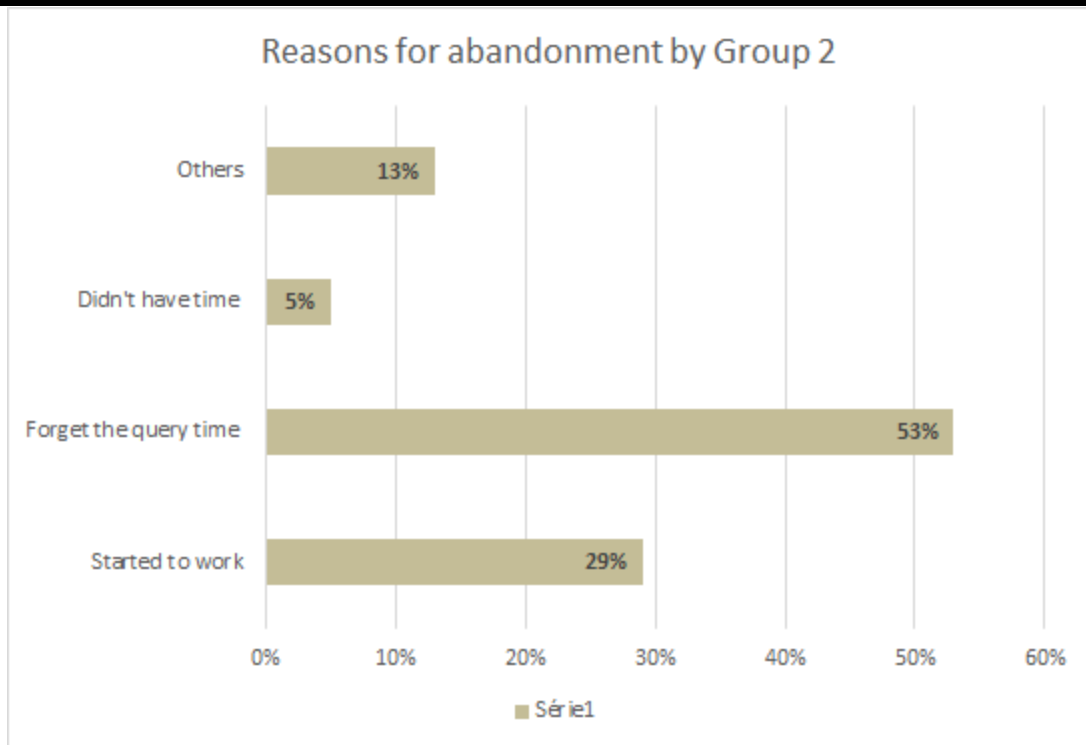


Fig. 1: Distribution in percentage of Group 2 mothers' reasons for evasion in a Public program.

The evasion of the G2 justified in your most (54%) forgot the query in UBS, 25% of mothers reported not being able to attend because they started to work, 4% because they didn't have time and 11% for other reasons. The index of caries in deciduous teeth (dmft) introduced different data groups, the G1 was equal to 0.05; the G2 was 1.96; the G3 was 3.30 of the affected children. In relation to caries disease (table 3), there was a linear relationship between the variables, in which all groups showed a significant difference. For gingivitis, there was no significant difference when comparing G1 and G2, but was extremely

significant between G1 and G3. In the occlusions, there was a statistically significant relationship between the three groups relating to circumvention of the program and the presence of child malocclusion. G2 and G3 have increased the prevalence of these changes since there were participating or partially from the program.

The most prevalent malocclusion in the groups was the open bite, followed by anterior and posterior crossbite, in which the group that never appeared on the show (G3) presented a statistical difference in this oral amendment about the G1.

Table 3: Submission of data analyzed by comparing group to group.

	Data Analyzed	N %	RR	95% CI	P Value
Caries	G1x G2	50 (30%)	0.149	0.064 , 0.346	<0.001*
	G1x G3	64 (38%)	0.102	0.044 , 0.24	<0.001*
	G2x G3	104(62%)	0.71	0.528 , 0.953	0.038*
Gingivitis	G1x G2	22(13%)	0.603	0.321 , 1.134	0.107
	G1x G3	41(24%)	0.281	0.141 , 0.561	<0.001*
	G2x G3	49(29%)	0.528	0.337 , 0.826	0.002*
Malocclusion	G1x G2	43(26%)	0.849	0.583 , 1.237	0.47
	G1x G3	61(36%)	0.512	0.342 , 0.767	<0.004*
	G2 x G3	66(39%)	0.618	0.432 , 0.884	0.007*

\*Fisher's exact test with a significance level  $p < 0.05$ ;

RR=Relative Risk; 95% CI = Confidence Interval



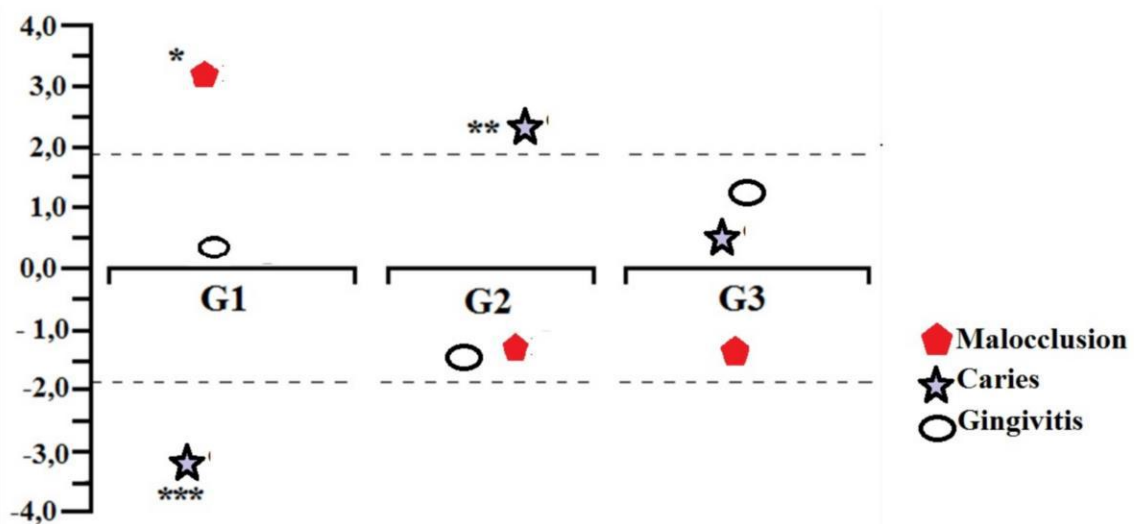
Table.4: Distribution in number and percentage according to oral diseases (caries, gingivitis and occlusion) found in all groups.

	G1		G2		G3		p value
	n	%	n	%	n	%	
Malocclusion	19	22.6%	28	28.6%	42	50%	
Gingivitis	8	8.3%	15	17.9%	34	40.5%	*0.025
Caries	5	5.9%	46	54.7%	59	70.2%	

\* Chi-square test with a significance level of  $p < 0.05$ .

Table 4 represents the percentage of oral amendments. Among the groups studied, it became apparent that the non-participation of an oral health promotion program promoted more oral diseases ( $p = 0.025$ ;  $X^2 = 16.39$ ).

To a satisfactory conclusion on the associations observed, the residue analysis technique to assist in the interpretation of data organized in Figure 1 and evaluate how the different diseases count toward significance obtained.



Residues above + 1.96 or below -1.96 indicate the significance obtained in the chi-square test and show the number of individuals with higher or lower disease levels, respectively, than would be expected if they were random.

Fig. 2: Adjusted residues (Raj) calculated from standardized data residues from the correlation between groups (G1, G2 and G3), according to oral diseases (caries, gingivitis and occlusion).

The positive residue (\*\*\*) Raj = -3.44) in G1 indicates the significance of the Chi-square test and shows a larger number of individuals under the decay that would be expected if it was casual, but the oclusopatia was higher in this group (\* Raj = 3.30). In the G2 positive residue (\*\* Raj = 2.10) shows that only the caries disease was greater than expected.

#### IV. DISCUSSION

The dental care early, through preventive education, results in better quality of the oral health of children [14]. However, the number of mothers who reported having sought assistance only after the child is high on G3 carious

lesion, seek professional assistance only after the disease manifests itself, demonstrating a curative view of dentistry that must be changed by public policies.

Health education in government projects must provide conditions for people to develop a sense of responsibility, both in relation to your own health and the health of your family and comunidade [15]. In this program were enrolled about of 1,303 children from 0 to 6 months between 2010 to 2014, when all the mothers received a card with registration and schedule the date of return, however, the number of tax evasion is still high, in which more than 800 children did not return. Although mothers G1 and G2 have received a schedule with the return date

scheduled, many still escaped the program (G2). These mothers claimed several reasons that led to losing the queries, such as: "lack of time", "return to work" and "forgot the query".

When the mothers believe that all is well in the first child visits to the dentist are and begin to look for health professionals only when the disease manifests itself, demonstrating the difficulty of accepting new paradigms in the promotion and maintenance of the health [16]. Mothers profile may affect the participation and collaboration of preventive actions, taking into account the socio-economic status, mother's age [17], the number of children and the presence of a partner [18].

An oral health promotion program based on repeated preventive guidelines cycles initiated during pregnancy the mother was successful in reducing the incidence of caries in these children [19]. The gestational period is the ideal time to start preventive and educational programs motivate the importance of infant frequency [4, 7, 14].

In the present study, several mothers of all groups reported not having received information about oral health during pregnancy in the prenatal period, which probably hindered the awareness to avoid the circumvention of the program. In this study, the marital status of the parents was significant, the mothers of the G3 had more children and were 10 years younger than the G1. According to Moimaz et al., [20] the presence of caries in children and the story of maternal caries associated with mentoring women, low economic level and family visits to the dentist. However, the marital status of the parents was not significant (0.695), but the number of children in the home in relation to dental caries was highly significant ( $p < 0.0001$ ).

There is evidence that early preventive visits may reduce costs [21]. The age of first dental appointment had a significant positive effect on preventive expenses related to dentistry and a study of early dental consultations as to the effect and cost of treatments. The average costs were lower for children who received early preventive care, with average costs per child, according to the age of the first consultation: before 1 year of age = US \$262; age of 1 to 2 = \$339; age of 2 to 3 = \$449; age of 3 to 4 = US \$492 and the age of 4 to 5 = \$546 (16) [22]. Therefore, the sooner the child is accompanied by a dental health education program, less public spending with restorative treatments and rehabilitation will be carried out.

The first visitors this program focuses on oral hygiene in children; dietary advice; information about oral habits and prevention of dental injuries, leading to reduction of dental costs. In this sense, it is necessary that public policy evaluate periodically their health programs, with longitudinal studies, seeking ideal samples and making them important indicators for health promotion. This will

bring a direct return to the population studied, as it allows a reduction in the costs of treatment and care of the sequelae of the main oral problems that affect children. Such actions achieve positive results, will be reflected in the improvement of the quality of life of this community.

Tooth decay is the most prevalent oral disease in the deciduous dentition, affecting approximately 50% of preschoolers, which may have a negative impact on quality of life of the child, as a result of the commitment of the chew, talk, sleep disorders and irritability due to pain, as well as psychological problems [23]. The present study showed that children who have left the program for 24 months and those that have not participated, showed a high rate of caries. The takeover and colonization of the caries disease and bacterial protection factors in children from 0 to 12 months of age showed that this colonization is mediated by eating habits and behaviors in this baby hygiene 8.

The data of this research have shown that preventive program was effective in preventing tooth decay, even those children who have not continued in the prevention program when compared to those who never participated. According to the classification of oral health by the World Health Organization (WHO), the safety index of the present study was considered too low in G1, the G2 was of low incidence and the G3 was medium. This demonstrates that the program was effective in the control of caries disease in the G1 for the first 5 years of the child.

In relation to gingivitis, all groups showed an index of bleeding, and the component free of caries of the G1 was the largest. Parents are instrumental in cleaning of the mouths of children under the age of 5, because they do not have the motor skills to fend for themselves [24]. This demonstrates that the encouragement of oral hygiene performed by the program was crucial in maintaining healthy habits, resulting in periodontal health, where children who attend preventive programs feature minor bleeding index that other children [25]. Caries and gingivitis index observed in G2 and G3 indicates that this epidemiological approach with questionnaire in table 2, in which often shows only the theoretical knowledge of these issues, not demonstrating the reality of the habits and attitudes of family.

In Brazil, an epidemiological study conducted in 2010 showed a 13.6% reduction in malocclusion to 12 years of age. Although there is a drop in the prevalence of malocclusion at that age, this change can still be considered an occlusal condition pública [26]. In the present study, the positive residue in Figure 1 shows that the free component of G1 of the malocclusion was not as low as expected, but two important factors must be considered, the genetic inheritance of the child and oral habits persisted. The

hereditary genetic factor can be mitigated by avoiding the use of harmful habits that can stimulate major deformities and sequelae of the child [27].

A major obstacle to the success of prevention programmes has been the lack of commitment of the families with the guidelines, as well as to the increasingly early insertion of inappropriate habits that lead to oral diseases, lack of attendance to queries may compromise the early approach for control [28].

Fracasso et al. [2] evaluated 100 children 2 to 5 years of age in two groups. The group consisted of 50 children served since the first year of life in an oral health program with education and prevention in bimonthly returns, and the Group B with conventional treatment (preventive and curative) and spontaneous demand in Health Center. The Group showed lower caries index, non nutritious habits and facial changes than in Group b. a reality that is in line with the present study, where the G1 obtained the lowest rates of oral diseases, indicating that the frequency and constancy in the programs help reduce diseases like cavities, gingivitis, and malocclusion.

Child care programs are more effective than the spontaneous demand, fulfilling the goal of keeping oral health in children. So, to demonstrate the success and effectiveness of a program, the results should be evaluated clinically after a given period [19]. The project was evaluated, seeking to meet the profile of the community participant, a diagnostic of results achieved, identify the main obstacles that interfere with the program and seek solutions to achieve the objective of the proposal in basic health.

Participate in a program of Early Dental Attention influenced positively on oral health of children, in addition to introduce food and correct habits in hygiene of children, promotes child health [4, 24]. Therefore, public policies are not enough to offer free programs early service, it is necessary to find ways to promote and motivate the children to an appropriate frequency.

The perception and motivation are important components in health education for mothers to assimilate and interpret information to produce actions or change inappropriate behaviors [29]. In this educational process, if these motivating forces are not enabled, the changes in behavior are unlikely to occur. This shows that the mere acquisition of knowledge by the community alone is not sufficient to promote health [30], and it is necessary to work within the range of values important in reality of each population.

## V. CONCLUSION

Children from 3 to 5 years who frequented the oral health program presented fewer individuals with caries,

gingivitis, malocclusions and habits than those who have left or have never participated in a program. To promote the oral health of children, it is essential to adhere to the program and adopt healthy habits early by those responsible.

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# Preferences and Perceptions of School Children in Relation to New Styles and Colors of Dental Attire

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**Abstract**—New designs and styles of attire such as coats, hats, and masks, colored and with prints are emerging in the market and offered to healthcare professionals, and in many situations, the justification is aimed at minimizing the stress caused by the white coat and optimizing the child dental treatment. To Verify the preference and perception of schoolchildren in relation to the new color patterns of dental attire. Transversal Descriptive study, Quality Quantitative Approved by the Research Ethics Committee of Human Beings. The sample consisted of 748 students of both sexes, aged randomly selected in public and private schools in the city of Gurupi, in the State of Tocantins, Northern Brazil. The Study was conducted with an interview and test to schoolchildren. The children of public schools (50%) and private (46%) they preferred the traditional white coat and the most rejected was printed/colored coat. In the hat and mask the groups among schoolchildren presented a statistical difference for preference ( $p > 0.05$ ). The mask rejected by children from private schools (70%) and public (84%) for being "ugly" was with an animal mouth. Children prefer the white color of coats, hats and masks, showing the selection by the traditional pattern, considering what would be "right" in their vision.

**Keywords**—Pediatric dentistry, Paramentation, anxiety.

## I. INTRODUCTION

Dentists working with children seek to establish a friendly relationship to reduce patient fear and achieve collaboration To Dental treatment. Children often make judgments about their dentist based In Appearance, kindness, willingness to listen and Clinical Competence during appointment (AlSarheeda, 2011) [1]. Some children have afraid about specific procedures such as anesthesia or high-speed pen noise (Taani et al., 2005) [2], other children report anxiety associated to the techniques employed and to the dental environment (Ashkenazi et al., 2002) [3]. So, children that have positive interactions with the dentist will be less likely

to develop fear and anxiety (Munevveroglu et al., 2014) [4].

The Personal Protective Equipment (PPE) should be used in dental clinics and there is an association between patients 'preference for medical professionals' clothing, indicates calling that clothing plays an important role in establishing trust, security, and also empathy the doctor-patient relationship (Chung et al., 2012) [5]. White has always been the traditional color of use In the health area and settled as most recognizable symbol of the profession (Blumhagen, 1979) [6]. Doctors started using white coats at the end of the 19th century, with the goal of protect patient and medical cross contamination because the dirt were Easy visualization. Then, the coat white became a symbol of the authority of the art of healing (Wong et al., 1991) [7].

Currently, health professionals are seeking new colors and designs in the models of coat, hats, and masks, introducing prints and colors In the garment, believing that the white color can promote anxiety and child fear, due to "white syndrome". This Way, the marketing released commercially new designs and colors of clothing that are widely disclosed in social networks and media over the Internet. The current generation of dentists has believed that they are more attractive to children and professional many are Adopting this differential of the garment.

Due to the importance of the theme and the need to seek scientific evidence, this study aims to verify the preference and perception of schoolchildren regarding the new styles and colors of dental attire.

## II. MATERIALS AND METHODS

This is a cross-sectional descriptive study, Quality Quantitative Carried out in the city of Gurupi, located in northeast region of Brazil. Gurupi is located in the watershed between the rivers Araguaia and Tocantins, latitude 11 ° 43 ' 45 "south and a longitude 49 ° 04 ' 07" West, at an altitude of 287 meters. Region of Bananal

Island, Legal Amazon, in the south of the State of Tocantins, Brazil. The municipality has an area of 28,445 square miles with a population of 76,755 People, data from the Brazilian Institute of Geography and Statistics. The research was approved by the Research Ethics Committee Of the University of Gurupi, with the CAEE: 54769716.7.0000.5518.

Were included 748 Children aged 7 to 12 years, of both sexes. The representative sample of the target population was randomly selected. Two public and two private schools were Randomly selected, as the municipality contained 31 public (7,244 students) and 4 individuals (670 students). Within the selected age group, the parents of 529 children

from public schools and 229 were randomly assigned to these schools. of private individuals.

The two examiners were previously calibrated to minimize variations between the different examiners (Kappa= 0,84). Data collection occurred in the school, through an individual interview.

The interview child addressed questions about dental history in relation to experience, fear and pain of the child. Shortly after, it was performed An exploratory, qualitative study, With The use of 3 car screens with photographs (Figure 1). Os cart Aces Had Images Plastics end with a size of 13 cm x 25 cm, Individualized: The (Medical Coats)B (Medical Caps) and C (Medical Masks).



Fig.1: Instruments presented for children in the form of Three Posters with pictures of garments. Cartaz A: Medical Coats; Cartaz B: Medical Caps; Cartaz C: Medical Masks.

The poster A (Medical Coats) has five pictures of coat: traditional white (1), Blue (2), white with colorful details (3), color print (4) and Green (5). The poster B (Medical Caps) has five types of bonnet: White (1), Tie Blue (2), colored print (3), disposable green (4), disposable white (5). The Poster C (Medical Masks) With five types of masks: white with smiling mouth design (1), disposable white (2), Green (3), colored print (4) and orange with animal's mouth (5). The figures of the coat, beanies and masks were Selected By the authors because they are being widely marketed and used by professionals in school clinics Dentistry (academics and teachers), public and

private offices (professionals).

In the test with images, a child pointed the finger to the coat figure she "preferred" that the dentist used in his dental care and reported the whyê of your preference. After was escorhid the coat she "no I'd rather that the dentist wore and also replied why of this response. Thus, it was repeated with the other two cards (B and C) respectively.

Data analysis was performed using the SPSS Statistical program (version 18). The clinical data and the information obtained through the questionnaires were described and the variables submitted to the test thurs-Square (P < 0.05).

III. RESULTS AND DISCUSSION

Tabela 1: Presentation in profile number and percentage Socio-demographic and children's dental history of public and private colleges (2017).

	Public		Private		Total	P-Value
Age	8.17 ± 1.49		8,07 ± 1.65			
	n	%	n	%		
Number of participants	519	100	229	100	748	0.261
Female	267	51	128	56	395	
Male	252	49	101	44	353	
<b>Children's History</b>						
With Dental Experience	341	65.7	189	82.5	530	< 0.0001 *
With Toothache Experience	302	58.1	101	44.1	403	0.0003 *
You're Afraid of a dentist	204	39.3	66	28.8	270	0.005 *
P-Value						0.0002*

\* Shi-square test with a significance level of  $P < 0.05$ .

Table 1 showed in number and percentage the profile Socio-demographic and dental history reported in the interview by the children. Regarding the age of children and gender, there was no significant difference between the students. The fear of the two groups in relation to the dentist was below 40%, and more Of Half of the public school children reported having felt toothache. Most

private school children had dental experience. The test thurs-Squared applied to the data of the child history, showed significant evidence at the level of 5% of there being an association between experiences, Pain, and fear reported by the schoolchildren With The fact that they belong to public or private schools ( $\chi^2 = 16.8; P = 0.0002$ ).

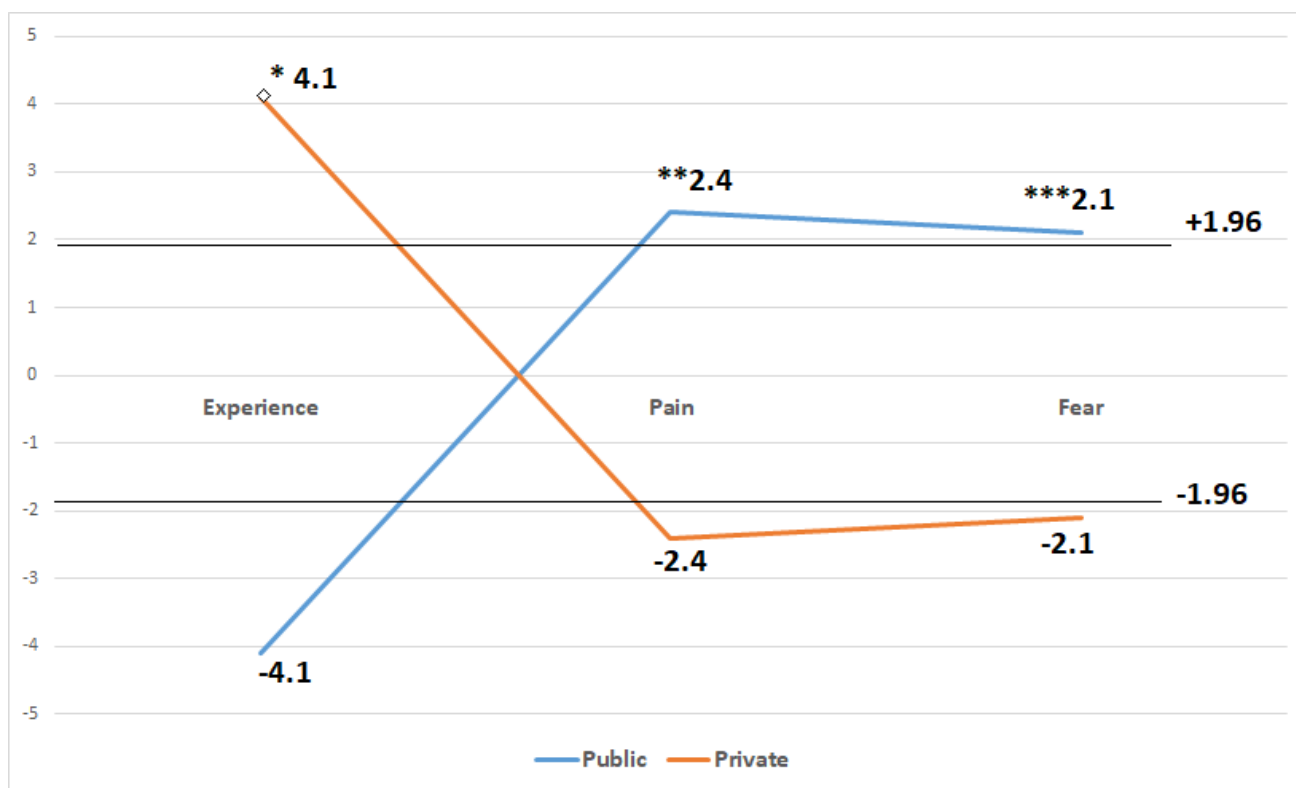


Fig.2: Adjusted residue Values (Raj) were calculated from the dental history data of children from public and private schools (Table 1). In the analysis of residues, the statistical criterion at the level of significance of 5%, which are positioned between the values -1.96 and + 1.96 were not considered statistically significant and thus express frequency values that would be expected Normally attributed to chance.

In this way, children from private schools had more experiences of nature dental (\*Raj = + 4.1), students from the public network had higher experience of pain tooth and fear (\* \*Raj = + 2.4; \*\*\*Raj= + 2.1). The differences in these behavioral aspects of children from public or private

schools seem to be associated with some discrepancies that have been observed in the preferences garment of dentists. Table 2 shows the general result regarding the "preference" and "no preference" to the dentist's clothing by the schoolchildren.

**Table.2:** Shows the general result regarding the "preference" and "no preference" to the dentist's clothing by the school children.

	1		2		3		4		5		P-Value
Preference											
School	n	%	n	%	n	%	n	%	n	%	
<b>Coat</b>											
Private	105	46	25	11	35	15	33	14	31	14	0.74
Public	259	50	52	10	63	12	78	15	67	13	
<b>Hat</b>											
Private	25	11	18	8	79	34	8	3	99	56	0.004*
Public	109	21	52	10	131	25	20	4	207	40	
<b>Mask</b>											
Private	97	42	62	27	29	12	32	15	9	4	< 0.001 *
Public	109	21	198	38	88	17	114	22	10	2	
NO PREFERENCE											
<b>Coat</b>											
Private	5	2	51	22	26	11	112	49	35	16	0.32
Public	6	1	120	23	46	9	285	55	62	12	
<b>Hat</b>											
Private	18	8	57	25	52	22	41	18	61	27	< 0.003*
Public	37	7	187	36	98	19	109	21	88	17	
<b>Mask</b>											
Private	11	5	11	5	25	11	22	9	160	70	0.08
Public	35	6	6	1	25	4	30	5	423	84	

\* Shi-square test with a significance level of  $P < 0.05$ .

In the demonstration of five images of the coats used by the professionals, the descriptive results showed that the children from public and private schools preferred the traditional white coat (n° 1) and the most rejected was printed/colored coat (n° 4). As for the choice of the bonnet, the children of the private school preferred the colored printed beanie (n ° 3) and the public school was the disposable white (n° 5). The most rejected hat by the public and private school children was number 2 (blue cap, straight tie). The preference of the mask in private school was white with smiling mouth design (n° 1) But the children of the public school were white disposable (n° 2). The Rejected Mask Unanimously By the children of private and public schools was with animal/colored mouth (n° 5).

The test thurs-Squared applied to the frequencies of "Preference" And "No preference" Children from private schools, showed a significant correlation at the level of 5%, respectively, for a lab coat, Hat and mask ( $p < 0.0001$ ), as well as in public schools ( $p < 0.0001$ ). However, when

comparing the results of the "Preference" between private and public schools, nIt was found that there was no significant difference In relation to the Jaleco ( $p = 0.74$ ), the schoolchildren preferred the traditional white coat (No. 1). In the bonnet and mask, the groups among schoolchildren presented a statistical difference for preference ( $p$

$> 0.05$ ). Regarding the "non-preference" of schoolchildren in the public and private schools, they did not present statistically significant data in relation to the coat ( $p = 0,32$ ) and the Mask ( $p = 0.08$ ). Just The most rejected coat was printed/colored (No.4) and the Mask rejected by the vast majority of school children Was number 5 (Animal/colored mouth)

The justifications of the children before the options were categorized with keywords. The two most cited words in interview by both sexes were presented in table 3.



Table.3: Presentation Of the two words in order of highest citation in the interview by Children Female and male Public and private schools (2017).

	Preference	Rejected
Coat	Right And "Cute"	"Not a dentist" and Ugly
Hat	"From the dentist" and "Cute"	"Ugly" and "colorful"
Mask	Normal And Beautiful	"Ugly" and "fear"

#### IV. DISCUSSION

The appearance of the dentist assists in the professional patient interrelation, according to psychologists, because of the use of friendly colors for children, such as yellow and blue in the dental clinic assists in the collaboration (Umamaheshwari et al., 2013) [8]. Currently, the Evolution of fashion produced a Less formal aspect to the appearance of health professionals (Nirmala et al., 2015) [9].

In Brazil, children of higher socioeconomic status usually attend private schools, while those with lower socioeconomic status attend public schools (Martins et al., 2015) [10]. Children with families with higher incomes usually take children from an early age to the dentist, where in many cases they have fewer oral diseases and CoThey suffer less pain (Ciocca et al., 2015) [11].

. Most of the children in this study did not report being afraid to go to the dentist, perhaps by maturity or by establishing a relationship of familiarity with the professional, but the residual analysis of the statistical test Thurs-Square, Applied to the frequency data of the child history, showed evidence that the behavioral profile presented by the children depends on the type of school, whether public or private.

The younger the Children, The more they preferred the colored lab coats (Münevveroglu, 2014) [4]. Studies conducted with children aged 7 to 12 years have shown that in this age group they are able to more easily control fear, different from smaller children who are terrified of the unknown (Ellore, the et al., 2015) [12]. Even with a different dental history profile, the interviewed schoolchildren selected the white color of the professional garment, demonstrating that this color is not rejected by this age group from 7 to 12 years. The casual clothes were preferred in studies where it was found that the children were anxious (Asokan et al., 2016) [13], with experiences of several passages in hospitals due to impaired health (Münevveroglu et al., 2014) [4], When the child does not would Regular visits to dental clinics and With a history of Toothache (Mistry, Tahmassebi, 2009) [14]. Agreeing with the study of Zeren et al. [15], which measured the

Preferenci of lab coats in 500 children (5 to 11 years) And their parents, where the Most Them preferred that the Odontopediatricians wore white lab coats but Children with systemic disease, dental trauma due to previous negative experience, preferably am Informal clothing (common clothes), and concluded that the previous experience and systemic health have a strong effect on the preferences of children related to the dentist's attire.

Color has a compensator effect for the biological balance, And that people establish associations with the colors, which can Auxiliary in the Establishment of balance and contribute to the harmony of the body, mind, and emotions (Read, 2003) [16]. The 400 adults interviewed, with a mean age of 52.4, preferred that physicians wore white coats because they reported that it would be the form Professional Of Dress Up, offering greater confidence and credibility to the patient (Tibdewal et al., 2010; Chung et al., 2012) [5, 17]. More patients than dentists, and especially The adults, Believe that the dentist should wear white garments as differential for easy identification (Kelly et al., 2014) [18].

A literature review (Kazory, Indme 2008) [19], there was a decline in the popularity of the white coat among physicians. However, many patients and Professionals Still prefer conservative and less casual appearance for physicians. It is not surprising that this preference is related to age for both Patients and physicians. Many Avgkos believe they don't wear a lab coat White Increases the Risk of infection, But There is no evidence whether the white coat helps prevent the spread of infection. However Currently The white coat came to be seen as a barrier By Changes in society and health services, That transformed physicians into "health professionals" and patients into "consumers or customers" (Babadji et al., 2017) [20].

The choice of Dental attire is mandatory for professionals, as in addition to protecting it, it prevents infections secondary to patients. In View of the data demonstrated, In this study, The type of coat, cap and mask not Seems Influencer On the issue of Fear of children, since most children chose the traditional dress with white color.

The white syndrome refers to people who have a phobia of third-party clothing with predominantly white color. In Psychol- ogy, this fact is reported by people with great history of painful medical experience (McCarthy et al., 1999) [21].

Is the responsibility of the professional to choose the color of the dress that will meet children, choosing colors or not. However, the regulatory Standards the National Health Surveillance Agency (Anvisa, 2011) [22] They argue that the garment should be prepared in clear tissues because thus, the dirt that will reach the odontologist during the procedures can be visualized With ease. Printed or colored

fabrics make this visualization difficult.

The data found in this research show that the dentist's attire does not cause fear in children. At this age, it seems that the children know that this is the coat of health area and accept the traditional as standard, since they responded, in their vast majority, who preferred to be "the right", "normal" or "dentist". The approach of the child with smile in the physiognomy of the professional and the decorated environment were significant in the study by James J. McCarthy (1999) [21], in which he evaluated the visual perception and Children's Eager And Your Parents about doctors. It was noted that this public did not present Fear by white lab coats.

The two groups rejected the orange mask "With Animal mouth" for being considered frightening by the children, because they reported "fear", and were not attractive to the groups School. That you can observe is that the market launches Masks with strong colors, drawings of animal mouths, without verifying their acceptance by the children. As for the choice of the bonnet, it was believed that the option Three Would be more attractive to children by being colorful, but the result has chosen the traditional disposable white.

It seems that children at the age of 7 to 12 years old already have discernment regarding the Care of Biosafety, because most of them reported being "from the dentist". Age can influence this selection of colors because the tradition of the use of white color by health professionals can already be incorporated in the concept "health" of these children. The Variation of these results reflects the different opinions of patients in different countries and time periods. It is up to professionals to understand the child, not only in the technical attribution of academic training but also to perceive the psychological aspects that can help in attendance with collaboration, favoring the patient-professional relationship. New studies on the perception of the attire of younger children are suggested, which may reveal different results, due to the reason for perception and maturity.

It should be considered that the study was submitted to some limitations. When interpreting the results, it is important to note that only the cognitive component of the experience of fear and Pain tooth were questioned to school children. The children could be evaluated by other types of tests, to understand whether they would have anxiety for dental care, however, these schools did not have dental offices that allowed other more consistent tests.

Despite being emerging in the market several types of models and colors of coat, beanies, and masks on the market, it is essential to check whether this new trend has an effect on the perception of children, and that these new

proposals do not lose the true objective of the attire as personal Health Protection Equipment, which is biosafety.

## V. CONCLUSION

A Preference of the attire coat, hat and mask of dental school was by the white color, demonstrating the selection by the traditional, considering that would be "right", "from the dentist" and "normal" in his visions.

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