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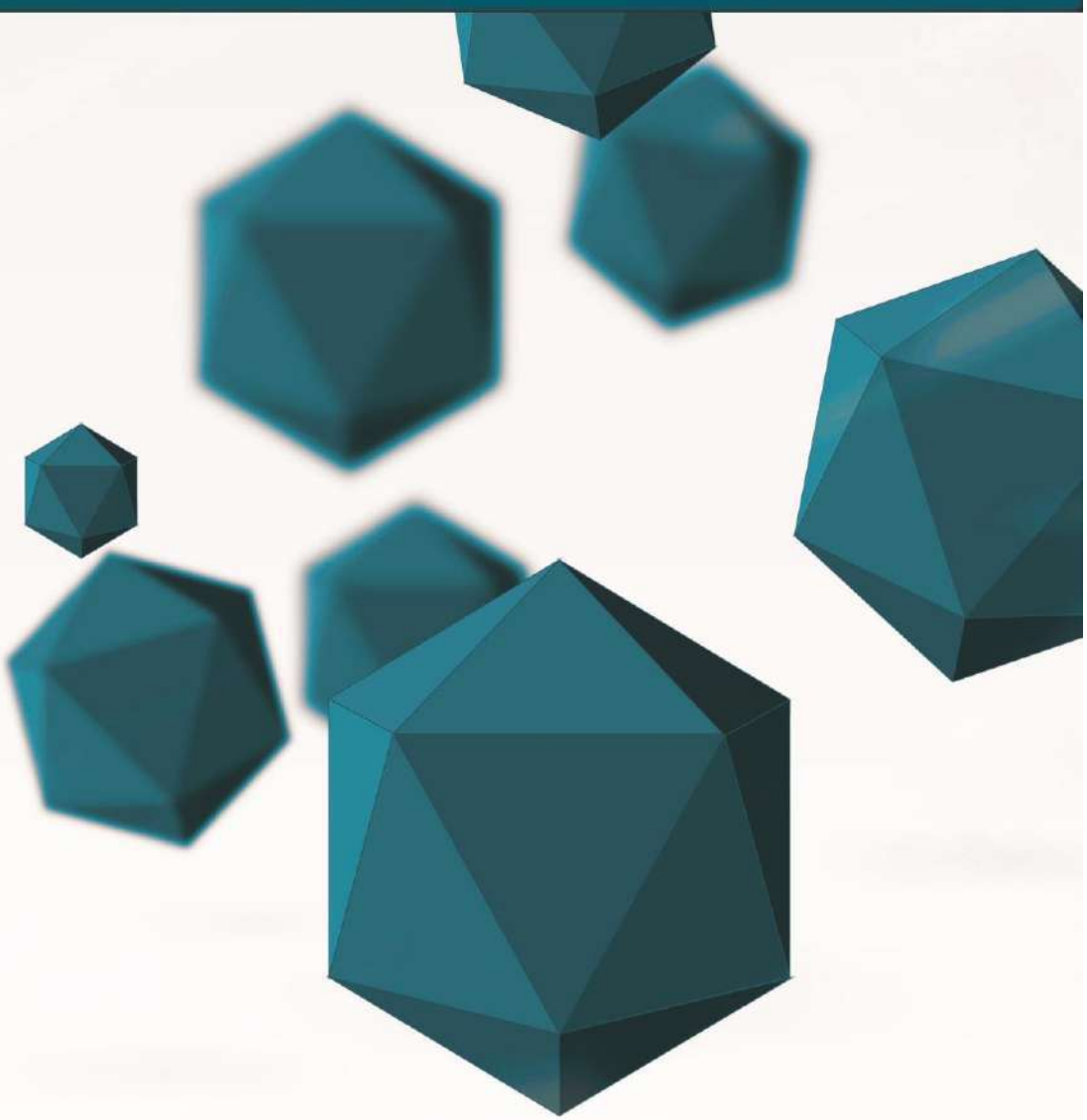

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# FOREWORD

I am pleased to put into the hands of readers Volume-6; Issue-12: 2019 (Dec, 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
January, 2020

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# Energy efficiency in the context of Industry 4.0

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***Abstract*— *The aim of this paper is to identify, through a bibliometric analysis, how and which technologies, in the context of industry 4.0, are explicitly capable of promoting energy efficiency. The research was conducted on the Web of Science platform, using an algorithm with keywords of interest to the theme. As a result, a total of 67 articles were reached. Studies have been identified involving energy efficiency in the fields of industrial internet of things, wireless sensor networks, energy harvesting, cloud manufacturing, big data, artificial intelligence, additive manufacturing, and interdisciplinary research.***

***Keywords*— *Advanced manufacturing, Cloud manufacturing, Energy, Smart factory*.**

## I. INTRODUCTION

In the last decades, the industrial scenario has noticed significant changes where, as new concepts and technologies develop, a trend in the manufacturing transformation can be noticed.

For Wang et al. (2016), technologies such as cloud computing, industrial internet of things, wireless sensor networks and processing large amounts of data have been causing profound changes in industrial processes.

Still, according to the authors, manufacturing processes, which were once manual, today have robust embedded control systems and this is a trend that indicates a new behavior of manufacturing industries, characterized by the implementation of smart manufacturing technologies that understand the context of the 4th industrial revolution, called Industry 4.0.

Liao et al. (2017) describe, through a comprehensive bibliographic review, and in a well-structured manner, the main technologically disruptive events that characterize the four industrial revolutions. Directly, the authors cite that the first three revolutions extended for approximately two centuries, whose main manufacturing impacts were, in order, the introduction of water and steam-based equipment, introduction of electricity-based production technologies, use of electronics and information technology (IT) to support the automation of industrial processes.

Plausible, therefore, to interpret that the set of processes that characterize the fourth industrial revolution comprises a natural way, where the automation of the manufacture becomes more efficient, as it has technologically strategic apparatuses, in the sense to digitize the manufacturing processes and connect faster, and more fully, to human management. Although Liao et al. (2017) demonstrate that the proposal to make intelligent, digital, and interconnected manufacturing systems attractive, it is necessary to look in detail at how the major categories of enabling technologies work and how they are able to make it real.

Parallel to this, Dornfeld (2014) discusses that as energy demand increases significantly, there is a tendency in the industrial context to employ efforts, making manufacturing processes more sustainable. The author also mentions that the sustainability factor is no longer utopia, and is becoming, besides the environmental magnitude, a factor of commercial strategy, through the economy of resources, operational guarantee, product quality and global competitiveness.

Considering the above, and the effects of Industry 4.0 in the context of energy efficiency, the use of the proposed bibliometric analysis is justified here. Despite being widely studied and disseminated in both the academic and casual environments, it remains, to some extent, what are the most relevant impacts of smart manufacturing in terms of energy efficiency. Additionally, it is necessary to highlight which types of enabling technologies from Industry 4.0 influence externally (causing energy efficiency through the provision of improved controls and assertive data for manufacturing management) and internally (causing energy efficiency through the intelligent use of power supply or the efficient use of sensors, transmitting or receiving devices and other equipment).

Therefore, the present work aims to develop the correlation of scientific publications that address energy efficiency in the context of Industry 4.0, by searching for articles in the Web of Science database.

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In order, to establish the concepts discussed here, we sought literature that provides the appropriate theoretical basis. IEL (2017) states that enabling technologies for Industry 4.0 can be classified into large clusters, which, due to suitability for this research, cite the internet of things; sensors and actuators; cloud computing; big data analysis; artificial intelligence and additive manufacturing. It should be noted that, in addition to these, other complementary technologies can help, in parallel, the feasibility of digitization of manufacturing, in its various facets.

Gubbi et al. (2013), Stankovic (2014) and Wan et al. (2016), address an important strategic communication link between man and machine, in the context of industry 4.0, the internet of things. The aforementioned research, as well as several works in the academy, propose that the term characterizes the connection among equipments, especially the machines, to the internet, through sensor instruments, responsible for collecting parameters of the chosen process and sending them to further treatment and use.

Wireless sensors, electronic equipment capable of collecting data of interest, send the information to cloud servers to be processed and made available to the end user, who can, among other resources, use them as an automatic response control, increment predictive maintenance analytics, or for more assertive decision making. Lin et al. (2016) mention that in conventional factories, it is common to apply wired monitoring systems (such as fieldbus or HART systems), however, they have high costs and do not represent an optimal solution in terms of flexibility in the layout of production lines. Thus, the authors propose the use of wireless sensor networks (WSN) as the most practical and inexpensive way to feed data into an industrial process management system.

Another relevant aspect in the treatment of sensors and automatic actuators concerns their power supply. Since electronic devices require electrical power to operate, cable powering, as well as being a costly and inflexible solution, is not capable of reusing resources that manufacturing processes can offer from power dissipation. In this reasoning, research such as that performed by Newell, Twohig and Duffy (2018) and Sherazi et al. (2018) demonstrate that energy harvesting devices, that is, dissipated energy reuse, have the flexibility to be installed in a wide variety of locations, which could not, due to the need for power via cables, moreover, have a strong call for energy efficiency.

Also, according to Sherazi et al. (2018), the main energy sources capable of feeding sensors through the capture in industrial environment are: photovoltaic energy, from artificial lighting of environments; thermal energy, from heat exchange in equipment; radio frequency energy, from radio signals inside the plant and mechanical energy, from vibration of machines. Additionally, Rubes, Brablc and Hadas (2019) state that the energy collection from vibration is based on mechanical vibration kinetics, which can be converted into electrical energy through a piezoelectric transducer.

Xu (2012) brings another important definition about technology that can digitize manufacturing, making it a more manageable and adaptable process to change: cloud manufacturing. In other words, and based on the National Institute of Standard and Technology - NIST definition for cloud computing, the author discusses that the concept of cloud manufacturing can be interpreted as a natural extension of the concept of cloud computing.

Cloud computing is a model for allowing ubiquitous, convenient, and on-demand network access to a shared set of configurable computing resources (i.e. networks, servers, storage, applications, and services) that can be quickly provisioned and released with minimal management effort or interaction with service providers (NIST, 2011).

Xu (2012) also points out that the typical benefits of adopting cloud manufacturing can be realized in both the technical and economic spheres, as the costs of acquiring and maintaining IT infrastructure can be reduced substantially.

In parallel with cloud manufacturing, data collected on the shop floor needs to be processed into strategic information. This treatment, also known as big data analytics, in terms of manufacturing, is approached by Wang, Wan and Zhang (2016), who broadly describe it through a feedback loop, starting with entering a volume of disarmed information once collected by the wireless sensor network, cloud analysis from specific servers and return information for process control.

Another type of technology that can make manufacturing processes more cognitive is artificial intelligence which, in other words, comprises algorithms and computer systems capable of autonomously making control decisions based on data collected in the most diverse situations. Monostori (2002) approaches the theme through the idea that software acquires cognitive abilities through the acquisition, manipulation and association of data, similar, in limited characteristics, to the natural process of the human mind.

Regarding additive manufacturing, which consists of machinery capable of producing other components by depositing layered material, similar to the term “3D printing”, Yoon et al. (2014) mention that the term “three-

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dimensional printing" was originally used at the Massachusetts Institute of Technology (MIT), published as part of a patent, the contents of which describe manufacturing processes from an inkjet head system, which, was quickly called by the public as 3D printing.

## II. MATERIALS AND METHODS

In order to identify relationships between energy efficiency and Industry 4.0, more broadly, we sought to use tags (keywords) that strategically characterize both contexts. In this sense, "energy", "industry 4.0", "smart manufacturing" and "advanced manufacturing" were selected. The database used was the Web of Science - WoS, due to the diversity of contents in the technical areas, robustness in the research and availability of data analysis tools.

The search algorithm used was: "energy" AND ("industry 4.0" OR "smart manufacturing" OR "advanced manufacturing"). In addition, the search timeframe selection field has been enabled for selection of documents in the entire database from its inception to the day the search was performed (1945 to 2019).

Aiming at a better understanding of the methodological step by step used in this study, a flowchart is presented in Figure 1.

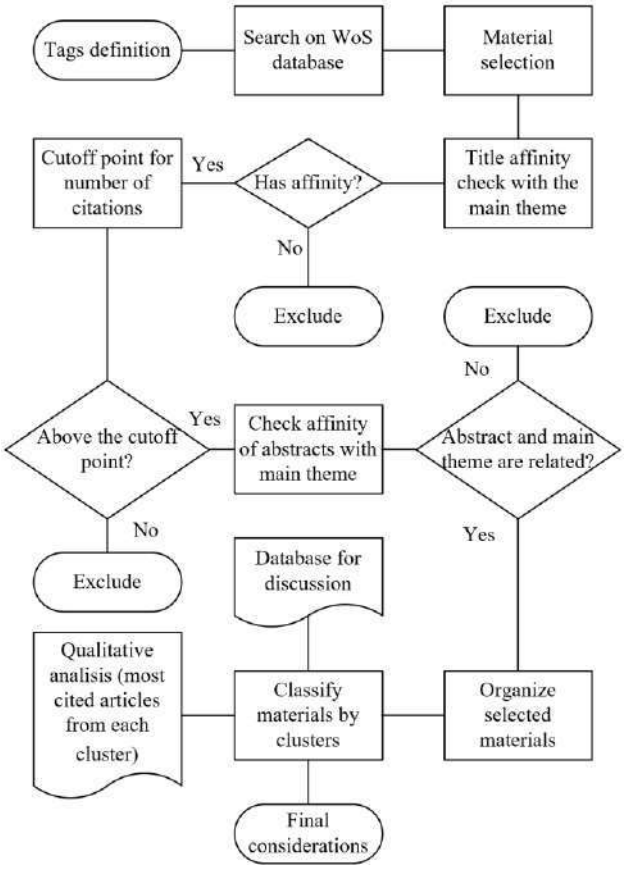


*Fig. 1: Selection and analysis flowchart.*
*Source: Prepared by the authors.*

## III. RESULTS AND DISCUSSION

From the use of the defined algorithm and initial search conditions, 493 results were obtained. Still at this stage, without the specific refinements, the authors consider it relevant to highlight some behaviors regarding publications. The first of these refers to the ten most active countries in publications of the genre (the research object of this paper is understood). As can be interpreted in figure 2, a considerable number of countries with strong performance in science and technology, including innovation, especially in the northern hemisphere, can be seen.

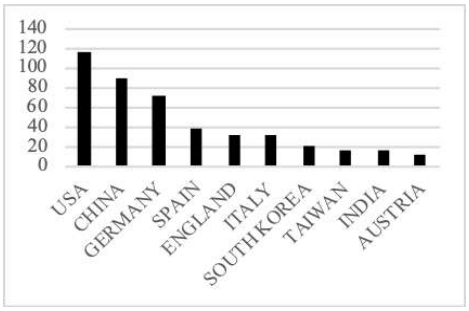


*Fig. 2: Publications by country.*
*Source: Adapted from Web of Science.*

From this stage, other refining tools were used, so that the results were restricted in publications in the last 10 years (2009 to 2019) and article type documents. As a result, the tool returned 239 items. Then, the results were sent to a list of marked documents, where, from the affinity analysis of the article titles with the proposal of this work, the first detailed screening was performed. As the screening identified that some articles had no proposals of interest, the number of results decreased to the point of establishing a list of 101 articles with titles that would be candidates for bibliometric analysis.

After this first screening, a more accurate identification and selection of documents from the abstracts was performed. The criterion for persistence in the selection was to analyze whether the abstract makes technology explicit, according to IEL (2017), that causes any impact in terms of industrial energy efficiency. In this screening 67 results were obtained.

At this point other considerations still fit. The first refers again to the ten largest countries active in energy efficiency research in the context of Industry 4.0. Comparing the graphs in figures 2 and 3, it can see a plausible behavior, so that the countries most active in research involving energy or advanced manufacturing are, in their majority, those with the highest representation in research involving energy efficiency in the same context.

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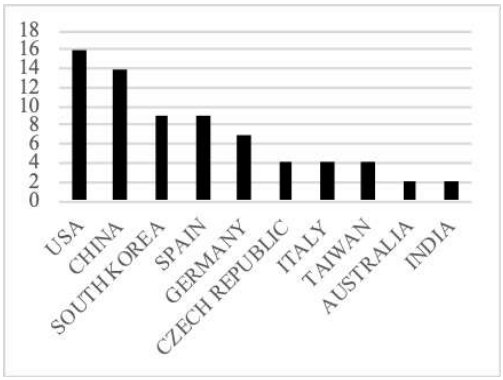


*Fig. 3: Publications by country (after abstract trial).*
*Source: Adapted from Web of Science.*

The second consideration refers to the amount of academic papers with similar proposals being published over the years. According to figure 4, an upward line is seen, which demonstrates the emergence of the theme and the commitment to use resources more efficiently, in contrast to the introduction of this work.

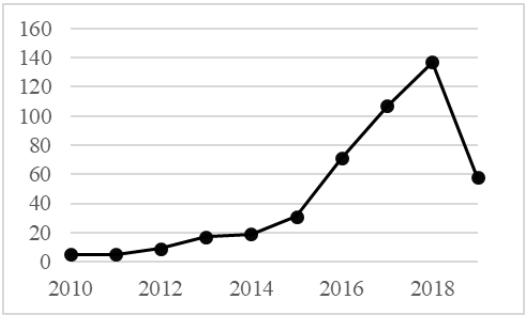


*Fig. 4: Publications by year (after abstract trial).*
*Source: Adapted from Web of Science.*

The third consideration refers to the number of publications per knowledge area, according to the Web of Science - WoS database classification criteria. Figure 5 indicates the areas with the most studies, with particular emphasis on engineering, computer science, telecommunications, and systems control automation. This data is relevant because it is consistent with the reality, where the degree of innovation and implementation of Industry 4.0 technologies is highly dependent on research and advances in the above fields.

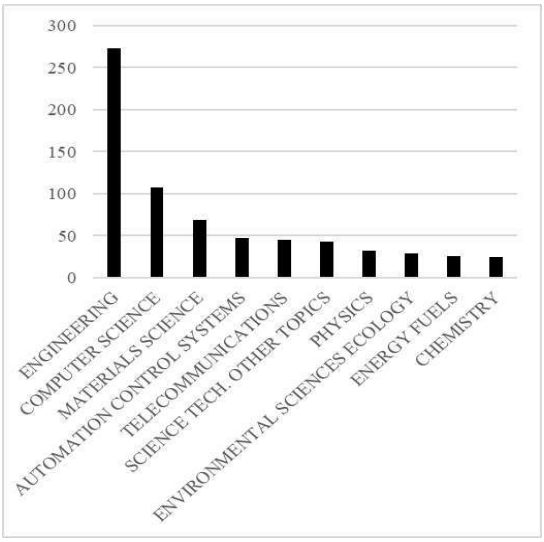


*Fig. 5: Publications by knowledge areas (after abstract trial).*
*Source: Adapted from Web of Science.*

By identifying which and how technologies within the context of Industry 4.0 may impact on industrial energy efficiency, the next step was to categorize the results into clusters, that is, into the major enabling groups of industry 4.0 technologies.

At first, it is possible to highlight, globally, some observations from the categorization of screened articles. Figure 6 shows the number of papers identified by the authors in each cluster. The criterion adopted for classification was the analysis of the proposed methodology applied in each work. Articles with methodology involving specific and well-defined technology were classified into one of the following clusters: industrial internet of things (IIoT); wireless sensor networks (WSNs); energy harvesting (EH); cloud manufacturing (CM); big data (BD); programming optimization and artificial intelligence (AI); and additive manufacturing (AM). Those that could not be classified in a specific cluster were counted as miscellaneous.

The figure presents the composition of the identified documents, from the categorization through clusters, highlighting techniques of programming optimization and artificial intelligence.

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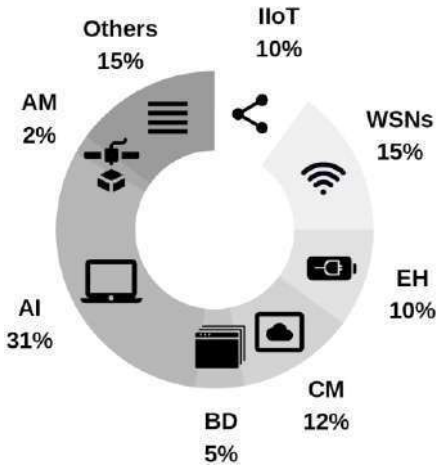


*Fig. 6: Filtered publications, categorized by clusters.*
*Source: Prepared by the author.*

Then, will be presented and categorized the articles selected at the end of the screening for abstracts. With this classification, which will follow the order of the technology groups presented in figure 6 and, through a discussion focused on the most cited articles in each of the following tables (based on the points of interest of this research), the authors seek to be able to conclude from how studies, in their respective clusters, tend to converge towards promoting energy efficiency in industrial processes.

Table 1 presents the categorized articles, according to the authors' judgment, in the internet of things cluster. Sisinni et al. (2018) explain that, in most cases, a low throughput is required by transmitting nodes in IIoT applications, demonstrating that companies, when choosing this type of implementation, are concerned with the possibility of providing informational synergy among its assets, both through internet connection and energy and hardware resources, all at a low cost.

The study makes it clear that it is characteristic of hardware for this type of technology to work for years on batteries, which implies the development of increasingly bold designs to improve them, shrinking them and making them more powerful and efficient.

In parallel, the concept of energy reuse is approached, where the power to supply these batteries can be collected through sources from the environment or processes, such as vibrations, radio frequency, thermal and solar.

Finally, in support of achieving energy efficiency, new data transmission technologies are being studied, such as the Low-Power Wide-Area Network (LPWAN), which enables long-distance data communication with power transmission significantly reduced.

*Table 1 - Internet of things publications*

| Title | Journal | Year |
|---|---|---|
| Industrial Internet of Things: Challenges, Opportunities, and Directions | IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS | 2018 |
| I3Mote: An Open Development Platform for the Intelligent Industrial Internet | SENSORS | 2017 |
| Metamodel for integration of Internet of Things, Social Networks, the Cloud and Industry 4.0 | JOURNAL OF AMBIENT INTELLIGENCE AND HUMANIZED COMPUTING | 2018 |
| Light-Weight Stackelberg Game Theoretic Demand Response Scheme for Massive Smart Manufacturing Systems | IEEE ACCESS | 2018 |
| The Energy Industry in the Czech Republic: On the Way to the Internet of Things | ECONOMIES | 2018 |
| IoT Heterogeneous Mesh Network Deployment for Human-in-the-Loop Challenges Towards a Social and Sustainable Industry 4.0 | IEEE ACCESS | 2018 |
| Novel Internet of Things Platform for In-Building Power Quality Submetering | APPLIED SCIENCES-BASEL | 2018 |

*Source: Prepared by the author.*

Table 2 presents the articles categorized, according to the authors' judgment, in the cluster of wireless sensor networks.

Lin et al. (2016) discuss the concept of wireless sensor networks, composed of components called sensor nodes, which capture the parameters of interest in a particular asset and send them to receiving hardware, which, in turn,

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will process the data and, based on the control criteria, the system will provide commands for production.

Based on this technology, the study takes an approach that proposes, and simulates, a kind of strategy that uses metaheuristic optimization tool (genetic algorithm) which learns and develops a schedule of operation and hibernation of network devices. According to the authors, only active sensor nodes will consume power, while those in hibernation mode, will not. The study reveals a tool capable of contributing to the increase of energy efficiency in industrial operations.

*Table 2 - Wireless sensor network publications*

| Title | Journal | Year |
|---|---|---|
| Key Design of Driving Industry 4.0: Joint Energy-Efficient Deployment and Scheduling in Group-Based Industrial Wireless Sensor Networks | IEEE COMMUNICATIONS MAGAZINE | 2016 |
| From Sensor Networks to Internet of Things. Bluetooth Low Energy, a Standard for This Evolution | SENSORS | 2017 |
| A Methodology for Reliability of WSN Based on Software Defined Network in Adaptive Industrial Environment | IEEE-CAA JOURNAL OF AUTOMATICA SINICA | 2018 |
| Energy efficient and QoS-aware routing protocol for wireless sensor network-based smart grid applications in the context of industry 4.0 | APPLIED SOFT COMPUTING | 2018 |
| MQRP: Mobile sinks-based QoS-aware data gathering protocol for wireless sensor networks-based smart grid applications in the context of industry 4.0-based on internet of things | FUTURE GENERATION COMPUTER SYSTEMS-THE INTERNATIONAL JOURNAL OF ESCIENCE | 2018 |
| Deploy&Forget wireless sensor networks for itinerant applications | COMPUTER STANDARDS & INTERFACES | 2018 |
| Autonomous micro-platform for multisensors with an advanced power management unit (PMU) | JOURNAL OF SENSORS AND SENSOR SYSTEMS | 2018 |
| Wireless sensor network routing method based on improved ant colony algorithm | JOURNAL OF AMBIENT INTELLIGENCE AND HUMANIZED COMPUTING | 2019 |
| Data cleansing for energy-saving: a case of Cyber-Physical Machine Tools health monitoring system | INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH | 2018 |
| An Experimental System for MQTT/CoAP-based IoT Applications in IPv6 over Bluetooth Low Energy | JOURNAL OF UNIVERSAL COMPUTER SCIENCE | 2018 |

*Source: Prepared by the author.*

Table 3 presents the categorized articles, according to the authors' judgment, in the energy reuse cluster. Following the idea of reusing energy from industrial processes that would eventually be wasted, Sherazi et al. (2019) state that while the more traditional Low-Power

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Wide-Area Network (LPWAN) architecture devices provide excellent energy efficiency, they are still powered by the battery, which means frequent maintenance and therefore more time spent and budget costs.

Based on studies that show that the life of a battery is strongly influenced by the amount of cycles (charges and discharges) it undergoes, a modified LoRaWAN (Long Rang Wide Area Network) architecture was proposed, the results of which were optimization of sensing intervals (and related costs), derived from scenarios with energy harvesting and without energy harvesting.

Three sources of energy were considered for energy reuse: photoelectric (from internal artificial light), thermoelectric (from heat dispersion of equipment with this characteristic) and radio frequency (from radio signals within the plant).

It was noticed that the applied methodology was able to adjust the transmission intervals optimally, putting the monitoring devices at rest after each actuation interval, prolonging the operation and reducing costs (long term).

Moreover, the scenario where the sensing devices are powered via energy harvesting demonstrates the significant increase in battery life due to the excess amount of energy supplied and the progressive increase in the sensing interval. Comparing the scenarios with and without energy harvesting, there is a strong reduction in costs (substitutions and labor time) for the first scenario.

*Table 3 – Energy harvesting publications*

| TITLE | JOURNAL | YEAR |
|---|---|---|
| Energy Harvesting in LoRaWAN: A Cost Analysis for the Industry 4.0 | IEEE COMMUNICATIONS LETTERS | 2018 |
| Effect of energy management circuitry on optimum energy harvesting source configuration for small form-factor autonomous sensing applications | JOURNAL OF INDUSTRIAL INFORMATION INTEGRATION | 2018 |
| Nonlinear vibration energy harvester: Design and oscillating stability analyses | MECHANICAL SYSTEMS AND SIGNAL PROCESSING | 2019 |
| A fully encapsulated piezoelectric-triboelectric hybrid nanogenerator for energy harvesting from biomechanical and environmental sources | EXPRESS POLYMER LETTERS | 2019 |
| A 500 Hz-wide kinetic energy harvester: Outperforming macroscopic electrodynamic arrays with piezoelectric arrays | MECHANICAL SYSTEMS AND SIGNAL PROCESSING | 2019 |
| Turning the Signal Interference Into Benefits: Towards Indoor Self-Powered Visible Light Communication for IoT Devices in Industrial Radio-Hostile Environments | IEEE ACCESS | 2019 |
| Triboelectric effect based instantaneous self-powered wireless sensing with self-determined identity | NANO ENERGY | 2018 |

*Source: Prepared by the author.*

Table 4 presents the categorized articles, according to the authors' judgment, in the cloud manufacturing cluster. Cheng et al. (2013) emphasize on-demand sharing and allocation of manufacturing resources by introducing the concept of cloud manufacturing, with the goal of minimizing costs and energy consumption.

The study proposes a strategy for scheduling cloud manufacturing services and resources. In this scheduling process, three criteria of importance are considered: energy

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consumption, cost and risk, for three different interested classes: supplier, consumer and operator.

According to the authors, the supplier (person, organization, company or third party) has the necessary resources for the life cycle of a manufacturing process. It registers idle resources on the cloud platform and delivers them to the consumer. The consumer is considered to be the subscriber of the feature available on the platform as per their demands. The operator is responsible for allocating available resources from suppliers, redirected to the demands registered by consumers.

After comparing four resource scheduling models, it was found that the centralized scheduling method has a better ability to optimize manufacturing resources through the risk sharing strategy, which promotes higher efficiency, higher sharing rate, sustainable use of manufacturing resources and hence energy efficiency.

*Table 4 – Cloud manufacturing publications*

| Title | Journal | Year |
|---|---|---|
| Energy-aware resource service scheduling based on utility evaluation in cloud manufacturing system | PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART B-JOURNAL OF ENGINEERING MANUFACTURE | 2013 |
| Context-Aware Cloud Robotics for Material Handling in Cognitive Industrial Internet of Things | IEEE INTERNET OF THINGS JOURNAL | 2018 |
| Fog Computing for Energy-Aware Load Balancing and Scheduling in Smart Factory | IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS | 2018 |
| IO-Link Wireless enhanced factory automation communication for Industry 4.0 applications | JOURNAL OF SENSORS AND SENSOR SYSTEMS | 2018 |
| Leveraging the Capabilities of Industry 4.0 for Improving Energy Efficiency in Smart Factories | IEEE ACCESS | 2019 |
| Multi-objective resource allocation for Edge Cloud based robotic workflow in smart factory | FUTURE GENERATION COMPUTER SYSTEMS-THE INTERNATIONAL JOURNAL OF ESCIENCE | 2019 |
| Energy-efficient cyber-physical production network: Architecture and technologies | COMPUTERS & INDUSTRIAL ENGINEERING | 2019 |
| Use of Statistical Correlation for Energy Management in Office Premises Adopting Techniques of Industry 4.0 | DYNA | 2018 |

*Source: Prepared by the author.*

Table 5 presents the categorized articles, according to the authors' judgment, in the big data analysis cluster. From a counterpoint to traditional manufacturing platforms, Woo et al. (2018) proposed the implementation of a system for collecting, processing and analyzing large amounts of data, with the aim of making more assertive and collaborative manufacturing processes.

The system is basically comprised of three steps, virtualizing manufacturing processes, real-time data processing, and data-driven decision making for predictive planning. In other words, the system processes and performs data analysis, creating decision-making models based on real-time parameters and history. Also, the application makes use of standardized data interface, which enables the exchange of information and data comparison with other factories that use it.

To illustrate the problem, the authors cite that this is a relevant solution in addressing the limitations of the traditional approach. If it were possible to process all data from a given historical series and cross-reference it with real-time data, it would be possible to create predictive models for resource optimization and energy efficiency.

An example used in the researchers' study was the data analysis modeling approach to an energy forecasting model required by a machining center. According to the authors, it is possible to develop a dynamic predictive model based on the behavior of this resource over its useful life.

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That said, it can be concluded that the development of technologies capable of storing, processing and analyzing large masses of data from a manufacturing process history, and cross-referencing it with real-time data, is able to promote industrial energy efficiency through the automatic creation of dynamic forecasting models as a tool to aid decision making.

*Table 5 – Big data publications*

| Title | Journal | Year |
|---|---|---|
| Developing a big data analytics platform for manufacturing systems: architecture, method, and implementation | INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY | 2018 |
| A big data driven sustainable manufacturing framework for condition-based maintenance prediction | JOURNAL OF COMPUTATIONAL SCIENCE | 2018 |
| Sustainable robust layout using Big Data approach: A key towards industry 4.0 | JOURNAL OF CLEANER PRODUCTION | 2018 |

*Source: Prepared by the author.*

Table 6 presents the categorized articles, according to the authors' judgment, in the programming optimization and artificial intelligence cluster. Aiming at a global analysis, Bányai (2018) develops a study based on the idea that in the traditional logistics planning methodology, issues such as energy efficiency and environmental preservation have been neglected through an individualized approach among the various value-chain agents.

Therefore, the author develops a mathematical modeling for the last mile process, that is, the moment when the products leave the distribution center for the final location. The modeling presented aims to establish the ideal tasks and schedules for each order, using a black hole-based heuristic optimization algorithm (BHA), aiming to reduce energy consumption, consequently promoting energy efficiency.

In the case study developed, the author presented a model with two delivery service providers, 17 destinations scheduled on three routes. After methodological execution, the algorithm was able to find the best logistic planning solution for this case, using fuel consumption as a function of the problem.

*Table 6 – Programming and artificial intelligence publications*

| Title | Journal | Year |
|---|---|---|
| Real-Time Decision Making in First Mile and Last Mile Logistics: How Smart Scheduling Affects Energy Efficiency of Hyperconnected Supply Chain Solutions | ENERGIES | 2018 |
| Smart Manufacturing Approach for Efficient Operation of Industrial Steam-Methane Reformers | INDUSTRIAL & ENGINEERING CHEMISTRY RESEARCH | 2015 |
| Multi-dimensional data indexing and range query processing via Voronoi diagram for internet of things | FUTURE GENERATION COMPUTER SYSTEMS-THE INTERNATIONAL JOURNAL OF ESCIENCE | 2019 |
| Energy Optimization of Robotic Cells | IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS | 2017 |
| Real-time optimization of an industrial steam-methane reformer under distributed sensing | CONTROL ENGINEERING PRACTICE | 2016 |
| Decision rules for energy consumption minimization during material removal process in turning | JOURNAL OF CLEANER PRODUCTION | 2017 |
| The cellular approach: smart energy region Wunsiedel. Testbed for smart grid, smart metering and | ELECTRICAL ENGINEERING | 2016 |

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| | | |
|---|---|---|
| smart home solutions | | |
| Smart manufacturing and energy systems | COMPUTERS & CHEMICAL ENGINEERING | 2018 |
| Green Production Planning and Control for the Textile Industry by Using Mathematical Programming and Industry 4.0 Techniques | ENERGIES | 2018 |
| Optimizing energy consumption of robotic cells by a Branch & Bound algorithm | COMPUTERS & OPERATIONS RESEARCH | 2019 |
| Simulation and Test Bed of a Low-Power Digital Excitation System for Industry 4.0 | PROCESSES | 2018 |
| Uncertainty reduction in measuring and verification of energy savings by statistical learning in manufacturing environments | INTERNATIONAL JOURNAL OF INTERACTIVE DESIGN AND MANUFACTURING - IJIDEM | 2016 |
| Autonomic smart manufacturing | JOURNAL OF DECISION SYSTEMS | 2015 |
| Optimization of the energy consumption of industrial robots for automatic code generation | ROBOTICS AND COMPUTER-INTEGRATED MANUFACTURING | 2019 |
| Improvement of Temperature Control Performance of Thermoelectric Dehumidifier Used Industry 4.0 by the SF-PI Controller | PROCESSES | 2019 |
| Use of On-Demand Cloud Services to Model the Optimization of an Austenitization Furnace | SMART AND SUSTAINABLE MANUFACTURING SYSTEMS | 2018 |
| Improvement of Energy Efficiency and Control Performance of Cooling System Fan Applied to Industry 4.0 Data Center | ELECTRONICS | 2019 |
| Intelligent Optimization of Hard-Turning Parameters Using Evolutionary Algorithms for Smart Manufacturing | MATERIALS | 2019 |
| Energy-efficiency-oriented scheduling in smart manufacturing | JOURNAL OF AMBIENT INTELLIGENCE AND HUMANIZED COMPUTING | 2019 |
| Optimal Operating Schedule for Energy Storage System: Focusing on Efficient Energy Management for Microgrid | PROCESSES | 2019 |
| X-DNNs: Systematic Cross-Layer Approximations for Energy-Efficient Deep Neural Networks | JOURNAL OF LOW POWER ELECTRONICS | 2018 |

*Source: Prepared by the author.*

Table 7 presents the categorized article, according to the authors' judgment, in the additive manufacturing cluster.

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Yoon et al. (2014) developed a comparative study of energy consumption in three different manufacturing processes: conventional mechanical conformation (methods of applying external forces to an object to acquire a specific shape), subtractive manufacturing (three-dimensional computed machining for object acquires specific characteristics) and additive manufacturing (three-dimensional computer modeling for an object to assume specific characteristics).

The results obtained by comparing the three case studies developed with the literature data show that, as the number of manufactured parts tends to grow, the specific energy consumption of the additive processes tends to approach a value up to 100 times superior to conventional mechanical forming processes, which is a relatively large difference. Already the subtractive manufacturing processes figured an intermediate position between the other two.

It is therefore noticeable that, in view of the growing demand for sustainable manufacturing, an efficient tool for comparing available manufacturing methods must be implemented, especially in helping decision making involving operational investments and energy efficiency.

*Table 7 – Additive manufacturing publications*

| Title | Journal | Year |
|---|---|---|
| A Comparison of Energy Consumption in Bulk Forming, Subtractive, and Additive Processes: Review and Case Study | INTERNATIONAL JOURNAL OF PRECISION ENGINEERING AND MANUFACTURING-GREEN TECHNOLOGY | 2014 |

*Source: Prepared by the author.*

Table 8 presents the categorized articles, according to the authors' judgment, as diverse, to the detriment of applications of technologies or varied methodologies. Dornfeld (2014) justifies his study, especially in the aspects of environmental preservation. The involvement of sustainable manufacturing technologies at all levels, whether tooling or process, is one of the strategies to promote conscious use of resources.

The author mentions that at the process planning level, for example, in a computerized machining center, planning the tool path can mean a reduction in the manufacturing time for a particular part. In addition, planning focused on minimizing idle times on these devices can mean a considerable increase in energy savings.

On the other hand, the author specifies that it is possible to implement more efficient energy control by detailing the resources consumed and the resources wasted at each stage of a production line, translating crucial strategic information as carbon dioxide equivalent, energy cost, water cost, among others.

Furthermore, it is described by the research, the use of ecological route maps, which specifies, from a baseline (involving current energy expenditures), what improvements should be implemented to maximize energy efficiency objectives.

Finally, considering the tools presented by the author, it is concluded that the technology factor is fundamental to promote an efficient management foundation of energy resources. Industry 4.0 enabling technologies have the potential to assist in automatic control of operations, speeding up processes and avoiding errors; provide more assertive and impactful strategic decision-making information; and reuse underutilized energy resources, promoting increasingly optimized and, especially, sustainable industrial operations.

*Table 8 – Other publications*

| Title | Journal | Year |
|---|---|---|
| Moving Towards Green and Sustainable Manufacturing | INTERNATIONAL JOURNAL OF PRECISION ENGINEERING AND MANUFACTURING-GREEN TECHNOLOGY | 2014 |
| Impact of advanced manufacturing on sustainability: An overview of the special volume on advanced manufacturing for sustainability and low fossil carbon emissions | JOURNAL OF CLEANER PRODUCTION | 2017 |
| A Cost-Effective Redundant Digital Excitation Control System and Test Bed Experiment for Safe Power Supply for Process Industry 4.0 | PROCESSES | 2018 |
| Smart Manufacturing for the Oil Refining and Petrochemical Industry | ENGINEERING | 2017 |

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|---|---|---|
| Toward Dynamic Energy Management for Green Manufacturing Systems | IEEE COMMUNICATIONS MAGAZINE | 2016 |
| Opto-Electronic Sensor Network Powered Over Fiber for Harsh Industrial Applications | IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS | 2018 |
| Exploring Organizational Sustainability of Industry 4.0 under the Triple Bottom Line: The Case of a Manufacturing Company | SUSTAINABILITY | 2019 |
| Trends in Advanced Manufacturing | INTERNATIONAL JOURNAL OF MULTIPHYSICS | 2018 |
| The Role of a Digital Industry 4.0 in a Renewable Energy System | INTERNATIONAL JOURNAL OF ENERGY RESEARCH | 2019 |
| Potentials for model-based energy supply forecasts - Energy management in the context of industry 4.0 | ATP EDITION | 2017 |

*Source: Prepared by the author.*

Table 9 provides a compilation of the most cited articles in each of the technology groups selected by the authors, which supported the discussion of this work.

*Table 9 – Most cited publications*

| Title | Year | Citations | Cluster |
|---|---|---|---|
| Industrial Internet of Things: Challenges, Opportunities, and Directions | 2018 | 12 | Internet of things |
| Key Design of Driving Industry 4.0: Joint Energy-Efficient Deployment and Scheduling in Group-Based Industrial Wireless Sensor Networks | 2016 | 25 | Wireless sensors network |
| Energy Harvesting in LoRaWAN: A Cost Analysis for the Industry 4.0 | 2018 | 2 | Energy harvesting |
| Energy-aware resource service scheduling based on utility evaluation in cloud manufacturing system | 2013 | 46 | Cloud manufacturing |
| Developing a big data analytics platform for manufacturing systems: architecture, method, and implementation | 2018 | 3 | Big data |
| Real-Time Decision Making in First Mile and Last Mile Logistics: How Smart Scheduling Affects Energy Efficiency of Hyperconnected Supply Chain Solutions | 2018 | 16 | Programming/AI |
| A Comparison of Energy Consumption in Bulk Forming, Subtractive, and Additive Processes: Review and Case Study | 2014 | 98 | Additive manufacturing |
| Moving Towards Green and Sustainable Manufacturing | 2014 | 68 | Others |

*Source: Prepared by the author.*

## IV. CONCLUSION

The internet of things, once interpreted simply as a network connection, represents a step beyond today's

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automation architectures because, coupled with wireless sensor networks, cloud computing and collected data analysis, it denotes a more efficient solution, in terms of hardware flexibility and costs saving in installation and maintenance. In addition, digitizing manufacturing processes, through hardware and software, can promote intelligent production management as it provides responsive and fast assertiveness response data, increasing operational availability and predictability, translating into energy efficiency.

Wireless sensor networks, through the energy harvesting from operational processes, characterizes a viable solution as it can reuse energy resources that would be wasted, such as artificial photoelectric light, mechanical vibration, heat and radio frequency signals, promoting energy efficiency and increasing service life by sharing industrial resources.

Despite the breadth of research in the context of Industry 4.0, a relatively small amount explicitly addresses how and which technologies are capable of promoting industrial energy efficiency, leaving the researcher to read thoroughly to address the issue. The report presented was able to demonstrate that there are few researches, compared to innovation studies in the same context. In addition, the growing publication of articles on this subject suggests its global relevance, given that industrial sustainability is pursued as a way of ensuring success, in its various interpretations, for small, medium and large organizations.

As future work, we suggest further research in the database used in this work, as well as in other databases, using a combination of tags involving energy and each of the industry 4.0 enabling clusters, identifying the works that address the theme energy efficiency even if implicitly.

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# Usage of Medicinal Plants and Phytotherapy Medicines by Elderly People who live with chronic noncommunicable Diseases

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***Abstract*****—** *This study had as goal to assess the use of medicinal plants and phytotherapy medicines by elderly people with chronic noncommunicable diseases. It is a descriptive study of quantitative approach, a section of the main extension project called "Education and interdisciplinary health practices for elderly people with chronic noncommunicable diseases approved by the Research Ethics Committee (CEP) with opinion nº 2,960,922.The study comprised 40 elderly women with chronic noncommunicable diseases, enrolled in the elderly interaction group in a Higher Education Institution in the interior of Bahia. For data collection, there were used as instruments the sociodemographic and economic questionnaires and the questionnaire of medicinal plants and phytotherapy. Data analysis was carried out by using the program Statistical Package for Social Science - SPSS). It was noticed that 97.3% of the study's participants said that they used medicinal plants and 81.11% phytotherapy medicines. In terms of the purpose of use, 49.2% said they use it as a lifelong habit acquired and 37.8% stated they used it for therapeutic purposes. It was evidenced that 56.8% of participants reported that they knew that by using these substances they could have some drug interaction and 59.5% said they knew that the use can lead to side effects. For 51.36% family influence was the primary motivation for the use. It was verified that the majority of elderly people stated they use medicinal plants and phytotherapy medicines because it represent the lifelong habit acquired, especially by the family environment what is required is the implementation of professional training actions, health education and the appreciation of traditional knowledge for a better understanding on the correct use of medicinal plants.*

***Keywords*****— Elderly People, Chronic Diseases, Medicinal Plants, Phytotherapy.**

## I. INTRODUCTION

The demographic transition happening in Brazil is motivated mainly by the reduction of birth and mortality rates indicated by the last census and observed in the age pyramid inversion. With this shift, the population aging is the most noticed characteristic [1].

Aging is a gradual process, it is an outcome of internal and external alterations like biochemical, morphological, functional, behavioral, cognitive and social modifications [2]. Therefore, among these modifications, a challenge for public health in Brazil has been the high predominance of Chronic Noncommunicable Diseases (CNCDs) that particularly affect elderly people. This shift in the epidemiological profile happened from the replacement of parasitic infectious diseases to a gradual increase of diseases with a chronic and degenerative character [3], [4].

CNCDs may result in disabilities by interfering with the autonomy and mobility of the elderly person, which reflects on their lifestyle habits and welfare [5]. The number of fatalities from chronic diseases has grown globally, with 41 million people each year representing 72% of all deaths around the world. These are long-term diseases and there are little resources for their control and

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treatment (WHO, 2018), and the subjects with CNCDs are the ones that most use the health service because of routine appointments, complications or health issues [6].

In this scenario, the Brazilian Public Health System (SUS) thinking about the integrity of individual assistance, inserted the National Policy on Integrative and Complementary Practices(PNPIC) with therapeutic resources that stimulates natural mechanisms of prevention and health issues, conducting a supportive listening and therapeutic bond [7]. The PNPIC endorsement considered other guidelines and establishment of alternative treatments, such as traditional Chinese medicine / acupuncture, homeopathy, social thermalism / crenotherapy, anthroposophic medicine, medicinal plants and phytotherapy in SUS [8], [9].

Among the Integrative and Supplemental Practices, medicinal plants and phytotherapy are widely used by the Brazilian population as a therapeutic resource [10]. Taken as a millenary practice, the use of medicinal plants happens due to the knowledge exchange through oral language and daily life habits that are passed on from one generation to another. Nevertheless, it has been used by a major part of elderly people, in an indiscriminate and random manner, without any previous knowledge regarding its pharmacological properties and the toxicity potential [11].

To address this situation, this study had as goal to assess the use of medicinal plants and phytotherapy medicines by elderly people with chronic noncommunicable diseases.

## II. METHODOLOGY

It is a descriptive study of quantitative approach, a section of the main extension project called "Education and interdisciplinary health practices for elderly people with chronic noncommunicable diseases." The study was carried out from October 2018 to June 2019 with an interaction group of elderly people in a Higher Education Institution, situated in the urban area of Vitória da Conquista - BA.

The study comprised 40 elderly women with CNCDs, after following the inclusion criteria: subjects that were 60 years old and older, of both sexes, with a diagnosis of CNCDs, enrolled in the elderly interaction group. The exclusion criteria were: cognitive deficit with the impossibility of answering the study's questions (it was assessed by the Mini Mental State Examination - MMSE).

For data collection, there were used as instruments the sociodemographic and economic questionnaires, comprised by information concerning some social, demographic and economic aspects like age, gender, color, marital status, schooling degree, profession, monthly individual and family income, religion, who they live with and how many children they have. Also he questionnaire of medicinal plants and phytotherapy with objective and subjective questions regarding the use of medicinal plants and phytotherapy medicines, the frequency, intention, species used and form of use, influence of other people and knowledge about the substances used.

The collection instruments were employed by the researchers in a reserved room, through the computational tool *Kobotoolbox*, a *software* with a set of tools for data collection which runs with and without internet support [12].

The analysis of quantitative data happened using the program *Statistical Package for Social Science* - SPSS (version 22.0, Chicago, IL, USA). The variables were displayed through frequencies and percentages and as mean and standard deviation (M±SD). The significance level of (0.05) and confidence intervals (CI) of (95%) was assumed.

All ethical and legal features of Resolutions 466/12 and 510/16 [8], [13] were thoroughly followed and after the approval by the Research Ethics Committee (CEP) of the Northeast Independent College / FAINOR with opinion nº 2,960,922. It was explained to all elderly participants the study's goals. The ones that accepted to participate signed the two copies of an Free and Informed Consent Form (ICF), one copy was given to the research participant and the other was kept by the researcher responsible for the study.

## III. RESULTS

Table 1 displays the participant's sociodemographic profile. According to the sociodemographic outcomes it was possible to determine that 40 (100%) were women, 13 (32.5%) were between 71 and 75 years old, 16 (40%) were white, 22 (55%) were widows, 16 (40%) finished elementary school I, 31 (77.5%) Catholic, 21 (52.5%) have individual income between one and two minimum wages, and the family income predominates21 (52.5%) between 1 and 2 minimum wages, 17 (42.5%) lived alone, and 38 (95%) have children, 10 (25%) stated they had 3 children.

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*Table 1. Sociodemographic Profile. Vitória da Conquista, Bahia, Brazil, 2019.*

| Variables | N | % |
|---|---|---|
| **Sex** | | |
| Male | 0 | 0 |
| Female | 37 | 100 |
| **Agegroup** | | |
| 60 to 65 years | 8 | 21,62 |
| 66 to 70 years | 7 | 18,92 |
| 71 to 75 years | 12 | 32,43 |
| 76 to 80 years | 8 | 21,62 |
| Over 80 years | 2 | 5,40 |
| **Color** | | |
| White | 15 | 40,54 |
| "Parda" (Brownish) | 12 | 32,43 |
| Black | 10 | 27,02 |
| **Marital Status** | | |
| Married | 8 | 21,62 |
| Single | 5 | 13,51 |
| Widow(er) | 21 | 56,77 |
| Separated | 3 | 8,11 |
| **Schoolingdegree** | | |
| Elementary School I (1º to 5thgrades) | 15 | 40,54 |
| Elementary School II (6º to 9º grades) | 5 | 13,51 |
| High School | 12 | 32,43 |
| HigherEducation | 3 | 8,11 |
| Withoutschooling | 2 | 5,40 |
| **Religion** | | |
| Catholic | 29 | 78,38 |
| Evangelical | 7 | 18,92 |
| None | 1 | 2,70 |
| **Individual monthly income** | | |
| Lessthan 1 minimumwage | 10 | 27,02 |
| Between 1 e 2 minimumwages | 20 | 54,05 |
| Between 3 e 5 minimumwages | 6 | 16,22 |
| More than 5 minimumwages | 1 | 2,70 |
| **Family monthly income** | | |
| Lessthan 1 minimumwage | 4 | 10,81 |
| Between 1 and 2 minimumwages | 20 | 54,05 |
| Between 3 e 5 minimumwages | 11 | 29,73 |
| Morethan 5 minimumwages | 2 | 5,40 |
| **Who they live with** | | |
| Withchildren | 8 | 21,62 |
| Withotherrelatives | 6 | 16,22 |
| Withthespouse | 6 | 16,22 |
| With the spouse, children e grandchildren | 1 | 2,70 |
| Alone | 16 | 43,24 |
| **Children** | | |
| No | 2 | 5,40 |
| Yes | 35 | 94,59 |
| **Numberofchildren** | | |
| 1 | 4 | 10,81 |
| 2 | 6 | 16,22 |
| 3 | 9 | 24,32 |
| 4 | 8 | 21,62 |
| 5 | 4 | 10,81 |
| More than 5 | 6 | 16,22 |
| **Total** | 37 | 100,00 |

**Source:**Research data

Table 2 displays data linked to the use of phytotherapy medicines and medicinal plants described by the elderly subjects of the study. It was noticed that 97.3% of the participants said that they used medicinal plants and 81.11% phytotherapy medicines, with a monthly and weekly frequency of 27%. In terms of the purpose of use, 49.2% saidthey use it as a lifelong habit acquired and 37.8% stated they used to treat a disease. As for the forms they use, 62,16% used it as teas.

*Table 2.Use of phytotherapy medication and medicinal plants by elderly people. Vitória da Conquista, Bahia, Brazil, 2019.*

| Variables | N | % |
|---|---|---|
| **Medicinal plant use** | | |
| No | 1 | 2,70 |
| Yes | 36 | 97,30 |
| **Phytotherapy use** | | |
| No | 7 | 18,92 |
| Yes | 30 | 81,09 |
| **Frequency of use** | | |
| Anually | 9 | 24,32 |
| Monthly | 10 | 27,03 |
| Weekly | 10 | 27,03 |
| Daily | 6 | 16,22 |
| Didnotanswer | 2 | 5,40 |
| **Use purpose** | | |
| Habit | 16 | 43,24 |
| Totreat a disease | 14 | 37,84 |
| Habit/Disease | 5 | 13,51 |
| Didnotanswer | 2 | 5,40 |
| **Formsof use** | | |

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| | | |
|---|---|---|
| Teas | 23 | 62,16 |
| Bottled | 3 | 8,11 |
| Infusion | 4 | 10,81 |
| Juices | 3 | 8,11 |
| Maceration | 1 | 2,70 |
| Anotherform | 1 | 2,70 |
| Didnotanswer | 2 | 5,40 |
| **Total** | 37 | 100,00 |

**Source:**Research data

The outcomes linked to the knowledge and influences received concerning the use of phytotherapy medicines and medicinal plants by elderly subjects of the study were displayed in Table 3. It was evidenced that 56.8% of participants reported that they knew that by using these substances they could have some drug interaction, 59.5% said they knew that the use can lead to side effects, 51.36% were influenced by family members to use these substances.

*Table 3. Knowledge and influences received regarding the use of phytotherapy medicines and medicinal plants by elderly people. Vitória da Conquista, Bahia, Brazil, 2019.*

| Variables | N | % |
|---|---|---|
| **Knowledgeondruginteraction** | | |
| Yes | 21 | 56,76 |
| No | 13 | 35,14 |
| I don'tknow | 2 | 5,40 |
| Didnotanswer | 1 | 2,70 |
| **ReactionsKnowledge** | | |
| Yes | 22 | 59,46 |
| No | 13 | 35,14 |
| I don'tknow | 1 | 2,70 |
| Didnotanwer | 1 | 2,70 |
| **Influence to use it** | | |
| Relatives | 19 | 51,35 |
| Friends | 3 | 8,11 |
| Doctor | 3 | 8,11 |
| Others | 8 | 21,62 |
| Media | 1 | 2,70 |
| Didnotanswer | 3 | 8,11 |
| **Total** | 37 | 100,0 0 |

**Source:**Research data

Table 4 exhibits the main species of medicinal plants used by elderly people in the research. Among the elderly participants, 9.61% stated that they use lemon grass, lemon balm and fennel, 6.76% used umburana, but 15.6% other types of species.

*Table 4. Main species used by elderly people. Vitória da Conquista, Bahia, Brazil, 2019.*

| Variables | N | % |
|---|---|---|
| **Espécies que costuma usar** | | |
| Rosemary | 10 | 3,56 |
| Boldo | 13 | 4,62 |
| Chamomile | 22 | 7,83 |
| Cinnamon | 18 | 6,41 |
| Lemon Grass | 27 | 9,61 |
| Lemon Balm | 27 | 9,61 |
| Fennel | 27 | 9,61 |
| Spearmint | 17 | 6,01 |
| Peppermint | 14 | 4,98 |
| Mastruz | 10 | 3,58 |
| Nutmeg | 21 | 7,47 |
| Pomegranate | 1 | 4,27 |
| Umburana | 19 | 6,76 |
| Others | 12 | 15.66 |
| **Total** | 281 | 100,00 |

**Source:**Research data

## IV. DISCUSSION

In Brazil there is a wide biodiversity of medicinal plants and their use has been seen in the entire humanity since ancient times. This knowledge has turned into a tradition and has been transmitted among generations [14]. With the elderly population being the one that use it the most [11], especially in a prophylactic and healing way, in the treatment of CNCDs or low-risk clinical diseases [15], [16]. In the scientific literature, various studies have demonstrated successful outcomes concerning the use of medicinal plants in the treatment of some illnesses, and for that it was a practice included in SUS for health promotion [7], [9], [11].

In this study, it was observed that the majority of respondents make regular use of medicinal plants. In accordance with Oliveira et al (2018) [17], the use of these plants ought to be in a rational and safe way, with the precautions starting with planting, storage and correct use. Because of the easy access, the precautions are frequently not noticed and the use is made without any scientific knowledge regarding cultivation, preparation, indication, side effects, toxicity and interaction with other plants and drugs used by the subjects. This way, self-medication and unfamiliarity on indications and toxic effects may lead to a practice that is harmful for the health.

A study carried by Viana and Ramos (2019) [19] has demonstrated that the majority of the elderly used some natural medicine before searching fora doctor, teas were the most used, mainly because of their specific medicinal value. Similar outcomes were achieved by

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Dantas et al (2018) [20], who noticed that the most used form (55%) was the teas with the plants leaves, with them being accounted for storing a greater active principle concentration of the plants, increasing the risk of side effects if not used in an ideal quantity. The majority of the elderly people said they had knowledge about drug interaction when using medicinal plants. However, this understanding happens through common sense and not by scientific knowledge. This does not mean that traditional/popular knowledge regarding the health-disease process and the use of medicinal plants should not be appreciated, but it requires orientation or supervision, mainly from healthcare professionals for the proper use. That is to say, there should be an interaction "between user groups, the traditional knowledge, scientists, technicians, healthcare workers and representatives of the medicinal and phytotherapy plant production chain" as stated by the PNPIC [21].

An important factor indicated is that many people replace their medicines for medicinal plants, that being either due to not attending to medical appointments, absence of prescription, low financial income or easy access to the plants, once they are generally cultivated in gardens of the patient's own home [22], [23]. This situation displays a risk to the patient's health, because several medicinal plants do not have scientific studies that evidence their effectiveness [23]. Some health issues, like hepatotoxicity, injury to the central nervous system, allergic dermatitis, abortion, nausea and vomits, risk of developing tumors, may be noted with the incorrect use of medicinal plants [23].

Other participants stated that they did not know the indications and side effects of the plants that they use being guided by the belief that natural products are incapable of causing health issues, side effects or interaction with other drugs. Reports like this were discovered in other papers, where the elderly people did not know the potential side effects of the medicinal plantsusage [24], [25].

Data reached by Santana and Neto (2017) [26] suggested that knowledge about the use of medicinal plants is the outcome of intercultural relations. Similar data were reached by Avila et al. (2019) [27], whose study pointed out that the majority of participants gave a positive reply to the habit of using medicinal plants by assigning this practice to intergenerational relation, as established in this study.

Among the species commonly used by the respondents, other studies highlighted as well the lemon balm (Melissa officinalis), lemongrass (Cymbopogon citratus), chamomile (Matricaria chamomilla) being the most used [28, [29]. Fennel (Pempinelaanissum) is a vasodilator primarily used for the digestive system discomfort, hypertension, eye hypertension and inflammation. There are no known contraindications, drug interactions or even side effects. Lemongrass (Cymbopogon citratus) is normally used in for intestinal cramps and insomnia and it is not known any contraindications and side effects and it should not be used with sedative because of drug interaction [30]. A study performed by Lima et al. (2018) [31] exposed that 46% of the sample used medicinal plants and 28% of them reported simultaneous use for the treatment of CNCDs, including hypertension, diabetes mellitus and heart diseases.

It is noteworthy that medicinal plants may be broadly used by patients and suggested by health services and professionals. Nevertheless, it is required the training of the professionals to better orient the users. It was determined that even with the Ministry of Health stimulating the use of medicinal plants and phytotherapy medicines, the colleges' curriculum do not offer disciplines to an specific training for it [32]. Furthermore, because of the lack of knowledge or prejudice there is a significant distrust of some health professionals, administrators and users concerning the efficacy and safety of their use [33].

The Ministry of Health, based on integrative and supplementary practices [8] suggests that it is mandatory the establishment of continued education for health professionals in the form of training programs on the use of phytotherapy medicines and medicinal plants. For that, institutional support of states and municipalities are required with the formulation and establishments of policies, programs and projects in SUS, promoting actions, investing in research projects and other measures [8].

So just with the improvement of scientific studies, and with the integration of this topic in the training of health professionals tied to traditional knowledge, the true potential of this type of treatment and how to use it in a risk-free way and without any prejudice will be achieved.

## V. FINAL CONSIDERATIONS

This study enabled us to assess the use of medicinal plants and phytotherapy medicines by elderly people that have chronic noncommunicable diseases. It was verified that the majority of elderly people stated they use medicinal plants and phytotherapy medicines because it represent the lifelong habit acquired, being especially influenced by the family and by the knowledge about the risks of drug interaction and possible side effects as a result of the use.

In view of this, there is a necessity for health professionals to know about the use of medicinal plants

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and phytotherapy medicines by elderly people who have CNCDs, primarily because of the need to orient these subjects regarding a reliable and balanced use of these plants preventing the side effects or even death by improper use.

Even with the establishment of National Policy on Integrative and Complementary Practices in SUS, it is required the assistance of states and cities in the implementation of professional training actions, health education and the appreciation of traditional knowledge for a better understanding on the correct use of medicinal plants, since it is an accessible and low cost form that may help. Used together with other treatment measures to enhance the patients' health.

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# The use of Conservation Units as an Environmental Education Tool: Literary Review on Mindu Municipal Park - Manaus -Am

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***Abstract*— *Conservation units (UCs) are legally protected territorial spaces that provide outstanding natural features, however (UCs) do not ensure that the areas are fully preserved. Brazil has a vast biological diversity, having several protected areas, these protected spaces have a fundamental role in the protection of nature, fauna and flora. The aim of this study was to make a literary review of the articles published about one of the existing conservation units of the capital of Amazonas, the Mindu Municipal Park, chosen for being located in the heart of Manaus about fifteen minutes from downtown. Parque do Mindu, is the dwelling that houses several species of fauna and flora of the region: animals like Sauim-de-Coleira (Saguinus bicolor). The maintenance of the park as observed in loco, it is noticeable that suspended trails are with maintenance on time. It is noteworthy that existing activities in urban parks aim to promote environmental education (EA). Do Mindu Municipal Park is a (UC) example of perseverance to exist today, thanks to the efforts of society and federal, state and municipal laws. Literary resources about the Park are of great importance to understand the history and development of a conservation unit located in an urban area feeling the impacts of anthropization.***

***Keywords*— Conservation Units, Parks, Environmental Education.**

## I. INTRODUCTION

In the middle of the last century humanity was able to follow the consequences of a remaining system that was the Industrial Revolution, where the focus was only productivity and economic growth, not ensuring environmental quality (POOT and ESTRELA, 2017). For Sampaio, (2015) "the Industrial Revolution was the triggering milestone of a society founded on consumption, and this society imposed increasing pressureon natural resources.

Among the existing environmental problems, we can highlight that the environmental problem is a result of capitalist globalization (MARION, 2013). In 1972 in Stockholm, Sweden, there was the first meeting with the environmental theme, it was considered a historical milestone, because there was the "'finding that the system of production of goods of industrialized countries negatively affected the environment planetarium" (ROCHA, 2003). The Stockholm declaration aimed to assist in preserving fauna and flora, reducing toxic solid waste and supporting underdeveloped countries (IPHAN, 1972).

About twenty years after the Stockholm declaration, there was the United Nations Conference on Environment and Development, known as Rio-92 or Eco-92, in the city of Rio de Janeiro, Brazil. It was an event that addressed dominant guidelines on the environmental issue, and especially sustainable development, its result was agenda 21, aimed at combating deforestation, poverty, biological conservation and changing consumption patterns (OLIVEIRA, 2012).

In 1995, the Conference of Parts I (COP-1) took place in Berlin. In 1996, COP-2 in Geneva; and in 1997, COP-3 was held in Kyoto, establishing a document called the Kyoto Protocol, these conferences had as its main obetive to reduce greenhouse gas emissions, and also defined strict adjustments regarding global warming ( ANDRADE and COSTA, 2008). Later, at Rio+20 held in Brazil, the following question was raised: "What future do we want?" (WENCESLAU, ANTEZANA, CALMON, 2012).

All environmental treatises aimed to reduce the causes of river contamination, air pollution and leakage of harmful chemicals. Against departure, rulers around the world began to discuss ways of remediation or prevention of these impacts on the environment(POOT e ESTRELA,

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2017).

Brazil has environmental laws set out in the National Environment Policy (PNMA), which aim to protect flora and fauna, waters, environmental instruction, environmental crimes and environmental administrative misdemeanors, as well as conservation units, genetic heritage, protection and elevation to classical knowledge, benefit sharing and genetically modified organisms (TRINDADE, DIAS, 2008).

According to the Ministry of the Environment (MMA), according to Law No. 6,938/81 (PNMA) that directs the guidelines, concepts, objectives on environmental issues, cites in Art 6 on:

> ‘‘The organs and entities of the Union, states, the Federal District, territories and municipalities, as well as the foundations established by the Public Power, responsible for the protection and improvement of environmental quality, will constitute the National System of the Environment Environment - SISNAMA. The National Council for the Environment (CONAMA) aims to advise, study and propose to the Governing Council, government policy guidelines for the environment and natural resources and deliberate, within the scope of its competence, on standards and environmentally friendly standards ecologically balanced and essential to sound quality of life’’.

The main laws covering the precautionary idea of environmental preservation according to the Ministry of the Environment (MMA) are: Law 9.605/1998 - Environmental Crimes Law; Law 12.305/2010 - Establishes the National Solid Waste Policy (PNRS); Law 11.445/2007 - Establishes the National Basic Sanitation Policy; Law 6,766/1979, provides for the Portionment of Urban Soil; Law 7,347/1985 - Law of Public Civil Action; Law 9,433/1997- Water Resources Law; Law 12.651/2012 - New Brazilian Forest Code, among others.

Through these laws, we seek ways to preserve, mitigate, reduce environmental impact and deforestation, and thus, the National System of Conservation Units (SNUC) was created in 2000, supported by Law No. 9,985/2000, with the innuuíde of protecting areas of relevant ecological interest(MMA,2019).

Conservation Units (UC's) are legally protected territorial spaces, which provide important natural characteristics, and have as main function to ensure the representativeness of significant and ecologically viable samples of different populations, habitats and ecosystems, in order to preserve biological, geological and evolutionary heritage (SOUZA, et al., 2017). According to Couto, (2017), conservation units (UC) do not ensure that the areas are fully preserved, the author shows that it is necessary to implement environmental education so that society can engage and become aware of the importance of preservation of the environment.

Brazil has a vast biological diversity, having several conservation units. In the Amazon according to the Secretary of State for the Environment (SEMA), there is the management of 42 conservation units (UC's), eight of which are full protection and 34 of sustainable use, totaling 18,907,378.34 hectares of legally protected forest, which represents 12.13% of the state area. The state of Amazonas has 97% of its fully preserved vegetation cover, and Sema acts with constant actions to ensure preservation and prevent deforestation (SEMA, 2019).

In Manaus, the capital of Amazonas, the total of protected areas according to the State Secretary of Environment and Sustainability (SEMMAS, 2019), there are twelve (12) protected areas in the city, ten (10) conservation units and two (2) Ecological Corridors. These specially protected territorial spaces occupy 4.75% of the area of the municipality of Manaus, with a fundamental role in the protection of nature, fauna and flora.

In view of the above, the main objective was to make a literary review of the articles published on one of the existing conservation units, which is the Mindu Municipal Park, chosen to be located in the urban area of Manaus about fifteen minutes from the city center (SEMMAS, 2019).

## II. LOCATION

Mindu Municipal Park is situated in the south-central portion of the city of Manaus, Parque Dez de Novembro district, between perimetral ii and efigênio sales avenues, is located under geographical coordinates 03°04'51" south latitude and 60°00'09" west longitude. It has approximately 29 hectares. The Mindu Municipal Park by the Manaus Environmental Code (Law No. 605, 2001) is a Conservation Unit - UC, including in the Municipal Park category (DRAY, SIMONETTI, 2012).

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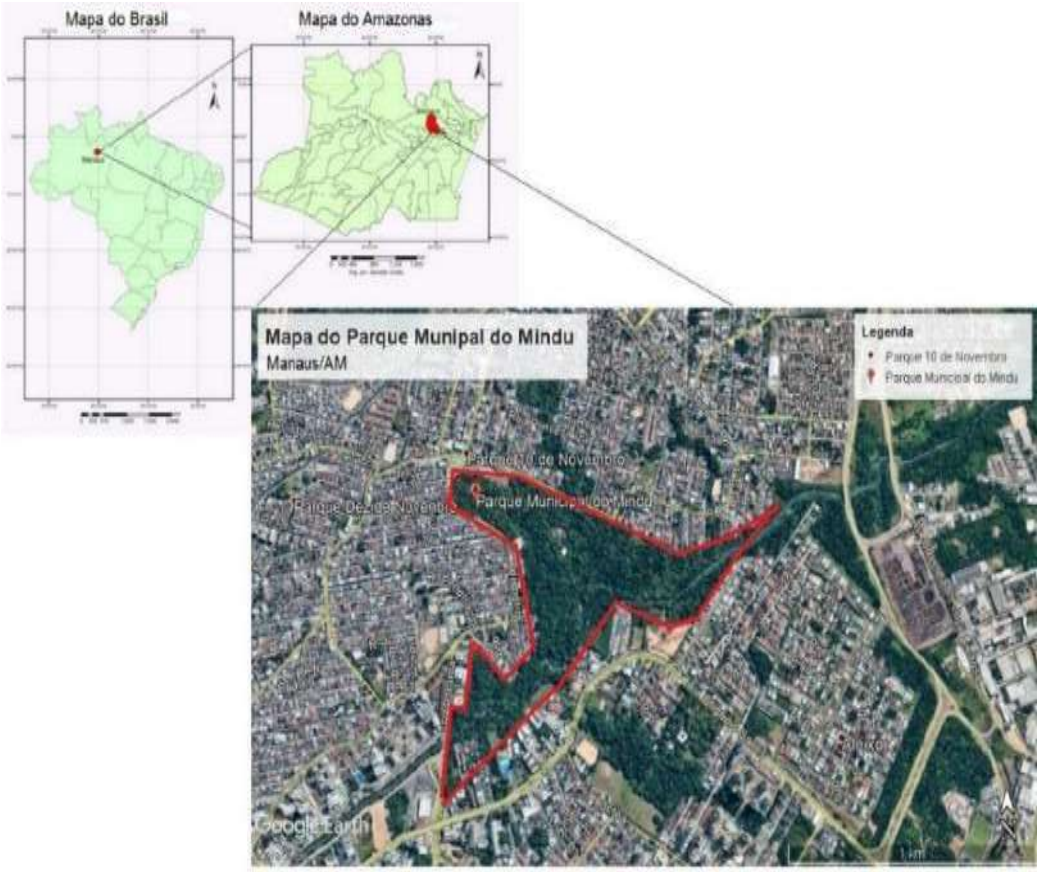


*Fig.1 - Map of the geographical location of Mindu Municipal Park,*
Manaus - AM. Source: (ALMEIDA, et al., 2017; GOOGLE EARTH, 2019)

## III. CONCEPT OF ENVIRONMENTAL MANAGEMENT AND URBAN PARK

To understand the literary results analyzed, it is necessary to describe about the environmental management sector. Corroborating this subject, Oven (2017) that management in Latin means gestìo: act of managing, management, of administering. The concept of management is associated with the administrative idea, for this reason, it is necessary to distinguish between the concepts of gestar and manage, so if management is to be, manage means to be and manage.

For Silva (2014) environmental management arises from the obligation that man had to organize his life, combining with his actions in the environment. However, Giesta (2009), environmental management is an alternative to achieve better adjustment with capitalist growth and environmental conservation.

The Mindu Municipal Park, has a management system led by the Manaus City Hall, through the Municipal Department of Environment and Sustainability - SEMMAS, which is the body responsible for hiring the manager, secretary, inspectors of security and also accepts the registration of academics to be volunteer interns. SEMMAS is the body that coordinates the protected areas and is subject to the standards of CONDEMA - Municipal Council for Development and Environment(CASCAS, 2011).

According to Gomes (2014), the creation and implementation of parks in many cities is related to the set of guidelines imposed by the United Nations since the 1970s, as a way to promote sustainable development, among other aspects, in the propagation of " green spaces." Urban parks are usually places rich in biodiversity, most of which are the fauna and flora of the locality, where according to Cascas (2011), a number of leisure, culture and teaching activities are carried out for knowledge about the environment, issues that need to be discussed in the community and by society.

The author Melo (2013), also mentions that in addition to leisure practices, the parks are representative in the urban environment, due to the presentation of nature, bringing a thermal comfort, mitigating air pollution, amortizing effects of soil waterproofing, in addition to species of fauna and flora in the world urban environment (Figure 2).

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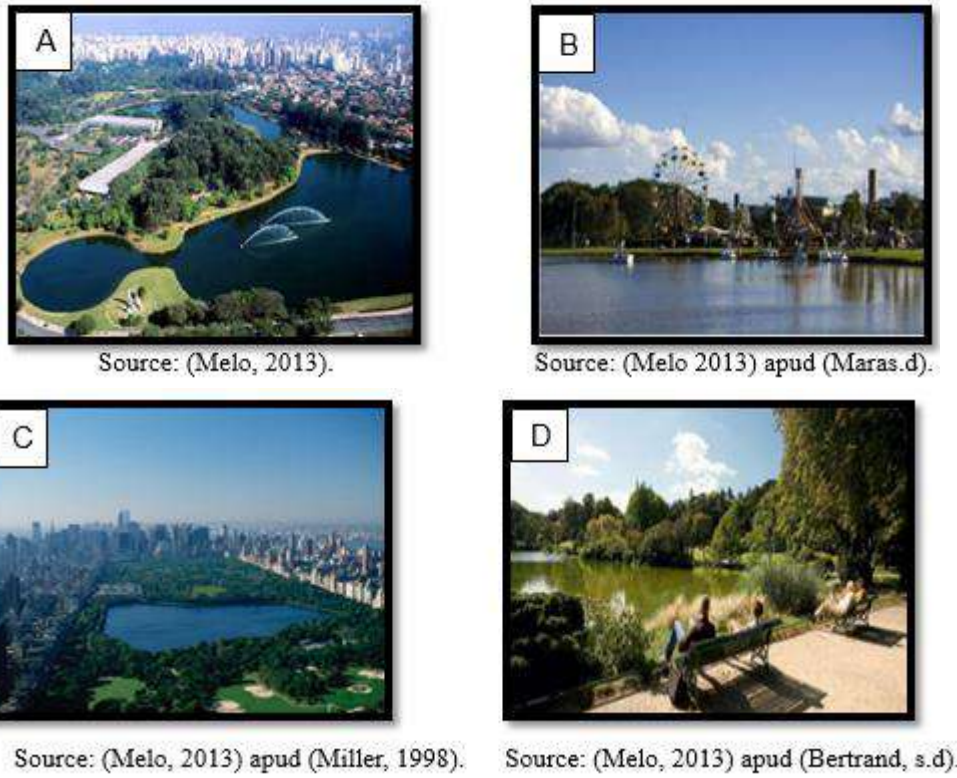


*Fig.2 - Urban Park. Legend: a) Ibirapuera Park - SP; b) Barigui Park in Curitiba - PR.; c) Central Park - NY; d) Montsouris Park in Paris.*

## IV. HISTORY OF MINDU MUNICIPAL PARK

According to Cascais (2011), in the area where today is located the Mindu Municipal Park, around 1940, a grotto was installed in honor of Our Lady of Lourdes, on the banks of the Mindu stream, an area that was known as the quarry site. At the beginning of 1960, the area was sold to the Redemptorist priests of the Parish Of Our Lady of Aparecida, being used as a retreat by the Salesian community, where activities were developed, such as planting fruit trees and growing Vegetables.

In the late 1960s and early 1970s, with the construction of the Humberto de Alencar Castelo Branco Housing Complex, located near the creek and with the land invasions, the mindu stream began to become polluted. In 1975, with increased pollution, the land was sold to the Ministry of Finance and incorporated into the green area of the city. Without the care due by the responsible body, the area began to be the target of real estate, invasions and deforestation (CASCAS, 2011).

Silva (2014), corroborates saying that the park originated through an initiative of the residents of the surrounding area and the Manaus City Hall, which intervened against an invasion, which aimed to transform the green area into an "area of real estate speculation", having even deforested about 15% of the total area of the park.

After reestablishing the control of the park the Manaus City Hall, according to CitaCascas (2011), developed a project called "Projeto Gaia" (Mãe Terra), composed of 142 adolescents from 44 countries. Author Silva (2014) corroborates informing that the "Gaia Project' took place on March 18, 1992, the City Hall led the movement with members with the presence of the Prime Minister of Norway, Gro Harlem, who planted one of the inaugural landmarks of the Park, a tree of the species "Sumaumeira" *(Ceiba pentandra L. Gaertn)*, currently, is a symbol of the defense of ecology and the breaking of limits. The Fertility Monument was also built, using stones sent by children from different countries.

The incorporation of mindu Municipal Park to the Municipal System of Conservation Units, according to Cascas (2011): "occurred in 1993, through Municipal Law No. 219, of November 11, Mindu Park received legal recognition as "area of interest with an extension of 309,518 m², being incorporated into The SNUC and is governed by the regulation of Brazilian National Parks. In 1994, a federal decree authorized the assignment to install public ecological park, with the objective of environmental preservation of the area, having its land situation regularized".

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## V. LAND TRAILS AND SUSPENDED TRAILS

In 1996, the Manaus City Hall implemented the physical infrastructure of the park: urbanization of trails, suspended trail, orchid, environmental library, thematic squares, parking, and educational signage, aiming to develop environmental education programs (CASCAS, 2011).

According to Dray, Simonnetti (2012), there are nine (9) trails in Mindu Park are all open for public visitation, according to (DOM, 2006), along the trails, which contain information about the region's rich ecosystem, all trails have nine specific so-called: Jungle Trail, located in the area of baixio; the MargarethMee Trail; the Banana Trail, which features the wild banana tree; the Trail of Life; the Sauim-de-Manaus Trail; the Baixio Trail; the Trail of the Springs, which is situated in an area of high incidence of plant species; the Buritizal Trail; and the Suspended Trail (Figure 3), which provides closer contact to the visitor with the treetops.

However, at the time when the authors Dray, Simonnetti (2012), described about the suspended trails stressed that they were under maintenance. And currently as observed on site, it was noticed that the suspended trails are up to date.


*Fig.3 – Hanging trails. Source: (A) (DRAY, SIMONETTI, 2012); Source: (B)(DIAS, 2019); Source (C) : (DIAS,2017); Source: (D) (DIAS, 2019).*

## VI. FEATURE ABOUT THE FAUNA AND FLORA OF MINDU PARK

The Park is the habitar that houses several species of fauna and flora of the region: animals such as the Collared Sauim (Saguinus bicolor), endemic monkey threatened with extinction, belonging to the Callitrichida family existing only in the region of Manaus, laziness (Bradypus tridactylus), typical rodents of the region such as cutia (Dasyproctaaguti) and squirrel (Sciurus antunes), birds such as hawk (Buteo spp), macaw (Ara macao) and a diversity of plant species (CASCAS, 2011). As Maia (2018) quotes Maia (2018), which in addition to the collared Sauim, the park has the presence of other species of The Amazonian fauna, such as Jacaré (alligatoridae), Cutia (Dasyproctaagui), Cobra Coral falsa (Dipsadidae) (Figure 4)

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*Fig.4 - Resident Fauna In Mindu Municipal Park*
Source: (DRAY; SIMONETTI, 2012; TAPAJÓS, 2014; ALMEIDA,2018).

It has native vegetation of baixio/igapó forest or flooded areas, dry land and secondary capoeira forest. According to Ribeiro, Araújo, Santana (2007), there are species that have been introduced (Euterpe oleraceae Mart., Eleaeis oleifera (Kunth) Cortés) and four species are of secondary forest or anthropized forest (AstrocaryumaculeatumG.Mey., Attaleamaripa (Aubl.) Mart., Oenocarpusbacaba Mart. and Syagrusinajai (Spruce) Becc.) increasing the number of species occurring in the park. The spring that runs through the park is called Igarapé do Mindu, from where the name of the park originated (CASCAS, 2011).

As Vieira (2012), the Igarapé do Mindú runs between the neighborhoods of Manaus, its source is located in the Neighborhood Jorge Teixeira, in the East Zone, in the Parque Nascentes do Mindu, near the Botanical Garden of the Ducke Reserve, then crosses the city towards northeast-southwest, traveling and delimiting numerous neighborhoods, such as Jorge Teixeira, Tancredo Neves, Cidade Nova, Cidade de Deus, Aleixo, Parque 10 de Novembro, N. S. das Graças, São Geraldo to the Neighborhood São Raimundo. It is noteworthy that the main source of the creek is preserved Parque Nascentes do Mindu, but the situation of the creek, as observed in the Municipal Park of Mindu is catastrophic, full of plastic, chemical and solid tailings.

## VII. THE INSERTION OF ENVIRONMENTAL EDUCATION IN MINDU PARK

Mindu Park receives tons of waste that are caused by the water course, resulting from the action of the anthropic, which irregularly discards its waste in the streets and streams of the city (SEMMAS, 2017). According to Maia (2018) programs aimed at reducing solid waste is poorly practiced in communities and for ecological awareness in the collective recycling projects to be a solution for public policies in relation to the reuse of waste.

Over the years, much has been heard about the problem currently installed about the misuse of man in relation to the environment. Comments Medina (2016), that the environmental problem is the result of the misuse of natural resources, air and water pollution, destruction of ecosystems, among other forms of destruction, in which it is in the dimension of inefficient public policies in the concerning the lack of political commitment and education.

In this context, Environmental Education (As) appears in a perspective to bring reflections on the actions of anthropic, in raising awareness and raising awareness of the permanence of biological biodiversity for future generations. With regard to EA incentives in Mindu Municipal Park, according to (SEMMAS, 2017) since 2013 a project called "D Day, all against solid waste",' where community is invited together with companies to participate in the collection of solid waste that accumulate in the creek inside the park. For Serafini, Santos (2007), the accelerated growth of the urban population of Manaus was accompanied by a density of environmental problems, related irregular occupations, the destruction of plant cover, pollution of watercourses and the lack of Sanitation.

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In 2018, this action removed 3.9 tons of waste from the banks of the creek, in the stretch that cuts through mindu park. And in 2019 the amount of waste collected was 3.6 tons (SEMMAS, 2018; SEMMAS, 2019).

According to Maia (2018), the solid waste existing on the banks of the Mindu stream are of various materials (Figure 5), which take years to decompose in the environment. The Ministry of the Environment (MMA, 2019), informs that the natural decomposition time of paper is three to six months, metal takes more than 100 years, aluminum 200 years, plastic takes more than 400 years and glass takes more than 1000 years to decompose.

In this respect, Carvalho (2008, p. 38), draws attention to us in terms of a socio-environmental vision in relation to nature, the Mindu Municipal Park recognizes that, in order to solve the environmental problem it is necessary that the community be involved.


*Fig.5 – Solid Waste characteristics found on the banks of the Mindu Creek.*
Source: (MAIA, 2018).

It is noteworthy that the socio-environmental context that THE appears in a perspective of bringing reflections on the actions of man, of raising awareness and raising awareness of the permanence of life for future generations (OLIVEIRA et. al., 2019). Corroborating the authors Cavalcante, Teixeira, Moura, (2013), stating that EA and its actions contribute to human and social transformation, focusing on the three R's (Reduce, Reuse, Recycle), sensitizing and informing society, with the objective of adding environmental awareness.

According to Oliveira et. al., (2019), on the term of sustainability, which has won the world, and the global concern of environmental problems has driven several conferences to discuss the paradigm of development in a sustainable way. The introduction of the community in conservation units is a means of informing about various environmental impacts that can often be mitigated with simple attitudes.

The Mindu Park, was reopened in 2006 by the Manaus City Hall, and gathered other activities to attract visitors through gastronomy with the restaurant in Chapéu de Palha, whose runs are on weekends and holidays, and also through activities such as lectures, theater and music held in the Amphitheater, in addition the park is an excellent place to perform physical education activities where there is even a public academy, and for those seeking some relaxing activity there is on Saturdays yoga. It is noteworthy that some activities are of public organizations and also private non-governmental organizations, the more the purpose is to promote actions to establish an internal visitation and knowledge about the operation of conservation unit, without assaulting resources Natural (CASCAIS, 2019).

Existing activities in urban parks aim to promote environmental education, corroborating the theme quotes Rezende et al., (2012), pointing out about the VictórioSiquierolli Park, located in Uberlândia - MG, which has an Environmental Education Center that aims to encourage extra-class activities by guiding users to explore the environment of a sustainable nature from the knowledge acquired in the park.

For Menezes (2011), based on his results collected in the Bosque John Kennedy Municipal Park, that of the frequency of visitors in the parks, demonstrates that the vast majority of users visit the place with due to the fact of the walkway for the practice of exercises physical, walking, walking, taking children to play. However according to Viana et al.; (2014), in Manaus in addition to mindu municipal park, there are other parks such as Sumaúma Park, Botanical Garden and Mindu Springs Park, both are located in the north and east zones, and according to their collected results the population has

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the view that areas greens only serve as shelter and misuse of marginals and addicts, who use the place to drug themselves and do robberies. This factor that should be analyzed, because for THE to be disseminated, socio-environmental actions need to be distributed equally.

## VIII. FINAL CONSIDERATIONS

Today's environmental issues are of great social importance in the face of threats that the degradation of the environment can lead to men and life on planet Earth. Conservation Units were children to prevent globalization from destroying native natural environments. The Mindu Municipal Park is one (UC) with an example of perseverance to exist today, thanks to the efforts of society and federal, state and municipal laws.

The literary resources about the park are of great importance to understand about the history and development of a (UC) located in urban area feeling the anthropic impacts. Widespread information and changing habits are the basis for mitigating the impacts on urban parks, environmental awareness can not only be too much in laws, it also has to be present in the daily attitudes of society, this can be done both at the national and local level. Finally, the realization of the literary study on CUs goes far beyond conservatism. It is a radical transformation of mentality in relation to quality of life, which is directly linked attitudes, values and actions with the environment.

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# Detection of burned regions in the state of Tocantins-Brazil through image segmentation

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***Abstract*—***Burns in the Cerrado biome are recurrent problems in the state of Tocantins, located in northern Brazil. It is possible to observe, through satellite images, large areas that were destroyed by fire. This paper proposes an algorithm that automates the detection of burn regions in satellite images. In this algorithm, image segmentation techniques are used in order to detect regions that most resembles burned regions, considering color information. The results showed that the method can be effectively used to detect burned regions in satellite images.*

***Keywords*—*Image segmentation, satellite images, burnings.***

## I. INTRODUCTION

The Tocantins state suffers from intense burnings every year, especially in the period from May to September, due to a severe drought. Throughout 2017, there were 22.531 fire outbreaks in the state, placing the state in 4th place in a national ranking of fires [1]. In 2018, the Tocantins state even declared risk of environmental disaster due to forest fires [2]. In addition, a large forest fire devastated several farms, killing over 1.000 animals and causing one person to die [3].

These statistics highlight the need to act, since Tocantins is a state that has different biomes and is considered a region of ecotones. It is noteworthy that forest fires affect nature in various ways, such as compromising the quality of soil, water, and air. In addition, the smoke generated can be toxic and aggravate respiratory diseases. Thus, combating burning can reduce public spending in other areas, such as health.

Currently, the monitoring of burned areas is not done effectively, because it basically consists of searches carried out by inspection teams, who act through complaints and try to find the responsible person so that they can adopt the appropriate administrative procedures [4]. Due to the difficulties encountered in controlling fires, their consequences are almost inevitable, and it is necessary to adopt other means to address the problem, to bring benefits to society and mitigate its consequences.

One way to help the public authority to take more efficient action to combat the burning of the Cerradobiome would be to map the areas hit by the fire outbreaks by processing and segmenting high resolution satellite images and measuring the damage caused by the fires, supporting the government in making decisions that seek to make the population aware. The Figure 1 taken from the Nature Institute of Tocantins (NATURATINS)[1]presents an example of satellite image that recorded areas of destruction generated by burnings. It is possible to observe that the burned areas are highlighted with a red outline.

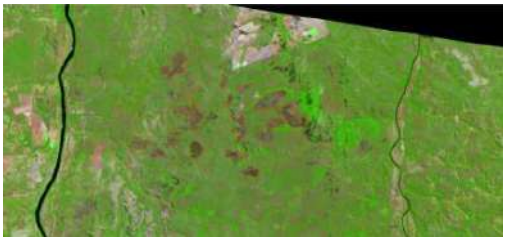

*Fig 1: Satellite image example of a region near the city of Palmas, capital of Tocantins, whose burnings caused destruction.*

Based on the facts presented, this paper aims to propose a method that can detect areas affected by burning by computationally analyzeof satellite images of the Tocantins state. For this purpose, digital image processing techniques, specifically image segmentation, will be used to detect the areas affected by burnings and to automate their mapping in order to help the government to make the population aware of the prevention and combat of burnings.

Image processing is an area of computer science that enables the manipulation of digital images such as photographs or video frames on a computer to visually enhance the image (to facilitate human interpretation) or to perform the processing of image data (storage,

[1]Available at: https://naturatins.to.gov.br/protocolo-e-servicos/diretoria-de-protecao-e-qualidade-ambiental/gerencia-de-monitoramento-e-gestao-de-infomacoes-ambientais/banco-de-imagens-/

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transmission and representation) to facilitate machine automatic perception. Depending on the purpose, it is only possible to pre-process the image or extract attributes from the image, allowing recognition of individual objects within a scene.

One of the most important steps in image processing is image segmentation, as all the following steps are influenced by your result. Image segmentation refers to the process of dividing a digital image into regions or objects, in order to simplify or change the representation of an image for easier analysis [5]. Based on this context, this work will focus on the detection of areas affected by burning in the state of Tocantins through the segmentation of satellite images. It is noteworthy that these images have several important information that can help identify various aspects of the region, such as lakes, forests, plantations, deforestation and regions affected by burning.

The proposed method uses an image segmentation technique in order to find a better range within the gray scale, which determine which pixels belong to the burned region and which do not belong. After the segmentation process, the image goes through a process called opening, which is responsible for removing noise in the resulting image, that is, small components left over from the previous step that are not interesting to the final result.

It is important to highlight that one of the challenges of this work is due to the high computational cost of working with satellite images, since these images are composed of bands with predefined spectral resolution based on the experience gained with the reflectance of more common types of satellite coverage. such as vegetation, water, soil and others [6]. Thus, it is necessary to use appropriate image segmentation techniques to work with high resolution images, which demand high computational cost.

This paper is divided into four well-defined sections: section 2 will address the theoretical foundations of the proposed approach, section 3 will present the methodology used to detect the burned regions in satellite images, section 4 will detail the results and, finally, section 5 will present the conclusion.

## II. THEORICAL FOUNDATIONS

Modern digital technology has made it possible to manipulate multi-dimensional signals with systems ranging from simple digital circuits to advanced parallel computers. The purpose of this manipulation comprises three main categories: image processing, image analysis and image understanding[7].

Image analysis can be understood as a set of techniques used to extract meaningful information from digital images. When used properly, image analysis can be a powerful tool that can provide important data about an image, but when misused, image analysis can produce misleading results[8].

Image understanding refers to techniques that attempt to interpret an image in terms of the "physics" of the imaging system, that is, a process that aims to understand the content of images. Generally, the process input is an image or sequence of images, and the output can be decisions, descriptions, actions, among others[9].

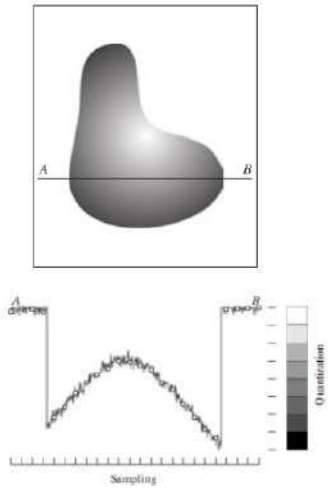
Image processing is used as a form of data processing, in which input and output are images such as photographs or video frames. This area of computing has two main applications: 1) Enhance visual information for human interpretation and 2) Perform image data processing for new processing, such as machine learning or pattern recognition.

In this work, image processing will be used in order to improve the image and automate the process of detection of areas affected by burns to facilitate the work of theinvolved people. The section 2.1 summarizes the concepts related to digital image processing.

### 2.1 DIGITAL IMAGE PROCESSING

An image can be defined as a two-dimensional function, $f(x,y)$, where $x$ and $y$ are spatial coordinates(plane), and the amplitude of $f$ at any pair of coordinates $(x,y)$ is called intensity or gray level of the image at this point. When $x$, $y$ and the intensity values of $f$ are finite and discrete quantities, the digital image is defined.

To convert continuous data to discrete data, two processes are performed: *sampling* and *quantization*. Sampling is a process in which image coordinate values are digitized. Amplitude digitization is called quantization. The basic idea behind sampling and quantization is illustrated in Figure 2.




*Source: Gonzalez [5]*

*Fig 2: Process of acquiring a digital image. (a) Continuous image. (b) Sampling and quantization.*

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According to Gonzalez [5], the field of digital image processing refers to the processing of digital images by a digital computer. For ease of understanding, this section has been divided into subsections. The subsection 2.1.1 addresses the steps that constitute image processing and the subsection 2.1.2 addresses the concepts of image segmentation and their variations.

### 2.1.1 IMAGE PROCESSING STEPS

The image processing area is divided into several distinct fields, but these can be synthesized into three main categories according to similar subjects:

1. Digitization and encoding: This is the process of image acquisition, in which a continuous image is converted to the discrete form with its subsequent compression to maintain storage capacity and the transmission channel.
2. Enhancement and Restoration: This area is concerned with enhancing certain important image features, as well as recovering images that have been degraded.
3. Segmentation and description: It consist of converting images into simplified maps with measures of characteristics and properties.

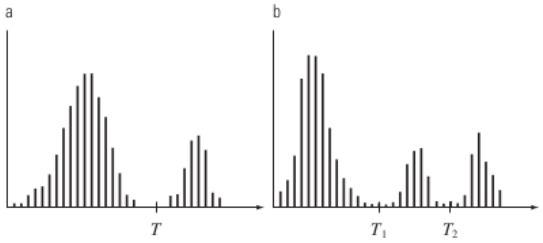
It is in the field of image segmentation and description that this work is focused. Through segmentation techniques it will be possible to map the regions of the Tocantins state that suffered damage caused by burning.

### 2.1.2 IMAGE SEGMENTATION

Image segmentation is an important step in Image Processing, which aims to divide an image into regions or objects, according to a certain criterion, which may be color, shape or texture. Often the result is not an image but a set of regions or objects. The accuracy of the segmentation phase determines the success or failure of image analysis procedures. Thus, segmentation becomes an important step in the attempt to detect the areas in which burnings occurred.

There are several image segmentation algorithms, each having their advantages and disadvantages, depending on the type of application in which the algorithm will be used. These algorithms are categorized according to two basic properties of intensity values: discontinuity and similarity. In the first category, the approach consists in divide an image based on sudden changes in intensity, such as the edges. The main approaches in the second category are based on dividing an image into regions that are similar according to a predefined criterion. Thresholding, region growth, and region division and fusion are examples of methods in this category. To achieve the best performance in image segmentation, it is often necessary to combine methods from different categories, such as techniques whose edge detection is combined with thresholding [5].

In this work, the proposed method for image segmentation is based on similarity, since a range of gray intensity values is found, which is responsible for identifying the regions that suffered burnings. The similarity segmentation process is based on the similarity between pixels according to a given criterion. Examples of techniques include thresholding and region growth. In this work, itwas considered the thresholding technique, which aims to separate the objects from the image considering the analysis of their histogram. A single threshold or multiple thresholds, as shown in Figure 3 can divide intensity histograms.




*Source: Gonzalez [5]*

*Fig 3: Image histogram. (a) Single Threshold and (b) Multiple Threshold.*

One of the difficulties of "thresholding" an image is determining the threshold value, i.e., separation point of the pixels. The simplest thresholding technique consists of partitioning the image histogram by a singlethreshold (**T**). With this, the segmentation is performed by scanning the image pixel by pixel and labeling each pixel as the object or background, depending on whether the gray level of that pixel is higher or lower than **T**. The success of this method depends entirely on how well the histogram can be partitioned.

### 2.1.3 MATHEMATICAL MORPHOLOGY

Mathematical morphology is an area of image processing that is concerned with the geometric structure of images. Through information from an unknown set related with topology and morphology, along with a defined completely set, called a structuring element, morphology is capable of segmenting, contouring, skeletonizing and eliminating noise from an image [10].

Erosion and dilation are the elementary operations of mathematical morphology and form the basis for the construction of the most complex transformations. In the morphological study of image processing, we have many operators, all of them defined from these elementary functions. Erosion combines two sets using subtraction vectors and can be denoted by equation 1:

$$A\ \theta\ B = \{x\ |(B)_x \subseteq A\} \quad (1)$$

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The effects obtained by erosion are the reduction of particles, the elimination of areas smaller than the size of the structuring element, the increase of "holes" and the separation of nearby areas. Already dilation combines two sets using vector addition, being denoted by equation 2:

$$A \oplus B = \{ x \,|(B)_x \cap A \neq \emptyset \quad (2)$$

The effects obtained by dilation are the filling of small holes and small particles and connecting nearby areas. From these two elementary operations in the morphological study, the opening process is obtained. The opening process is intended to eliminate unwanted particles from the images without abruptly changing the size of other areas. This process consists of erosion and then dilation of the erosion result, and can be denoted by equation 3:

$$A \circ B = \{(A \; \theta \; B) \oplus \; B\} \quad (3)$$

The purpose of morphological processing is primarily to remove imperfections added during segmentation, highlight shapes, extract components, among others. Through elementary operations (dilatation and erosion), it is possible to achieve more advanced operations and achieve very different results. Opening will be an important process used in the proposed method, as it is responsible for eliminating some noise from the images.

## III. METHODOLGY

The images used in this paper were acquired from a satellite image bank provided by the Nature Institute of Tocantins (Naturatins). These images cover the entire territory of Tocantins and were obtained from Landsat 5, Landsat 8 and Resourcesat satellites.

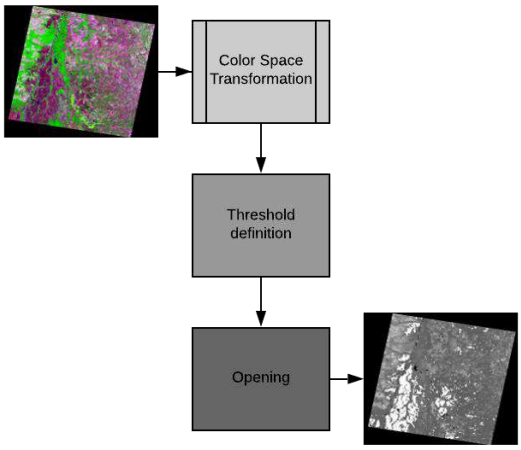


*Fig. 4: Methodology of detection of burned regions in satellite images.*

Basically, the methodology used to detect the burned regions in satellite images consists of three well-defined steps: color space transformation, definition of the threshold for identifying pixels that make up a burned region and choosing the parameter to perform the opening process, as shown in the flow chart in Figure 4 and detailed in the following subsections.

### 3.1 COLOR SPACE TRANSFORMATION

In the process of transforming the image from RGB color space to grayscale, the image is simplified to allow analysis of only one parameter: the gray intensity of the pixel. In addition, the results obtained by analyzing the grayscale image were better compared to the results obtained by analyzing a color image in the RGB model. The following equation 4 presents the process of converting a color image to a grayscale image, where *R* represents the intensity value of red, *G* represents green, and *B* represents blue.

$$L = R * \frac{299}{1000} + G * \frac{587}{1000} + B * \frac{114}{1000} \quad (4)$$

### 3.2 THRESHOLD DEFINITION

After conversion to grayscale, the image goes through the segmentation process. It is at this stage that all the pixels in the image are analyzed and classified as being from a burned region or not, depending on the gray intensity. The thresholds used are different for the different regions of Tocantins, since the vegetation cover in the state varies due to the transition of biomes. After performing several experiments to obtain the best threshold, it was found that for the region of the Palmascity, capital of the Tocantins state, the best threshold is in the range of 16 to 100, as shown in the following equation:

$$\begin{cases} \boldsymbol{burn}, & pixel[x,y] \in [16{,}100] \\ \boldsymbol{not\ burn}, & otherwise \end{cases}$$

For the “Bico do Papagaio” region, located in the north of theTocantinsstate, the gray intensityrangewas from 12 to 85, according to the following equation:

$$\begin{cases} \boldsymbol{burn}, & pixel[x,y] \in [12{,}85] \\ \boldsymbol{not\ burn}, & otherwise \end{cases}$$

Finally, for the “Ilha do Bananal”,transition region between the Amazon rainforest and the Cerrado biome, the gray intensity range used was 22 to 90, as seen in following equation:

$$\begin{cases} \boldsymbol{burn}, & pixel[x,y] \in [22{,}90] \\ \boldsymbol{not\ burn}, & otherwise \end{cases}$$

It is emphasized that experiments were performed with color images, considering the RGB color space, but did not obtain satisfactory results. With this method, each pixel color channel is analyzed separately, considering a certain range of established previously intensity values. If three color channels of the pixel fit within their respective ranges, the pixel is classified as a burn region. However, experiments have shown that using grayscale images yields better results.

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### 3.3 OPENING PROCESS

After the segmentation process, the resulting image goes through the opening process, which is responsible for removing any remaining noise from the previous step. In this process, the image receives a filter called a "structuring element", which passes from pixel to pixel eliminating small components that do not matter to the result. The size of the structuring element determines the proportion of details removed from the image. Therefore, it returns different results depending on the size chosen.

The choice of the structuring element must be made carefully so that to remove as much noise as possible without impairing the detection of the burned regions. In the experiments, the sizes 2, 3, 4, 5 and 6 were used for the structuring elements. Structuring elements of size 4 and 5 presented the best results, as they were able to remove more details without distorting the final result.

## IV. RESULTS AND DISCUSSION

This section presents the results obtained by the proposed method, as well as the image bank used for the experiments. The subsection 4.1 presents the image base and the subsection 4.2 presents the details of the performed experiments.

### 4.1 IMAGE BANK

The database used is a public repository of satellite images, covering the entire territory of the Tocantins state. This repository was created and is maintained by the Nature Institute of Tocantins (NATURATINS)[2], which has a department called "Management of Monitoring and Environmental Information", responsible for collecting and maintaining these images. In addition, it is committed to "planning, designing and structuring information and data relevant to the issue of loss of vegetation cover, fire/burn scars and environmental emergencies, water use and licensed activities" [9].

In addition, the images analyzed were separated into three different regions, due to the extensive size of the Tocantins state and its peculiarities of vegetation cover. The three regions chosen were: the city of Palmas, the "Bico do Papagaio" and the “Ilha do Bananal”. These three major regions were chosen because they represent very well the different vegetation covers present in the state: the region of the "Bico do Papagaio" represents the Amazon rainforest, the region of Palmas represents the Cerradobiome, and the region of “Ilha do Bananal” represents the transition region between the two mentioned biomes.

[2]Can be downloaded at: http://sinat.naturatins.to.gov.br/arquivos_web/index.php

### 4.2 EXPERIMENTS

The first experiment performed were made from the color analysis of the RGB channels. When analyzing the value of each color, a threshold range was found that resulted in satisfactory segmentation, as can be seen in Figure 5. In this example we used the intensity ranges of [3,191] for channel *R*, [30,85] for channel *G* and [60,160] for channel *B*.

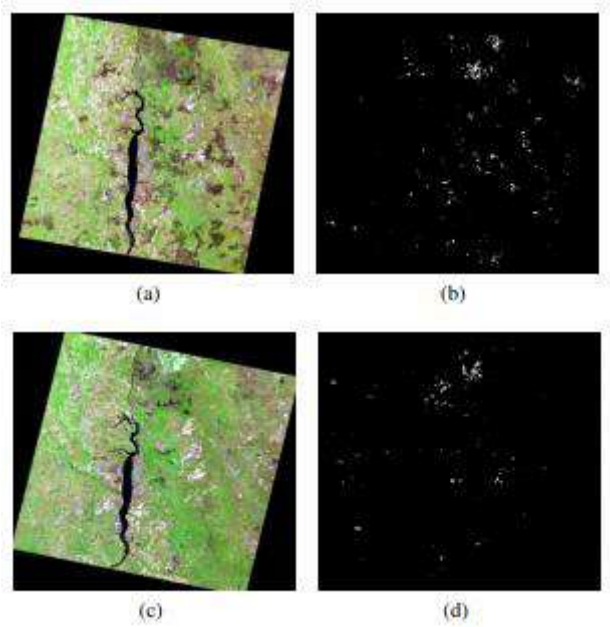


*Fig. 5: Result of the Palmas region image segmentation, using the analysis of the values of each RGB channel. (a) Original image of the year 2010. (b) Result of the image of the year 2010. (c) Original image of the year 2014. (d) Result of the image of the year 2014.*

Although thresholding range, considering RGB color channels, gives good results for some images, it no longer offers the same for other images. For example, Figure 6 shows an example of a segmentation that did not yield a suitable result, because segmentation identified deforestation regions as being burned regions. It should be noted that this result can be explained by the similarity of colors between some deforestation regions and burn scars.

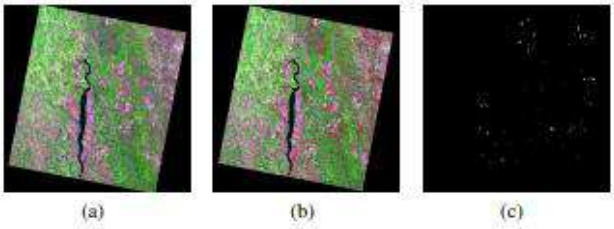


*Fig. 6: Result of the satellite image segmentation of the Palms region using the RGB color space. (a) Original image from year 2009. (b) Red dots show pixels identified as burn scar (c) Segmented image after application of opening process of size 3.*

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Then, from the difficulty of finding a threshold for each color channel of RGB model that could generalize well to all images, experiments were performed with the images converted to gray scale. Thus, the results obtained were better for allimages in general. Figure 7 presents a comparison of the threshold considering the RGB color channels and the gray scale. Note that the result of using gray scale conversion has less noise, and the identification of pixels that represent burned regions is more accurate.

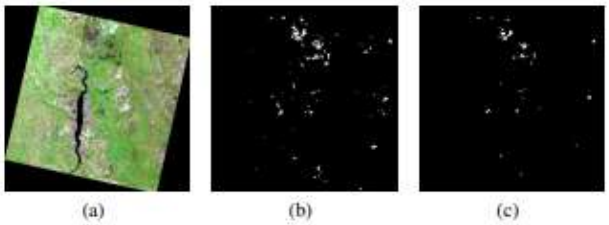


*Fig. 7: Result of the satellite image segmentation of the Palmas region. (a) Original image; (b) Color image segmentation (c) Grayscale image segmentation.*

Thus, satellite images were segmented after conversion to gray scale and, for each region of the state, a different interval was defined. For the Palmas region, the range of [16,100] was stipulated, the region of Bananal Island has the range of [22,90] and, finally, the region of the "Bico do Papagaio" used the gray level range of [12.85]. The Figures 8, 9 and 10 present the results for the region of Palmas, Bananal Island and "Bico do Papagaio", respectively.

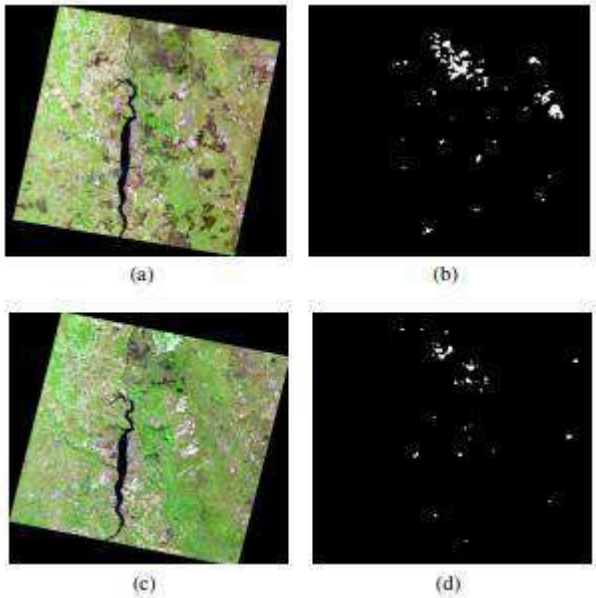


*Fig. 8: Segmentation of Palmas region. (a) Original image of the year 2010; (b) Image segmentation for 2010; (c) Original image of the year 2014; (d) Image segmentation of the year 2014.*

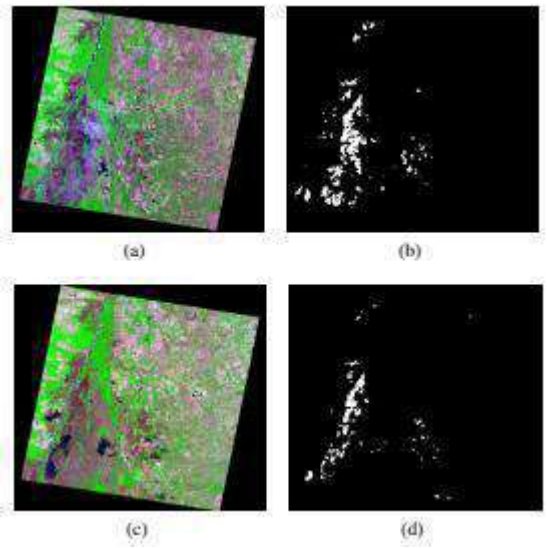


*Fig. 9: Segmentation of theBananal Island region. (a) Original image of the year 2010. (b) Result of the image of the year 2010. (c) Original image of the year 2011. (d) Result of the image of the year 2011.*

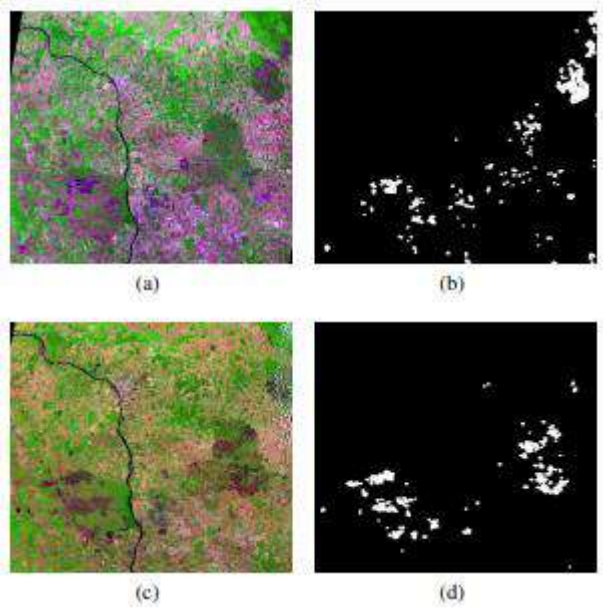


*Fig. 10: Segmentation of the "Bico do Papagaio" region. (a) Original image of the year 2014. (b) Result of the image of the year 2014. (c) Original image of the year 2015. (d) Result of the image of the year 2015.*

The results were interesting because the algorithm was able to detect the regions where the presence of burn scars is noticeable. The region that obtained the best results was the region of Palmas, where the detection of burn regions was the most accurate compared to the other regions. On the other hand, the region of the "Bico do Papagaio" showed the worst result compared to other regions. This fact can be explained by the greater presence of

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deforestation, making the process of detection of burns more difficult.

## V. CONCLUSION

The proposed method for detecting burned regions from satellite images makes use of image processing techniques, such as color space conversion, color-based image segmentation and noise removal by mathematical morphology, more specifically, the opening process. The results were satisfactory for most images used in the experiments, considering the peculiarities of each region analyzed.

From the visual analysis of the segmentation, the segmentation performed was able to accurately detect most of the burned regions in satellite images. However, the biggest difficulties encountered were in the images, in which the colors of the deforestation regions resemble the colors of the burned regions, that can confuse the algorithm, causing it to segment in a wrong way.

Over the years, by observing the results, it can be concluded that there was an increase in the burned areas and then decreased again. In the region of Palmas, the peak of burns were observed in 2010 and 2015, while in the region of Bananal Island, the years with the most burns were 2009 and 2010, and the region of the "Bico doPapagaio" presented highest burns rates between 2013 and 2015.

In addition, as part of future works, it is intended to measure the burned area detected in the segmentation process to determine the size of the area that was destroyed by fire. This new function could be used to better make the population aware of the large amount of destruction that the burning is causing, as well as to inform another research.

## ACKNOWLEDGEMENTS

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# PID Algorithm Applied on Led Lamps Luminosity Control

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***Abstract*****—** *Aiming sustainability and great demand of electric energy, there is a need for new technologies development, creating equipments to reduce costs generated by electric energy consumption, this article presents a prototype of control and energy monitoring applied dimmable LED lamp illumination circuit in a room, zenital architecture and sheds topology. To keep appropriated luminosity level, this system act monitoring natural light available on the environment and adjusting luminosity of the lamps, the control basis used in this project is a PID controller with retroaction because it is an industrial control algorithm very disseminated on automation sector which although being a robust system, it is very easy understanding and provide satisfactory results on automated processes. The control and monitoring take place from reading of luminosity sensors, of tension and current installed on prototype besides an LCD display that shows information from data obtained by sensors, this system has more flexibility to the user. A PID controller was designed to analyze and domain process, driving the system to get highest efficiency levels.*

***Keywords*****— Dimmer, LED, controllers, PID.**

## I. INTRODUCTION

The global electric energy wasting reaches high rates, having a consequence of climate change in the last years, therefore it is an important to promote and implement conscious use if electric energy. ISO 50001 deals with energy management, it is one more proof that worldwide companies have same objectives that is wasting reduction, preservation of natural resources and sustainable development.

Beyond benefits on correct use of electric energy, the energy efficiency projects contribute to people quality improvement, once the saved resources can be invested in health, education and leisure. The environment is also favored with these measures (SANTOS, 2012).

With that, the emergence if practical and effective methods of equipment optimization, that use electric energy, are the new market trend. In this view, the devices are designed with the intention of perform activities in the shortest time possible and generate high production, in view of the need for an efficient control so that no performance loss occurs (LOPES, 2018).

With the arrival of technology, that is possible developing autonomous equipments applying control basis and a management system, we can control the way electricity is delivered to the charge and assist in the consumption standards avoiding wasting.

This article has as objective to develop an illumination control system to assist on electric energy consumption reducing through automatic control of its luminosity intensity making better use of natural light of the environment. Design and evaluate a PID controller to control environment luminosity.

Also it was developing a hardware of control that analyze through sensors of illuminance in a specific environment and subsequently control power applied on illumination circuit.

## II. THEORICAL REFERENCE

### 2.1 Controllers

According to Ogata (2005), the robust and efficient control of variables as temperature, luminosity, color, level, humidity and flow rate, for example, guarantees good performance of automated process once these variables influence directly to products quality, there are two models adopted on control system.

#### 2.1.1 Open Loop

Open loop systems are those where output does not interfere with the control signal. That is, a process without feedback, but having a constant operating situation for each

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output value. It is recommended to use this model in systems where there are as few external disturbances as possible which are undetected and may interfere with the process. As illustrated in figure 1.


Fig. 1: Open Loop.

### 2.1.2 Closed Loop

The retroactive (closed loop) model uses feedback data from the controller output, acting proportionally to the error corresponding to the difference between the desired setpoint value and the system output value, as shown in figure 2. Thus, the system becomes less susceptible to external disturbances.

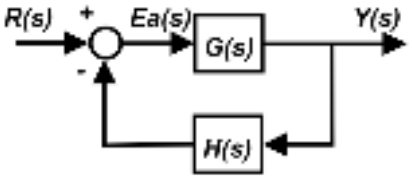


Fig. 2: Closed Loop.

### 2.1.3 Lighting Setpoint

The setpoint is the response value that is to be achieved with a control system, this value needs to be set and informed when controlling system adjustment.

An NBR 5413 (Brazilian Association of Technical Standards, 1992) establishes the minimum average illuminance values in service for indoor artificial lighting, where trade, industry, education, sports and others are performed.

### 2.1.4 ON/OFF Controller

Starting from a simple automatic control process, we have the ON/OFF method where the control variables are Boolean values (true or false).

This is an intelligent control form widely used in automatic lighting controls with electric photo relay or timer relays. And can be represented by the following equation:

$$u(t) = \begin{cases} U1 \text{ se } e(t) > 0 \\ U2 \text{ se } e(t) < 0 \end{cases}$$

Where U (t) only takes two values 0 or 1.

An ON / OFF control system can be represented by the block diagram of figure 3.

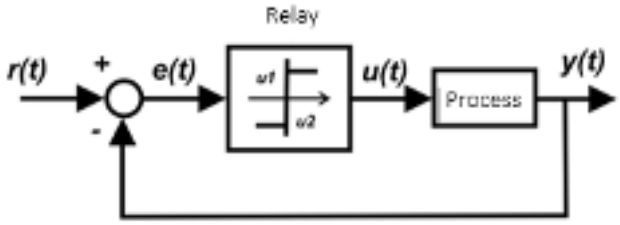


*Fig. 3: On/Off control.*

This control mode adopted in automatic lighting systems is elementary and relatively economical.

However, it does not provide the combination with high efficiency hybrid systems associating natural light, because it does not have a convergent behavior to the error acting dynamically in closed loop permanent regime.

### 2.1.5 Proportional Controller

For a controller with proportional control action, the relationship between the controller output signal u (t) and the acting error signal e (t) is:

$$u(t) = Kpe(t) \qquad (2)$$

Or, in the frequency domain,

$$\frac{U(S)}{E(S)} = Kp \qquad (3)$$

Where Kp is called proportional gain.

Whatever the actual mechanism or form of energy used in the operation, the proportional controller is, essentially, an adjustable gain amplifier.

A block diagram illustrating the action of this controller is shown in figure 4.


*Fig. 4: Proportional Controller.*

### 2.1.6 Proportional and Integral Controller

The performance of a P.I controller is defined by:

$$u(t) = K_p e(t) + \frac{K_p}{T_i} \int_0^1 e(t)\, dt \qquad (4)$$

Or by the transfer function given by:

$$\frac{U(s)}{E(s)} = K_p \left(1 + \frac{1}{T_i s}\right) \qquad (5)$$

Where Kp represents the proportional gain and Ti, called full time. Both values are adjustable. The integral control action is corrected from full time. However, a change in proportional gain affects both the proportional and control action. The figure 5 shows the block diagram of a proportional and integral controller.

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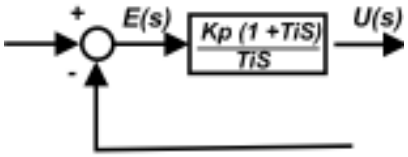


*Fig. 5: Proportional and Integral Controller.*

The combination of the proportional, integral, and derivative control action is called PID.

This combined control action has the advantages of each of the three individual control actions (proportional integral and derivative). Which is represented by the equation,

$$u(t) = K_p e(t) + \frac{K_p}{T_i}\int_0^t e(t)dt + K_p T_d \frac{de(t)}{dt} \quad (6)$$

Or by transfer function:

$$\frac{U(s)}{E(s)} = K_p\left(1 + \frac{1}{T_i s} + T_d s\right) \quad (7)$$

Where Kp represents the proportional gain, Td represents the derivative time and Ti represents the integral time. The block diagram of a PID controller is shown in figure 6.

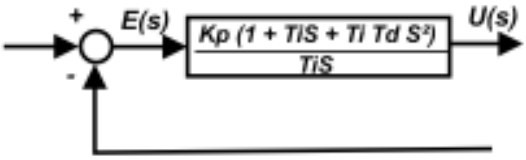


*Fig. 6: Integral and Derivative Proportional Controller.*

**2.2 Proportional, Integral and Derivative Controller Actions**

The control signal generated by PID controller is intended to achieve good steady-state transient performance of the controlled system.

According to Ogata (2003), the purpose of the controller is to compare the actual value of the plant output to the reference input, and to provide a control signal that will reduce the error to zero or as close to zero as possible.

By analyzing the presented controllers, it is possible to determine four basic configurations, defined from a specific plant, such configurations are:

1 - Proportional Controller (P).
2 - Proportional-Integral Controller (PI).
3 - Proportional-Derivative Controller (PD).
4 – Proportional-Integral-Derivative Controller (PID).

Where control parameters are:
Proportional gain Kp.
Full time Ti.
Derivative time Td.

The characteristic of the proportional controller is that it can be used in simple low precision processes because it cannot reset the control output difference and the setpoint value, Figure 7.

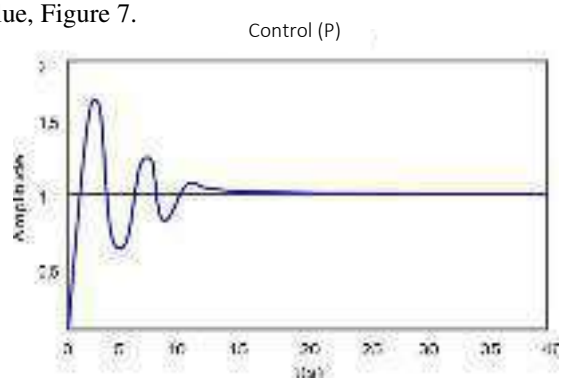


*Fig. 7: Control (P).*

The integral component of the proportional and integral controller is intended to accelerate the system response with respect to the size and duration of the error, in other words, to the accumulated error, reducing the off-set error generated by the proportional action. The integration gain requires moderate adjustment, as too low values may cause the system to have a slow response, while a high gain will lead to an unstable system response, figure 8.

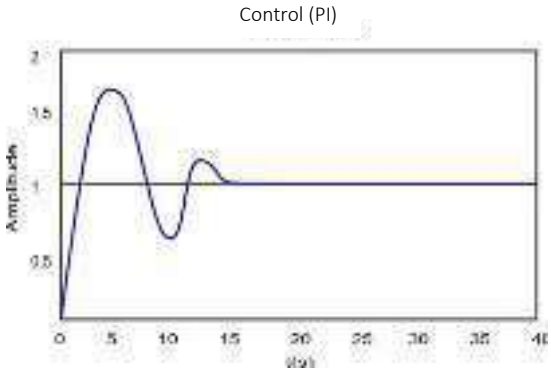


*Fig. 8: Control (PI).*

The derivative component of the proportional and derivative controller is applied to the system inertia which is explained by the process performance that has a natural delay in the output signal by modifying the input variable. Derivative action anticipates error correction by decreasing system response time.

The objection to the use of, exclusively derivative, a controller is at its extreme points, where in a system with excessive noise tends to a highly variant error that interferes with the control algorithm leading to an undesired output, while a derivative controller tends to zero if the error value is constant, in which case a proportional variable is required to generate a signal at the controller output.

The rate of change of the error is determinant in the action of the derivative controller. In the point of view and

Control (PD)

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one application practices the derivative controller and determinant in the stability of the system acting in the reduction of the overshoot caused by the integrative gain, Figure 9.

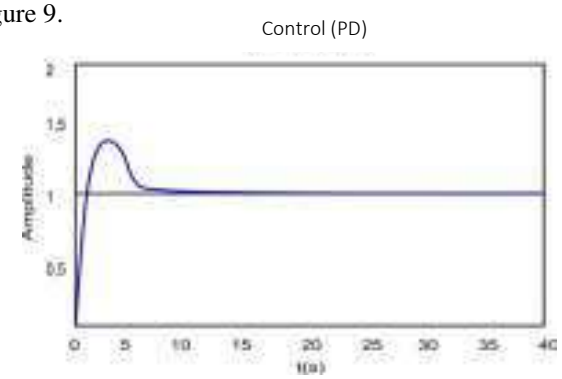


*Fig. 9: Control (PD).*

The proportional, integral and derivative controller combines the advantages of the PI and PD controller. The integral action is directly linked to the accuracy of the system being responsible for the null error in steady state.

The destabilizing effect of the PI controller is balanced by the derivative action that tends to increase the relative stability of the system while making the system response faster due to its anticipatory effect, figure 10.

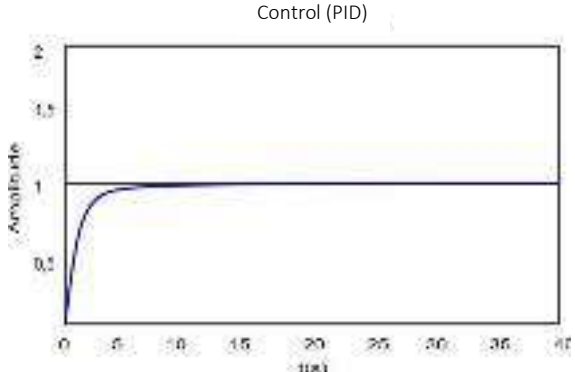


*Fig. 10: Control (PID).*

### 2.3 Manual Tuning Method

When designing a PID controller, it is necessary to adjust some parameters that influence the system behavior, these are specific gain values (kp, ki, kd). The literature presents numerous methods that allow this adjustment. In the case of manual tuning, the parameters are adjusted separately and the system behavior is analyzed until the desired results are obtained.

## III. HARDWARE

### 3.1 ATMEGA328P

The Atmega328P is an AVR microcontroller developed by ATMEL, it has fourteen digital inputs / outputs (six of them PWM), six analog inputs, 32Kb Flash Memory, 2 kb RAM (SILVA et al., 2014).

The microcontroller is responsible for processing the data obtained through the light, current and voltage sensors, transforming the voltage levels generated at the sensor output into the physical equivalent of each unit of measurement using a linear equation implemented in the embedded software. It is also responsible for configuring Pulse Width Modulation (PWM) signal generation to configure the TRIAC conduction angle (Triode for Alternating Current), controlling the amount of energy delivered to the load.

### 3.2 TRIAC

The TRIAC, alternating current triode, is an electronic component equivalent to two SCRs, connected in anti-parallel (anode with cathode) and terminal (Gate) tripped. This type of connection results in a two-way electronic switch as well as a DIAC (Diode for Alternating Current), conducting two-way electrical current (SILVA et al., 2014).

The TRIAC (Triode for Alternating Current) - an alternating corrective period represented by schematic figure 11.

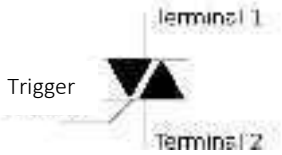


*Fig. 11: TRIAC (Triode for Alternating Current).*

The TRIAC is used to switch alternating current from a signal applied to its gate terminal. The trigger signal can be generated by a microcontroller that sends a variable period pulse train, where the average voltage delivered to the load is delimited by the time the generated signal has a high logic level. The operation of the TRIAC is illustrated in the graph of figure 12, which shows the triggering at different points of the sinusoidal signal.

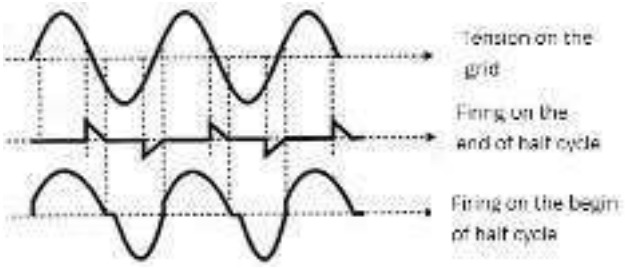


*Fig. 12: TRIAC Operation.*

### 3.3 BH1750

The BH1750 is a digital light sensor IC module designed for I²C bus interface. It is equipped with 16-bit digital output that provides a resolution from 1 to 65535 lux

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(WEERASINGHE, 2016). The block diagram representation of the sensor can be seen in figure 13.

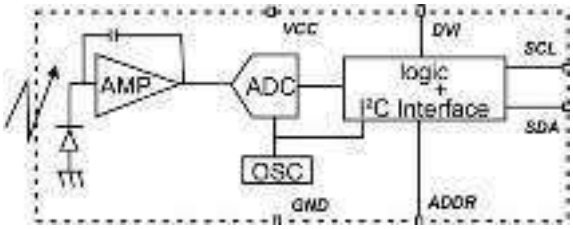


*Fig. 13: Block Diagram of BH1750.*

The BH 1750 is an ambient light sensor with digital data output, and has built in every circuit essential for its operation, including a silicon photodiode, a signal amplifier that converts photodiode-generated electrical current into an analog voltage signal that features a 16-bit resolution AD converter for the amplifier-generated voltage signal, which is calculated and expressed in the lux unit of measure. Data generated on the sensor's internal circuits is transmitted in I²C protocol to other devices with the same technology through the data pins (SLA) and (SLC) clock, and more than one sensor can be connected to the same data bus.

### 3.4 Integrated Module NRF24l01

The NRF24L01 communication module consists of an integrated radio frequency wireless communication circuit developed by Nordic Semiconductor Company. That uses the NRF24L chip. Depending on the manufacturer, the module is Transceiver, that means, operate as sender or receiver, depending only on modifying its settings.

In the case of communication between frequency radios of the same type, it can present up to 2 Mbits for the data transfer rate, has 125 channels and works in the frequency range of 2.4 - 2.5GHz (ORTIZ, 2013).

In the module integrated circuit, besides the passive components, it has an antenna that helps to send and receive data, also has 10 interface pins between the transceiver module and a microcontroller with SPI protocol. The module in figure 14, together with the electrical scheme shown in figure 15.

*Fig. 14: Module NRF24L0.*

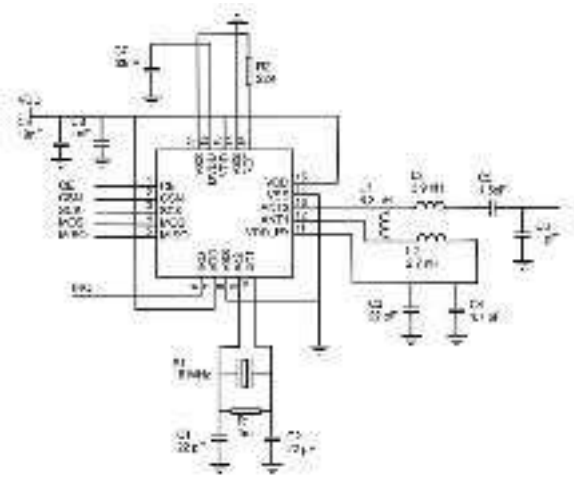

*Fig.15: Electrical Scheme NRF24L0.*

### 3.5 LCD Display

The operation of the LCD (Liquid Crystal Display) is based on the existence of an electric field in the region where the liquid crystal is located, which tends to organize its molecules, thus allowing the passage of polarized light, the control of electrode voltages, providing the necessary characteristics so that an image or information summing up all the pixels can appear (MUNARINI et al., 2015).

The LCD controller has a RAM, called display data memory and referenced with the acronym DDRAM (Display Data RAM), which receives the data we want to display. For example, to make the letter “A” appear in the first position of the display, simply write the byte 41H (ASCII of the letter A) at position 0 of the DDRAM (SANTOS, 2012).

The LCD display used in this project has 16 columns and 2 rows in which they indicate the voltage, current, power and luminous flux values. This display was chosen due to the low-cost in the market, besides having a HD44780 controller, that is an easy-to-communicate with microcontrollers.

### 3.6 Current Sensor

The ACS712 - 30A current sensor, which supports instantaneous current values between - 30A and + 30A. The sensor output is a voltage value between 0V and 5V, proportional to the measured current (Pacheco et al., 2016).

According to information from ACS712 datasheet reads DC / AC current, and generates a potential difference that can be read by a microcontroller, when there is no electric current the voltage value is 2.5V in alternating current according to the graph illustrated in Figure 16.

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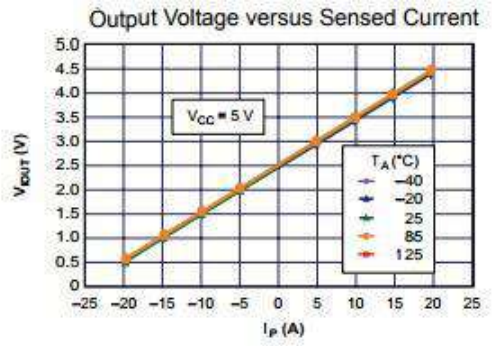


*Fig. 16 Voltage current ratio ACS712.*

## IV. APLICATIONS

In order to rationalize the consumption of electricity, many projects are currently being developed, among them architectural projects that present new geometries and buildings with the purpose of absorbing natural resources, such as wind minimizing thermal loads and light decreasing the current consumption generated to illuminate environments.

Natural light offers many advantages in terms of energy efficiency in buildings and can be a determining factor in reducing electricity costs.

There are many projects that aim to use natural light as we can mention the use of zenith openings in buildings. However, the design and sizing of lighting circuits in most cases does not meet the main disadvantage of these types of architecture, which is the variation in ambient light levels due to climate change. Which characterizes a problem to be corrected. Projects are being developed with the same purpose which encourages the pursuit of improvement, in this case a low-cost application with a robust control strategy, aiming to obtain better results.

## V. RELATED WORKS

The development of this project starts from the bibliography of similar works with common objectives, which allow the study of applications and comparisons of the results achieved between them.

### 5.1 Case Study

#### 5.1.1 Developing a Light Controller for Alternating Current Power Leds

Silva; Siqueira and Alberti (2013) feature present the development of an AC power LED light controller, which brings economic advantages of the product in relation to those present in the market, taking into account the importance of adequate lighting in study, work and leisure environments. The importance of the development of new technologies that help in the rational use of electricity and reduce environmental impacts is known.

The technology used as a light source is the power LED that has its AC power supply. Being widely used for longer durability and lower power consumption, the advantages of this technology increase through power control, bringing the lighting to levels suitable for certain environments.

The tests in the development of this project showed the luminous variation of the LED's from the change of voltage value, leading to the development of a dimmer circuit.

The use of Seoul Semiconductor's Acriche LED line has assisted in the development of this project by operating on AC power without the use of converter circuits, ideal for residential and industrial applications that have AC power sources.

The emitter used for this project was the A3 W series 4 W AN3200 and the temperature is approximately 3000 K, an illumination level of 200 lux (measured at 50cm distance) and a luminous flux of 180 lumens.

Control of the voltage and current amplitude in this design is done by a PWM-controlled AC-AC buck converter, which features two-way IGBT switches with internal diodes, applying a voltage to the load at a given time and proportional to the duty cycle network operation by controlling the effective voltage range on load.

The control PWM signal is generated by means of a PIC 18F4550 microcontroller and intermediated by an HCPL-314J driver with the function of integrating the control and power circuits controlling the semiconductor switches, drive frequency parameters and made by means of a potentiometer.

The final design has advantages in the use of low-power, long-life AC power LEDs that can reach over 30.000 hours of operation, which makes it possible for domestic and industrial use to control with two-way switches using MOSFET, which operates at a given angle of conduction of the voltage delivered to the load, controlling the light intensity and the power consumed by the LED. However, operation of this type of switch may cause damage to the circuit due to excessive time or signal overlap when switching the switches.

The use of the HCPL-314J driver for key actuation, which can drive two MOSFET independently, made the interface between the controller and the converter generated by PWM was not enough to activate the keys, which were sized to work at 15V dc.

All the electronic arrangement developed in this project proves that the ideas are fully applicable, and with objective achieved in relation to the economic advantages that reaches fifty percent compared to other imported products with the same functionality, according to the authors research.

#### 5.1.2 High Efficiency Lighting Control, Adaptable to the Environment, Using Led Lamp

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The project developed by Diego Zeuner Fagundes Santos (SANTOS, 2012) in which addresses a high-efficiency light control, adaptable to the environment, using LED lamp. It seeks to show the rational consumption of electricity from the control of light, and the application of natural light in certain environments, causing the power of the lamps to be reduced or increased according to the amount of light in place, maintaining a range practically constant lux and specific for each environment, avoiding energy waste.

For this control practice, a prototype was developed that uses LDR (light dependant resistor) that has its physical characteristics modified, by incident light on its surface generating values that are interpreted by a PIC16F877 microcontroller which controls the power of LED lamps, through an array of components such as a 4n25 optical coupler to isolate the circuit to prevent burnout of the microcontroller port and a TIP122 transistor operating as a pulse width modulation (PWM) pulse width modulation.

The prototype features a 16 x 2 LCD display, which shows the user the minimum and maximum light levels to choose from within a range of 200 to 1200 lux. Predefined setpoint values are shown on the display and vary within a range of 100 to 100 lux, until user choice made via a button installed on the control board.

The implementation of an LCD display has made machine-man interaction more efficient. Enabling the visualization of control parameters and monitoring of sensor data, making a system more dynamic without the need for direct interaction with source code files and the compilation of new data, which would require specific programming language knowledge.

The application of a PWM control provided the variation of LED brightness due to the pulse width applied to the load, in this case in LED lamps. The PWM control is widely indicated for control in direct current circuits which was used in this project with 12V LED lamps, which makes the prototype unfeasible considering that the residential electric circuits use alternating current voltage and amplitude above 100V. Then requiring a transformer to reduce this voltage as well as rectifier circuits and filters in the lighting circuit to be controlled by PWM.

To obtain the luminous intensity which is measured in lux, an LDR photodetector was used which has its resistance altered according to the amount of light in the environment, a simple component to be used in certain applications. However, since it is a nonlinear component, it requires the use of mathematical tools to obtain the characteristic equation, which converts the signal of the resistance variation at the system input into an output signal expressed in lux.

The developed prototype has the sensor installed on the control board making the design less coherent, as it requires both to be exposed to the monitored environment. However, the developers were successful in relation to the proposed project, which combines an automatic control system for artificial lighting, further enhancing the savings in the use of LED lamps.

**5.1.3 Smart Low Power Lighting Control by Android Operating System Devices**

Paulo Souza (SOUZA, 2016) proposes intelligent low power lighting control through devices with Android operating system.

The development of this project starts from the idea of housing resources management applied to lighting, through home automation seeks to develop in the android system a process of control of light intensity and color in LED strip lighting, this control will be done automatically or remotely. with wireless communication and Bluetooth protocol.

The project also aims to prove the efficiency in thermal and visual comfort to those who are exposed to environments with light controls.

For this it was necessary to search for concepts such as smart home. A smart home connected to a network that can be remotely or automatically controlled making coherent system decision making.

The developed prototype uses an ATMega328P-PU microcontroller responsible for the storage and processing of control variables. To capture the amount of light, the hardware uses an LDR light-dependent resistor, which has its physical characteristics modified according to the incidence of light, as shown in other study projects.

The controlled light source was a Ws2812b addressable LED strip with additive RGB (Red, Green, Blue) color system. This addressing technology enables different control data values to be sent over a single cable, which carries the digital signal generated by the microcontroller.

Wireless communication uses the Bluetooth protocol through a smart phone and a Bluetooth Transceiver module, which can communicate with other devices with the same technology as mobile phones, tablets and laptops.

The ATMega328P-PU microcontroller is easily found and has a relatively low commercial value which facilitates the development of low-cost projects with strong technological power. Using the LDR component as a light sensor requires the development of filters and mathematical equations that aid in an accurate reading of the amount of light, since it is not a linear device.

The use of RGB addressable LED tape is an interesting application because it allows the color variation and luminous intensity of the LED's, with only one digital output from the microcontroller providing control of several

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tapes individually through the various digital ports contained in the ATMega328P-PU. This LED strip operates at a voltage of 5V, the same operating voltage range as the microcontroller.

A feature that facilitates the design and use of smart phones as a means of controlling lighting system parameters through the Bluetooth protocol. This protocol communicates over a relatively short distance but sufficient in residential environments, for use on android operating system requires the development of an application, however this is not a problem as Bluetooth interface applications are easily obtained from app stores, or can be developed with Android Studio software as in the case of this project. Other interesting points in this project are the ways of control being them remote via smartphone and automatic with the reading of the light sensor. The authors of this research emphasize the great relevance of automatic control projects, which is increasingly present in everyday life with smart homes that bring comfort and convenience to users.

## VI. MATERIALS AND METHODOLOGICAL PROCEDURES

With technological advancement, smart devices are being widely developed in order to assist in certain activities, enabling to achieve better results for certain tasks.

For this purpose, an electronic control and automatic monitoring board for ambient lighting was developed. For system management an AVR microcontroller, the ATmega328P, was used.

The firmware was developed using the IDE arduino integrated development environment which is available at www.arduino.com, which has a C++ based programming language, so it was necessary to write the arduino bootloader to the microcontroller. The use of IDE arduino helped in the development of the project with ease in the elaboration of the system embedded in the prototype.

The control board layout was designed using Proteus Designer Suite 8.5 software, in this software it was possible to design the electrical scheme, perform the routing of components to build the printed circuit board layout, and the 3D visualization of the printed circuit board.

The control board operates on 127V alternating current voltage and controls loads of up to 5A of current draw corresponding to approximately 20 units of 23W LED lamps.

The interface contains a 16x2 LCD display where the user can view the voltage, current, power and brightness intensity values of the lamps. In this circuit the LCD display is configured for 4-bit data sending commands through four digital pins. The data reported on the LCD display is obtained through sensors installed on the board and through calculations made by programming such as the case of the power value.

To measure the load current, the ACS 712-30A current sensor was installed invasively in the circuit. The voltage values are obtained in the circuit through a P8, which is a sensor that detects alternating current 127V/220V voltage levels, and informs the microcontroller through analog ports, the use of this sensor in this type of application was interesting. The P8 module contains a 10kΩ and a 220kΩ resistor, and acts as a voltage divider, containing an electrolytic capacitor to stabilize the output values, also has an optical coupler that isolates the AC voltage from the DC signal sent to an analog port on the microcontroller.

The developed board has three control options: local, remote and automatic. By means of a push button, the user chooses the control option, the chosen option is informed on the LCD display. In the local option the brightness control of LED lamps is done manually and with a potentiometer installed on the board that allows the adjustment of light intensity.

The remote option is made with a smartphone or any other Bluetooth-enabled device that is previously paired with the control board using an HC-05 module, pairing access to send commands to the system for brightness adjustment, and receives values from lighting circuit monitoring. An HC-05 Bluetooth module was installed on the board and was configured using AT commands, operating in slave mode, sending RX / TX serial data.

In the automatic option the plate obtains the values of light intensity in the environment and autonomously controls the power of the lamps.

The luminosity measurement is made using a BH1750 light sensor that determines the amount of light measured in lux that falls on its surface, the values detected by this sensor are transmitted through an I²c protocol communication interface to the microcontroller. These values are for adjusting the wattage of the lamps thus maintaining the amount of lux required for the environment.

The determination of the illumination setpoint was made to comply with NBR5413 in item 5, subclause 5.3 Illuminances in lux, by type of activity, 5.3.13 Schools - meeting room which the standard indicates three illuminance values, 150-200-300. Following the sub-item 5.2.4.1. Which recommends to adopt the intermediate value in which it will be used in all cases.

The board contains a circuit with the TIC246 TRIAC that controls the lamp power by controlling the firing angle at a given point of the sinusoidal signal. A signal from digital pin 3 of the microcontroller to a circuit containing a 430Ω resistor and an MOC3021 IC triggers the TRIAC GATE, so that triggering occurs at the right time, a zero-

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pass detector that uses certain components is required, a rectifying bridge, two 30kΩ resistors and one 4n25 CI, this part of the circuit indicates the 0 volt path and is connected to digital pin 2 of the microcontroller. The lamps used were 9W dimmable LED light bulbs with 100l m/W luminous efficiency.

## VII. VALIDATION AND CHARACTERISTICS

Following the positioning patterns of lighting electrical panels, where they are generally positioned in discrete locations outside the common access area. This accommodation logistics requires the development of a wireless sensor network, since the light sensors need to be positioned in the environment to be controlled and the control board must be in the frame that distributes the lighting circuits.

The wireless sensor developed is a simple electronic circuit containing an AVR microcontroller, a BH1750 sensor and a NRF24L01 communication module, the BH1750 sensor detects the light levels and transmits through an I²c protocol communication interface to the microcontroller, deals with this information and sends it to the control board via module NRF24L01 giving feedback to the control system. This process of operating of the wireless light sensor is best represented by the block diagram of figure 17.

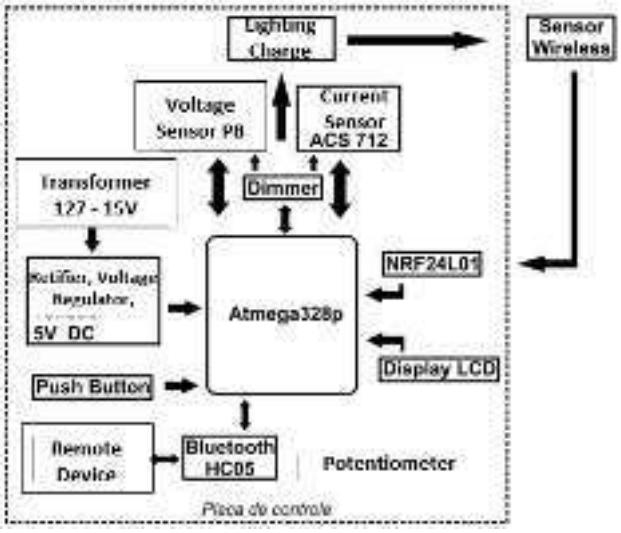


*Fig.17: Wireless Sensor Diagram Block.*

The developed control board carries within it all the tuning peripherals and system interface, where the user determines the control option established to the environment, it is up to him to choose the remote or automatic local control mode in all options the monitoring data is exposed through the on-board LCD display enabling data collection for personal reports or even efficiency comparison with other power controllers. The block diagram of figure 18 represents the control board hardware.

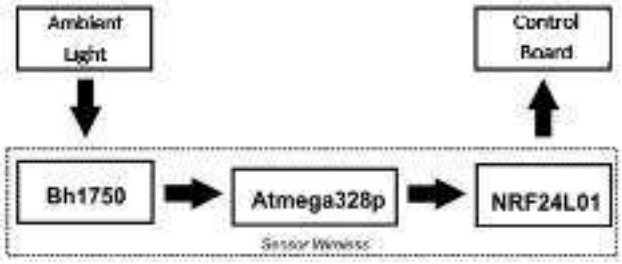


*Fig. 18: Control Board Block Diagram.*

The manual mode is a brightness adjustment in which it is not influenced by the variation of the outside light but also allows a reduction in energy consumption through the power control. However, combined with a zenithal illumination will have in the environment varying level of brightness being higher or lower than the standard.

The remote mode has the same characteristics as manual mode but with some advantages, among them, the possibility to obtain the monitoring data directly on the smartphone or notebook just by access pairing, to make control parameterization does not require direct access to the control board, these adjustments can be made directly from your device with bluetooth technology.

In view of the technology and intelligent devices that are being developed it was decided to keep the focus on automatic mode, in this version of the proposed project the automatic mode uses more elaborate control fundamentals, in it was implemented a PID controller, which enabled a better response to light levels in the controlled environment. In the PID controller design there are some parameters that influence system performance.

The strategy used to parameterize the PID controller gains was manual tuning by applying changes to the controller parameters and checking the process behavior until the desired result was obtained.

As said earlier application of this project refers to environment that uses natural resources as a source of light energy we can cite as an example the zenith lighting, so technical standards determine the appropriate light levels for each environment, so the lighting variation in a Zenith system due to climate variation can affect human health since very low as well as very high levels are detrimental to vision, so the automatic system tends to compensate for these variations by keeping the light level appropriate to the environment.

## VIII. RESULTS AND CONCLUSION

As indicated in the abstract of this document, the application of the control system was in a meeting room

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with zenith lighting in the sheds topology as shown in Figure 19.

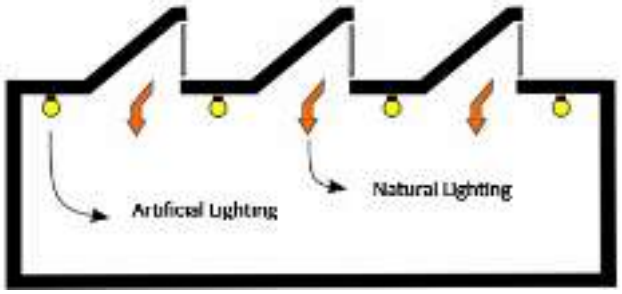


*Fig.19: Zenital Lighting Topology Sheds.*

The light levels adopted followed what is established by NBR 5413 (Brazilian Association of Technical Standards, 1992), which concerns the illuminance of interiors where trade, industry, education, sports and others are performed. Although the standard does not deal with hybrid or natural lighting, it serves as a basis for lighting-related design as no technical standard has been found to set parameters for such lighting respectively.

A lighting circuit in the room had its lamps replaced by dimmable LED lamps, the wireless light sensor was placed on the working plane where it could capture the light intensity of the room and the control board was installed in the lighting panel with a setpoint value of 200 lux, at that time the natural light had low intensity but still influenced the internal lighting of the room which needed the complement of artificial light but not at full power which already characterizes a reduction in electricity consumption, and enabled us to adjust the parameters of the PID controller. It has the following characteristics in relation to the parameter values.

With increasing Kp the process becomes slower and less oscillating with less overshoot. High value Ki makes the system accelerated making it possible to reach the setpoint value faster but has instability and more overshoot. Increasing the value of Kd slows down the system with less overshoot.

The controller was parameterized so that there was no overlap to the setpoint signal, avoiding light peaks of the controlled process, but with inadequate values the response signal did not reach the desired value as we can see in the graph of figure 20.

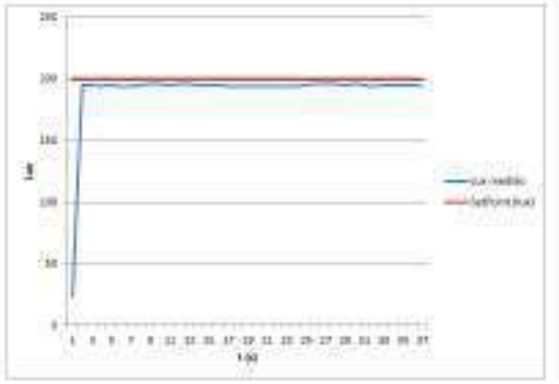

*Fig. 20: System Response with Inappropriate Values.*

Analyzing the system behavior, and adjusting new gain values obtained a value closer to the desired, as we can see in the graph of figure 21.

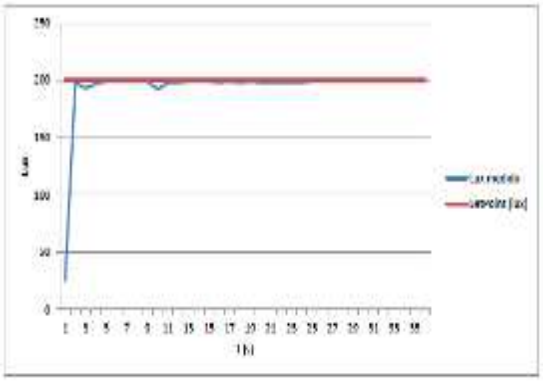

*Fig. 21: System Response with Appropriate Values.*

Through the analysis of the graph and table we detected an average value corresponding to 198.3 lux with the setpoint at 200 lux. That shows the application of the control method applied in this project reached an error rate of 0.85%. on a permanent basis.

Because it is a variant system due to the natural influences of the external illumination, the graph of figure 22 represents a transient analysis with high external variation as well as a unit step response.

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*Fig. 22: System Response to Single Step.*

In this case the initial error at 200 lux corresponds to 1.5% of the average read response values of the system, applying a radical variation of the setpoint value corresponding to half of the previous value, that means, 100 lux, the system took 3 seconds. to reach the desired light levels and followed with an error rate of 0.64%.

From the graphical analysis of the data obtained with the proposed prototype, we can notice the efficiency of a control system in obtaining desired results, emphasizing the energy saving with this system and easily perceived when not using, the maximum power of the lamps as previously, the simple control of power in relation to time characterizes a decrease of the consumed energy, besides maintaining the adequate light levels contributing to the visual health of those who frequent this environment.

The implementation of voltage and current sensors in addition to different control modes in this project aimed to show the numerous possibilities in an intelligent control project adding value to the developed product and inspiring new related projects.

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# Environmental impacts Caused by Irregular Occupation around the City of Lights, in the city of Manaus-AM

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***Abstract*— *In recent years the numbers of irregular occupations, so-called "invasions" are growing rapidly. Thus, this article deals with the environmental impacts caused by irregular occupations around the City of Lights, which is environmentally friendly. The objective of this work is to analyze the worsening of the environmental impacts caused by the "invasion" and irregular occupation of the City of Lights, in the city of Manaus-AM. This research is a case study based on lap visits and direct observation of the studied site and application of a closed questionnaire containing ten bibliographic questions and research and exploratory study technique. The results obtained indicate that it is advantageous to preserve and implement green areas around the City of Lights of Manaus, because influence on good air quality, in the local landscape, allows good thermal comfort and consequently influences d of people's quality of life, but there are some disadvantages, such as irregular occupations on site that is environmentally friendly.***

***Keywords*— *Invasion; City of Lights; Environmental Impacts.***

## I. INTRODUCTION

The search for housing spaces has multiplied in recent decades in large urban centers. Allied to this demand, there is the growth of social conflicts in cities, competition between social classes, a scenario, where the majority of the population is forced to look for less privileged places of services and with precarious infrastructure. In these areas we can verify that formal and informal dispute for physical space. Also, according to Carlos (1992), "society and space cannot be seen unboundmind, because at each stage of the development of society, will correspond to an stage of the development of space production".

Moreover, the high growth of cities combined with a lack of public housing policies does not allow cities to absorb and integrate the population, emerging from the need to expand their urban boundaries. Consequently, the landscape of cities ends up changing and areas covered by primary forests often suffer spontaneous occupations (invasions) (ROVERE e CRESPO, 2002; OLIVEIRA e SCHOR, 2009).

Therefore, irregular occupations are growing more and more and more often bringing changes to the environment, it is the case of irregular occupation around the City of Lights. Moreover, in many cases, significant portions of this population begins to occupy the "free" areas, areas aimed at environmental protection, common use of the people, planning of cities, protection of natural drainages, climate balance, protection of fauna and flora, construction of collective equipment (squares, parks, health center, schools, among others), further aggravating the socio-environmental problems experienced in cities.

The city of Manaus/AM is an example of this strong growth and modification of the landscape. A recent example, it was the Tarumã neighborhood that developed with the construction of the City of Lights, where less privileged people erect shacks causing various environmental impacts in the region through clearing and burned harming the natural environment, According to Assad (2011), almost always in these areas the deforestation index is high due to the construction of the shacks, this removal of vegetation directly impacts on the soil structure, as well as other impacts such as the loss of vegetation cover and soil compaction. In addition, the city of Manaus is valued as capital-nature for its location in the center of the Amazon, known for its great biodiversity (ARAÚJO *et al.*, 2015).

The area of the City of Lights, in the Tarumã neighborhood, West Zone of Manaus, was occupied irregularly, the place was to have been recovered and transformed into an ecological park to maintain the

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environmental preservation of the region, according to manaus prefecture, but what we see is u scenario of destruction with many shacks erected. The occupation causes problems in the natural environment, as often the "invaders" make fires to lift the shacks on site. The authors Durigan et. al., (2011) mention that, in order to avoid further anthropic degradations, measures can be made by surrounding the area and placating.

The impacts of invasions cause changes in the physical, chemical and biological properties of the invaded area, and these changes tend to compromise the structure of the site and the functioning of the natural ecosystem temporarily or definitively, making that disturbed environment (MMA, 2013). Thus, everything is aggravated mainly when they invade places of forest where environmental preservation is necessary, causing several impacts to the environment due to irregular occupations.

Albuquerque (2007) states that socio-environmental problems cannot be considered an imbalance in a relationship between man and nature. The author also states that it is not because nature is disgusted with the man who therefore wants to exterminate him. Nature has its own dynamics of transformation, but it is a man/nature relationship that is causing the environmental problems that threaten to extinguish our own species, after all the results come from a relationship of man with himself. In addition, environmental impact can be defined as " a set of social and ecological changes caused by disturbances in the environment, as well as the relationship between nature and society that transforms with time and place" (COELHO, 2001).

One of the main problems related to the occupation of urban areas, according to Nascimento (2007), are the environmental impacts, almost always noticed through floods, landslides, landslides, garbage production, erosions, among others.

The social impacts resulting from this irregular occupation is the situation of the low-income population suffering from the lack of resources to have a dwelling. According to Carvalho (2015). Environmental impact "is a set of social and ecological changes caused by disturbances in the environment, as well as the relationship between nature and society that transforms with time and place" (COELHO, 2001).

Therefore, data and information were sought with the purpose of analyzing the worsening of environmental impacts caused by the invasion and irregular occupation of the City of Lights, in the city of Manaus-AM. Linked to the general objective of the work, the specific objectives were limited: to verify the main damage caused to the environment around the invasion of the City of Lights and identify how the government acts to minimize these impacts. Thus, in this work, on-site visits were made to obtain the information and thus evaluate the impact of irregular occupation on the City of Lights community.

## II. MATERIAL AND METHODS

The research was carried out in the area of the City of Lights, located in the Tarumã Zona Oeste neighborhood of Manaus / AM, which has about 57,000 hectares and has approximately 500 families living on site irregularly.

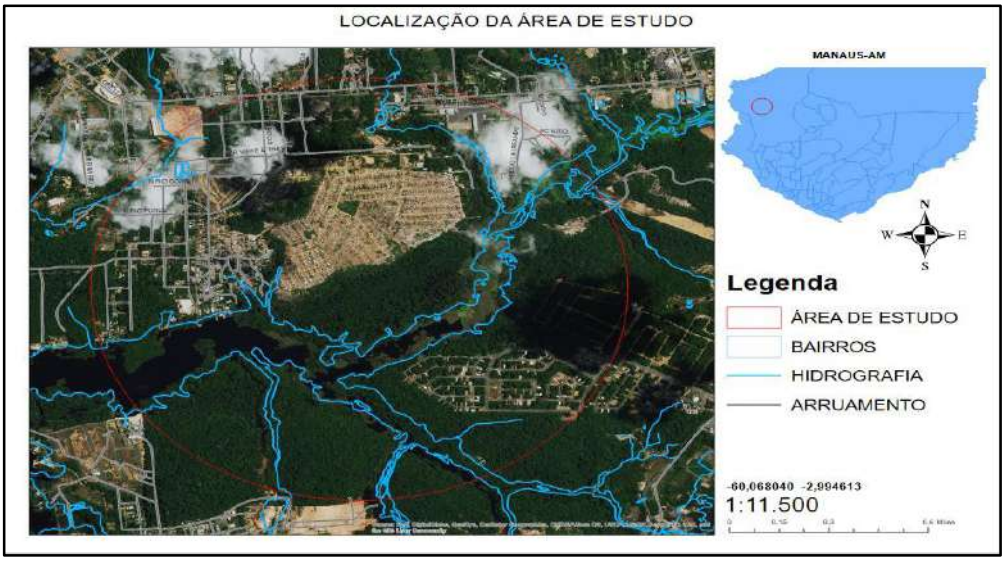


*Fig.1 - location of the occupation of the City of Lights, Manaus-AM.*
Source: (GOOGLE EARTH PRO 2019).

For the development of this research and data collection, the following procedures were adopted: There

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were visits on site, where photographic records of the site were made. Observations at the site were made in September 2019 at the site of the "invasion" in the City of Lights community, located in the Tarumã Zona Oeste neighborhood of Manaus/AM. Due to start in 2015 it was necessary to survey satellite images to have a real dimension of the loss of native vegetation. In addition, a closed questionnaire was applied to the residents of the place in order to know what they think about the problems caused by these irregular occupations and the impacts they cause to the environment.

The relevant aspects of this type of invasion begin by felling vegetation and fires to obtain space for the beginning of the construction of houses, for each aspect raised there is an impact of relevance not only for the occupants of the site, but also for the population in general. For fires there is the air pollution factor affecting the entire region due to smoke being carried by the force of the winds.

Irregular occupation brings waste accumulation problems since the area has no planning for traffic of collecting trucks, with this the problem of attracting animals that comes with the bad smell and remains of food, animals that attract diseases to adults and children who transit near the waste. Diseases that affect residents is a problem for public authorities to have to invest not only in the treatment of these diseases, but to mitigate the problem caused by the dumping of waste and effluents. In the case of effluents, given the location is close to a tributary called tarumã açu, where people from all over the city attend for leisure and outdoor bath.

The data collected during this research were tabulated in Microsoft Excel program spreadsheets so that they could be analyzed later. For analysis of the questionnaire and the interview conducted with the residents of the invasion, bardin content analysis (2012) was used, the set of analysis techniques may be systematic procedures and objectives of describing the content of messages and Documents. Therefore, the data were interpreted to verify the main environmental impacts caused by irregular occupations of the site studied.

In addition, the CHECK-LIST method was used, the model consists in the identification and enumeration of impacts, from an environmental diagnosis, which should include the physical, biological and socioeconomic means. After diagnosis, the diagnosis of the impacts caused at the site is made, and classify them into positive and negative (MEDEIROS, 2010).

## III. RESULTS AND DISCUSSION

The irregular occupation around the City of Lights generates several environmental and public health problems, mainly due to the lack of an efficient system of selective garbage collection. In the short term, the residues generated in the occupation are responsible for: bad smell, contamination of groundwater and surface waters, visual pollution (NASCIMENTO, 2007). In addition, incorrect disposal provides the appearance of vectors, worms, cockroaches, rats, spiders and all kinds of venomous animals, and can even expand the appearance of diseases and epidemics (BACKES, *et. al.* 2007).


*Fig.2: a) irregularly occupied area in the City of Lights; and b) irregular occupancy area.*

It is possible to observe in Figure 2 the emergence of degraded areas in the region of the new neighborhood, the cause of the degradation of the site according to Santos (2013), is related to the uncontrolled population increase of Manaus, including the environmental damage caused by the construction of the shacks in the occupied area.

In the area where irregular occupations occur, there is no collection of solid waste, so these are accumulated in a place and later burned. The burning of this manaus waste greatly affects the quality of air in the neighborhood City of Light, but the smoke generated by burning is transported to the central areas of the city of Manaus (Figure 3).

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In addition to discarded waste, occupations cause changes in soil characteristics in the region. First, soil mischaracterization began with the removal of vegetation cover for the opening of roads and constructions of residences (Figure 3), making the soil more exposed and vulnerable. Giangiulio (2009) showed in his analysis that one of preventing soil erosion from occurring is through the insertion of grassy species that do not require so much of soil, water and nutrients.

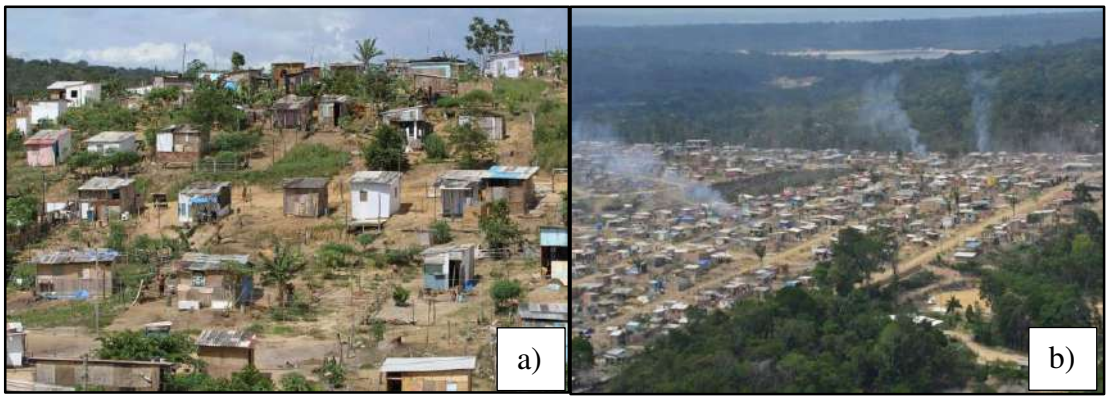


*Fig.3: a) irregular occupation, "invasion" City of Lights; b) burned in the City of the Lights (occupation)*

As Figure 4a shows, about 90% of people living in the area assume they have deforested the site to build their homes, while only 10% deny having done any kind of deforestation. Deforestation causes a serious ecological imbalance, especially in invaded areas, according to Batista (2016) rates of infectious diseases increase in environmentally degraded areas, there is epidemic incidence as cases of dengue malaria due to the aggressive process of deforestation of green spaces.

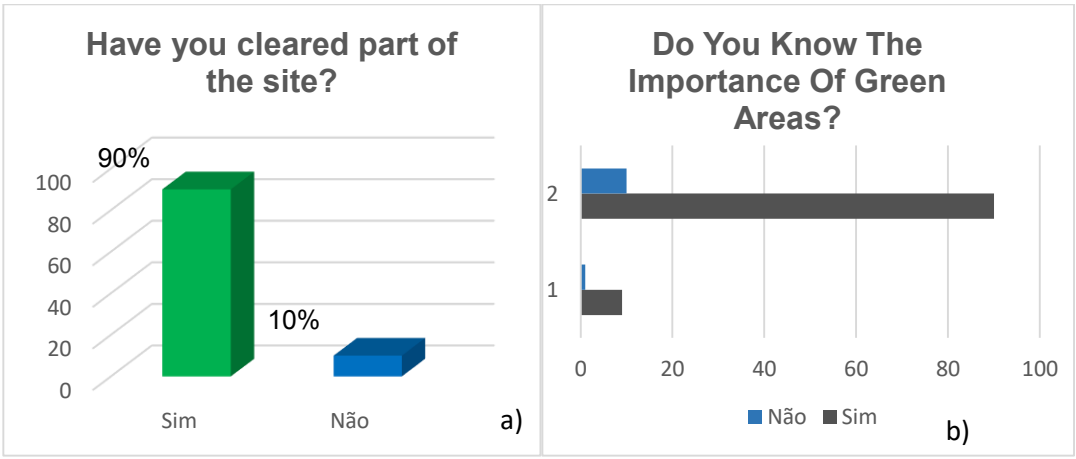


*Fig.4 a) and b) Questioning the residents of the neighborhood Cidade das Luzes*

Regarding the agreement of the interviewees regarding the influence of green areas on the preservation of springs and bodies of water, the result was positive since 82% of the interviewees fully agree with the importance of maintaining the Areas of Permanent Preservation, while only 18% partially agree, that is, most can identify the importance of joining the two biomes (Figure 4b). Still, Sánchez (2013). Therefore, fauna is seriously affected according to the Municipal Secretary of Environment and Sustainability (2018), and the impacts of deforestation can affect the well-being and behavior of wild animals.

At extremes, wild animals can extinguish species that are threatened with extinction. The main existing animals of the Amazon region according to Jabur and Junior (2018) are: beetles, butterflies, spiders, ticks, centipedes, shrimps, garden armanets, worms, blind snakes, royal hawk, eagle, falcons, macaws, parrots and parakeets among others.

Degraded areas need to be recovered, the main degrading activities are: agriculture, mining, desertification and uncontrolled urbanization. However, there are several models and techniques for the recovery of a degraded area, whose choice depends on the situation of degradation of the area and the regeneration conditions of the affected ecosystem (MMA, 2013).

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*Table 1: Conceptualization of the Attributes Used in the "Check List" and Definition of Attribute Valuation Parameters.*

| Attributes | Evaluation Parameters | Symbol |
|---|---|---|
| **CHARACTER**<br>Expresses the change or modification generated by an action of the<br>Enterprise<br>proposed on a given component or factor environmental by her Affected. | **BENEFICIAL**<br>When the generated effect is positive for the environmental factor considered. | + |
| | **ADVERSE**<br>When the generated effect is negative for the environmental factor considered. | - |
| **MAGNITUDE**<br>It expresses the extent of the impact, to the extent that a gradual valuation is attributed to the variations that actions may produce in a given component or environmental factor affected by it. | **SMALL**<br>When the variation in the value of the indicators is inexpressive, the environmental factor considered. | **MP** |
| | **AVERAGE**<br>When the variation in the value of the indicators is significant, but without scope to mischaracterize the environmental factor considered. | **MM** |
| | **BIG**<br>Where the variation in the value of the indicators is such that it may lead to the mischaracterization of the environmental factor considered. | **MG** |
| **IMPORTANCE**<br>It establishes the significance or how important each impact is in its relationship of interference with the environment, and when compared to other impacts. | **NOT SIGNIFICANT**<br>The intensity of interference from the impact on the environment and in relation to other impacts does not imply a change in quality of life. | **IN** |
| | **MODERATE**<br>The intensity of the impact on the environment and in relation to other impacts, assumes recoverable dimensions, when adverse, for the fall in quality of life, or assumes improvement in quality of life, when beneficial. | **IM** |
| | **SIGNIFICANT**<br>The intensity of impact interference on the environment and with other impacts causes, as a response, loss of quality of life, when adverse, or gain, when beneficial. | **IS** |
| **DURATION**<br>It is the record of the time of permanence of the impact after the action that generated it has been completed. | **SHORT**<br>There is the possibility of reversing the environmental conditions prior to the action, in a brief period of time, that is, that immediately after the completion of the action, there is the neutralization of the impact generated by it. | **DC** |
| | **AVERAGE**<br>A certain period of time is required for the impact generated by the action to be neutralized. | **DM** |
| | **LONG**<br>A long period of time was recorded for the permanence of the impact, after the completion of the action that generated it. In this degree, those impacts whose length of stay, after the completion of the generating action, assumes a definitive character. | **DL** |

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*Table 2: Conceptualization of attributes used in the "Check List" and Definition of Attribute Valuation Parameters.*

| Attributes | Evaluation Parameters | Symbol |
|---|---|---|
| **CONDITION OR REVERSIBILITY** Delimits the reversibility of environmental impact as a result of this action. | **REVERSIBLE** When the action that generated the change has ceased, the affected medium can return to its primitive state. | **RR** |
| | **IRREVERSIBLE** When the action that generated the change has ceased, the affected medium will not return to its previous state. | **RI** |
| **ORDER** Establishes the degree of relationship between impactful action and the impact generated on the environment | **DIRECT** It results from a simple cause-and-effect relationship, also called primary or first-order impact. | **OD** |
| | **INDIRECT** When it generates a secondary reaction to the action or, when it is part of a chain of reactions also called secondary impact or umpteenth order, according to the situation in the chain of reactions. | **OI** |
| **TEMPORALITY** Expresses the interinity of the alteration or modification generated by a project action on a given component or environmental factor affected by it. | **TEMPORALITY** When the generated effect presents a certain duration period. | **TT** |
| | **PERMANENT** When the generated effect is definitive, that is, it lasts even when the action that generated it has ceased. | **TP** |
| **SCALE** It refers to the magnitude of the environmental impact in relation to the geographical area of scope. | **LOCAL** Where the scope of the environmental impact is restricted only to the area of direct influence where the action was generated. | **EL** |
| | **REGIONAL** When the occurrence of environmental impact is more comprehensive, extending beyond the geographical boundaries of the direct area of influence of the project. | **ER** |
| **CUMULATIVENESS** Accumulation of changes in environmental systems, time and space, in an additive and interactive way, caused by the sum of past, present and/or predictable impacts in the future, generated by one or more of an isolated but contiguous undertaking in the same environmental system. | **CUMULATIVE** When there is accumulation, overlapping impacts of different natures or not on a given target (system, process or environmental structure). | **CS** |
| | **NON-CUMULATIVE** When there is no accumulation, overlapping impacts of different natures or not on a given target (system, process or environmental structure). | **CN** |

Source: adapted by the author.

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*Table 3: Conceptualization of attributes used in the "Check List" and Definition of Attribute Valuation Parameters.*

| **Observed Impacts** | **Attributes** | | |
|---|---|---|---|
| | **Positive** | **Negative** | **M/P** |
| 1. Elimination of flora and fauna | - | X | X |
| 2. Suppression of biodiversity corridors | - | X | X |
| 3. Increase in vector population | - | X | X |
| 4. Landscape change | - | X | X |
| 5. Formation of disease processes | - | X | X |
| 6. Change in water quality | - | X | X |
| 7. Increase in waste generation | - | X | X |
| 8. Increase in local population | X | X | X |
| 9. Increase in car movement | - | X | X |
| 10. Increased noise levels | - | X | X |

Source: adapted by the author

*Table 4: Environmental Impact Assessment Matrix - Control Listing.*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| - Landscape changes | **-** | **MP** | **IM** | **DM** | **RR** | **OD** | **TT** | **EL** | **CS** | **SS** |
| - Landscape degradation | **-** | **MP** | **IM** | **DM** | **RR** | **OD** | **TT** | **EL** | **CS** | **SS** |
| - Loss of vegetation cover | **-** | **MP** | **IN** | **DL** | **RI** | **OI** | **TP** | **EL** | **CS** | **SS** |
| - Fuga da fauna | **-** | **MP** | **IN** | **DM** | **RR** | **OI** | **TT** | **ER** | **CS** | **SS** |
| - Imbalance of trophic links | **-** | **MP** | **IN** | **DM** | **RR** | **OI** | **TT** | **ER** | **CS** | **SS** |
| - Loss of floristic potential | **-** | **MG** | **IS** | **DL** | **RI** | **OD** | **TP** | **EL** | **CS** | **SS** |
| - Damage to fauna | **-** | **MG** | **IS** | **DL** | **RI** | **OD** | **TP** | **EL** | **CS** | **SS** |
| - Ecosystem changes | **-** | **MG** | **IS** | **DL** | **RI** | **OD** | **TP** | **EL** | **CS** | **SS** |
| - Landscape change | **-** | **MM** | **IM** | **DL** | **RI** | **OD** | **TP** | **EL** | **CS** | **SS** |
| Morphological alteration of the terrain | **-** | **MM** | **IS** | **DL** | **RI** | **OD** | **TP** | **EL** | **CS** | **SS** |

PE - PHYSICAL ENVIRONMENT; BM - BITIC MEDIUM; AM - ANTHROPIC MEDIUM ‖ C - CHARACTER; M - MAGNITUDE; I – IMPORTANCE; D - DURATION; R - REVERSIBILITY; O - ORDER; T - TEMPORALITY; S - SCALE; C - CUMULATIVE; S - SYNERGY

Fonte: Longaretti (2015) adaptado pela autora

P (+) – Positivo – N (-) – M/P Medidas e Progra

The use of check-lists methods are standardized relationships of environmental factors from which the impacts caused in the natural environment are identified, thus environmental impacts when environmental impacts are identified most often it is necessary to create a project that is intended to reduce these damage caused to the nature of the.

As visualized in Table 4, all those mentioned suffer from the actions of impacts related to irregular occupation around the City of Lights.

In addition, it is possible to visualize in table 4 the negative aspects that interfere in the damage related to flora and fauna. Also analyzing the impacts described in Table 3 related to vegetation cover becomes cumulative due to several impacts that happen at the affected site.

Therefore, the main environmental impacts that can be observed in the area surrounding the City of Lights are presented in the control list, which can be noticed in Table 4. In which the analysis of the Control List present in Chart 01, it is verified that the main impacts observed are: Biological Medium: Elimination of flora and fauna, biodiversity and increase in the population of vectors and

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diseases. Regarding the Physical Environment: change in the landscape, formation of processes that harm the environment, change in soil quality Environment Anthropic: increase in waste generation, increase in local population.

Thus, among the measures adopted for these impacts the impacts on the biotic environment, we highlight the creation of protection areas for flora and wildlife, as well as the planting of new seedlings; isolate the protected area to prevent people and domestic animals from entering the site. Adopt an environmental education program, through lectures and courses on the environment and insert signage signs with phrases on environmental conservation.

## IV. FINAL CONSIDERATIONS

This work highlighted the irregular occupation of the City of Lights as an example of a degraded area due to irregular occupations that occurred in recent years at the site. From the observations made from visits *in colo* it was possible to observe: deforestation, fires and damage to the natural environment.

In addition, the relationship between the human being and the environment needs to be carefully managed so as not to worsen negative environmental pressures and impacts on the environment. It has been identified that more effective work is needed by the bodies responsible for green areas to be truly conserved, so that they are preserved and function properly by providing benefits to society as a whole, currently Manaus suffers from the lack of effective actions, lack of awareness of the population regarding the importance of preserving and conserving green areas and what is so important to ensure a healthier environment for future generations.

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# Environmental education in Manaus Municipal Schools: South-Central Zone

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***Abstract***— *Society is increasingly concerned about environmental issues and this makes educators increasingly reflect on how to disseminate environmental education in the school environment and how students will practice social sound and environmental fundamentals. This research aimed to analyze the pedagogical practices of Environmental Education in five municipal schools of Manaus, having as fundamental the pedagogical practices of Environmental Education and, above all, if the projects and actions in environmental education in the municipal schools bring significant results that express in personal practices in the daily lives of their students. A multicase study was carried out in the form of field work. The main results were related to the approaches of authors of the literature on the subject, and it appears that most of the students have knowledge about the subject, besides exposing the desire to be addressed even more in the school environment theme of environment, since it was observed in the graph that in many schools is still little worked by teachers, finally it is noted that the actions of environmental education agitate behavioral changes and arouse in adequate students commitment to find doors to environmental problems.*

***Keywords***— ***Sensitization; School Management; Environmental Education.***

## I. INTRODUCTION

Today, there is a wide spread of all sectors of society with the implications of environmental degradation. Therefore, these issues have shown great concern, especially educators. Thus, one should think of educational actions to develop citizens who can relate harmoniously with society and the environment, for survival in the land of future generations (TRISTÃO, 2004).

According to Law No. 9,795 of April 27, 1999, Environmental Education (EE) should be continuous, stable in National education and should be present at all levels and modalities of the formal and non-formal education process. Therefore, this causes managers to look for ways to insert Environmental Education on a daily basis so that it is disseminated of a natural and conscious character.

As provided for in the Brazilian Federal Constitution, environmental education must be implemented at all levels of education, so that in future time people can be more aware and careful with the ecologically balanced environment. In need of this concern for the environment, environmental education is entrusted is a strategy for effective transformation (LOREIRO, 2004).

In turn, schools make up high spaces in the practice of activities that promote this reflection. Nevertheless, it is of paramount importance to insert students into classroom activities and field activities with sustainable projects and practices aimed at EA, and awareness of teachers, students and staff (DIAS, 1992). However, exceptionally in some municipal schools in the municipality of Manaus, EA is not inserted in the planning of education as it should be. In this context, EA can become an ally in guiding education and sustainability (TRISTÃO, 2004).

The capital of the state of Amazonas, recorded during the last years around 435,082 thousand students enrolled in the public network, between elementary and high school. According to the State Secretariat of Education and Teaching Quality (2016) the capital of the state of Amazonas has about 231 state schools, both are divided by district education coordinators, while municipal ones have a number of 458 schools.

Furthermore, the Municipal Department of Education (SEMED), (2009) presents the technical-pedagogical model of the School Environmental Agenda (SEA) to schools of the Education Network, which aims to support The practices in the Municipal School Network, in order to build fundamentals working on the multiple dimensions of the city's space. Furthermore, this

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pedagogical model envisions sustainability through the processes of cultural changes, developing an ecologically correct posture in strengthening vulnerable social groups.

In this sense, this article presents some results of the research that investigated how the EA is being addressed in five municipal schools in the south-center zone of the city of Manaus/AM. Therefore, some aspects of the acts provided for in the technical/pedagogical model of the SEMED School Environmental Agenda and the Environmental Agendas of the schools surveyed will be evidenced.

## II. METHODOLOGY

The research was developed through technical visits in five municipal schools in the city of Manaus/AM (Table 1) from August 2018 to September 2019. The objective of the visits was to understand how municipal schools develop the theme of EE.

The work was developed in two stages, which was the first to contact and present the letter of the research project with the board of schools and the second stage of application of questionnaires for elementary school students 1 and elementary school 2 of the municipal schools corresponding to the South-Central Zone, totaling three hundred and forty-two (342) students, to analyze the students' perception of THE. contained seven (6) questions and three (3) objective questions, which were organized and tabulated in spreadsheets in Excel.

The present study had a quantitative and qualitative approach that observed the factors of pedagogical practices of Environmental Education in five municipal schools in the South Central Zone of Manaus-AM, having a delineated analysis of the facts related to the activities inherent in the environmental actions that are practiced by schools, aiming to characterize the effectiveness of these pedagogical practices of Environmental Education, developed in the schools in loco of the research from the School Environmental Agenda.

*Table 1- Participating schools for field research*

| School | Address | Acronym adopted |
|---|---|---|
| E.M. Escritora Nisia Floresta Brasileira | Santa Cruz, R. Celso Machado, 455 - Flores, Manaus – AM, CEP: 69028-320 | *NFB* |
| E.M. Antonio Matias Fernandes | Street Dois de Agosto, 79, Comunidade União - Parque Dez de Novembro.Manaus – AM, CEP: 69050-700 | *AMF* |
| E.M. Oswaldo Sobreira | Street Vista Alegre - Parque Dez de Novembro. Manaus – AM CEP: 69054-630 | *OS* |
| E. M Abílio Nery | Torquato Tapajós, Km 5 - Flores. Manaus – AM CEP: 69048-660 | *AN* |
| E.M. Profª Leonília Marinho | Street 7 S/N Conjunto Castelo Branco - Parque 10. Manaus – AM CEP: 69055-250 | *LM* |

## III. RESULTS AND DISCUSSIONS

At a time when people on the planet are faced with the scarcity and misuse of natural resources, the EA theme has become a requirement for a sustainable society. Thinking about it, from August/2018 to September/2019, a survey was developed in five municipal schools in Manaus/AM, in order to analyze the perception of students about the environment. First, a visit was made with the objective of knowing the work dynamics and understanding the profile of the students of each school. To facilitate understanding, the participants of the research were characterized in gender and age group, as shown in Table 2. With a student ratio interviewed, 51.24% are male and 48.76% are female, according to Table 2.

*Table 2: Quantitative of the Questionnaire's Answers*

| Genre | | | Age Group | | |
|---|---|---|---|---|---|
| **Gênero** | **Amount** | **Percentage** | **Age** | **Amount** | **Percentage** |
| **Female** | 157 | 48,76 % | **Under 15 years old** | 286 | 88,82 % |
| **Male** | 165 | 51,24 % | **Between 15 and 18** | 36 | 11,18 % |
| **Total** | **322** | | **Total** | **322** | |

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In addition, it is noted that of the total number of interviewees (322) 88.82% are under 15 years of age and only 11.18% are in adolescence, from 15 to 18 years. This shows that the latter quantitative do not comply with Law No. 9,394 of 1996 – Law of Guidelines and Bases of National Education (LDB), which establishes the age group corresponding to the series. It is still possible to verify that of the 322 students there is a gender balance, with 51.24% of males, compared to 48.76% female, however, in many cases these balances do not reach universities.

Figure 1 presents one of the questions present in the questionnaire, it is observed that in general students have heard of the theme related to AS, however the graphs still show that many students not familiar with the theme. It should be demonstrated that the results presented in Figure 1 do not reflect Souza et. al., (2019) also applied in the city Manaus-AM. The authors showed that of the students participating in the actions of the EE group, ACOSUS, showing that students had knowledge about the environment and sustainability, and that the results were mainly due to the easy access of the students to the media and Channels.

Regarding schools, the comparison showed that the LM school presented a higher number of students with knowledge on the subject EE. Despite this, it was found that among the schools visited, NF and OS presented only one student without knowledge about the theme, showing a low number when the other schools are analyzed. Thus, if we verify all the students interviewed, only 77 answered never, with a high number for little number of schools.

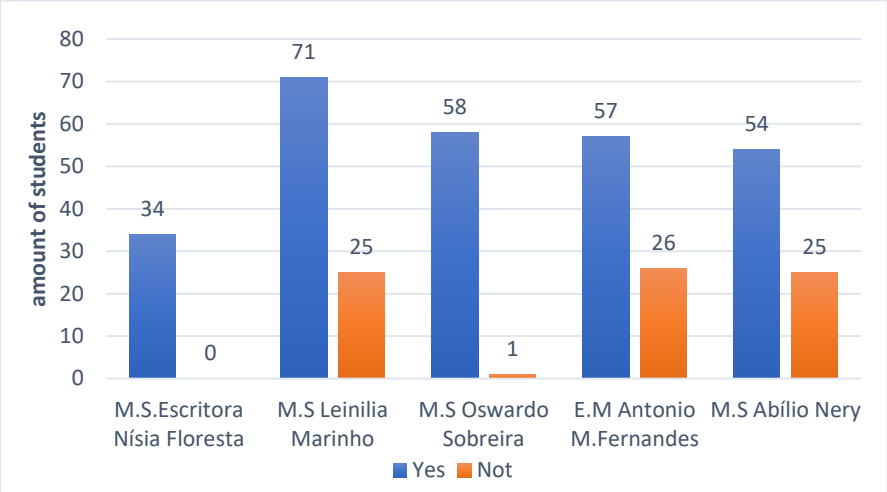


*Fig.1: "Have you ever heard of what Environmental Education is?"*

When students were asked, whether the school applied EE only during the week of the environment (Figure 2), the answers were more balanced in most schools. It was found once again that LM presented higher results for questioning, similar to the results presented in the previous figure.

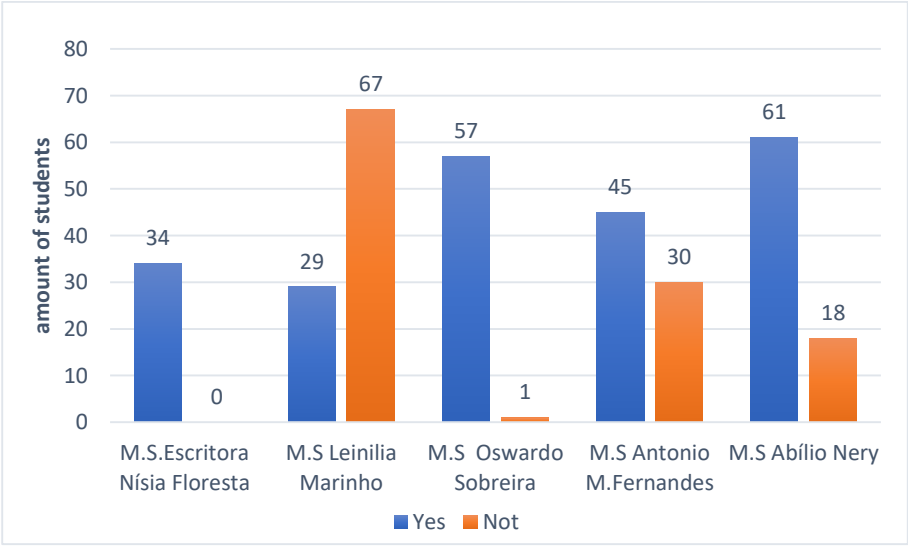


*Fig.2: "Is Environmental Education worked at your school only in the week of the Environment or throughout the year"*

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An was noted, the AN presented a total of 61 students who reported that AS is worked only in the week of the environment, after 57 students of OS, unfortunately the figures show that a movement or commemorative date is required in school calendars to address EE. For this reason it is necessary for pedagogical measures to undergo analyses to highlight and contribute to the even greater insertion of EE in the classrooms and parallel projects of schools, for this it is necessary to discuss the guidelines reducing the obstacles for the environment to be worked at the school (RODRIGUES, 2018).

In the continuity of the questionnaire, Figure 3 presents questions to students about whether teachers generally work with EE. The LM, despite having presented satisfactory results in previous figures, it is opposed in Figure 3 exhibited one of the highest results, with 73 students opting for the answer "no".

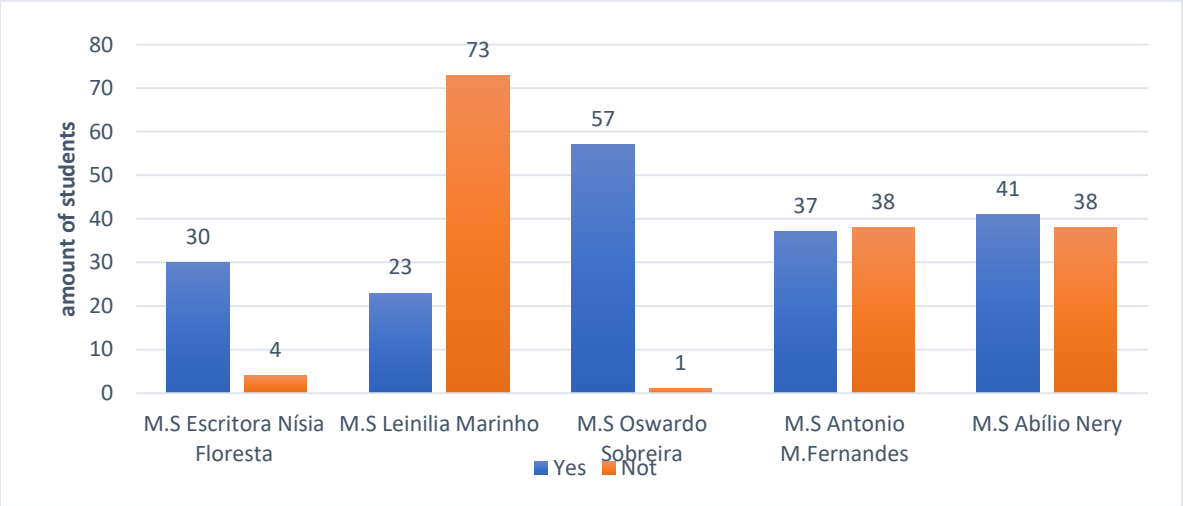


*Fig.3: "In your school do teachers work environmental education?"*

It is observed that the AMF and AN schools presented a balance in the results and still, in the OS school, quantitative were obtained more acceptable, emphasizing an expressive value of 57 students, responding that AS is worked in their school. According to Sousa et. al., (2017), although EE is often inserted in the school environment, it is extremely important that it is added to several factors of everyday life and also in disciplines, besides involving social, political, environment and school issues. Thus, teachers can clarify that EA goes far beyond the environment.

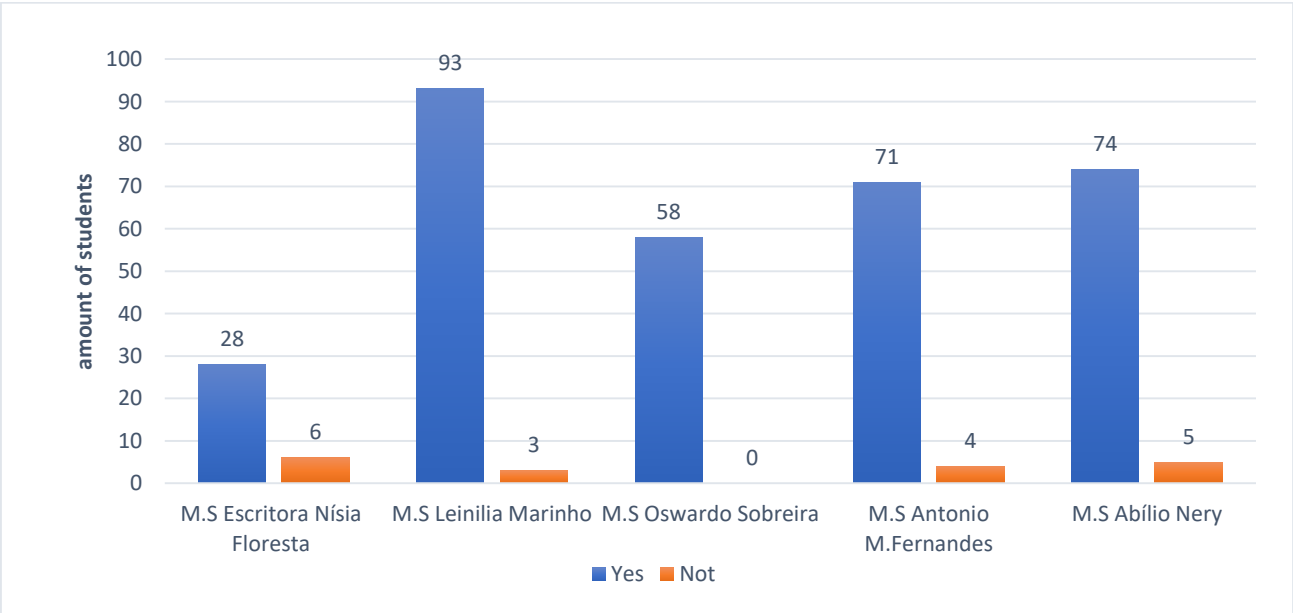


*Fig.4: "In your opinion, should Environmental Education be worked more often at your school?"*

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Figure 4 shows the opinion of the students and their concern about the low frequency of subjects related to EE. In all schools analyzed, it was possible to verify a high number when the question was the fact that the subject should be more often addressed. Thus, the results presented in Figure 4 still demonstrate positive points in relation to the knowledge of students from all schools, being demonstrated through which some students chose to mark the answer "no". This demonstrates a strong interest of students to the theme of the environment. However, the EA approach should not be limited only on commemorative dates, but should have a continuity in approaches, mainly through awareness-raising across the school. Thus, in order for the theme to be addressed more often, one of the best ways to work, is through interdisciplinarity in all school disciplines (SANTOS, 2009).

When asked how they could collaborate to improve or conserve the environment in which they live, students responded that most students chose the subject related to pollution. It is noteworthy that when asked about topics such as " Pollution: water, soil, atmospheric, sound", Figure 5 shows that a total of 247 of the students answered the theme, air pollution, while approaches on selective collection and energy totaled 159 and 84 of the students, respectively.

At the same time, France and Guimarães (2014) in their study in municipal schools in different neighborhoods of the city of Manaus /AM, show that students' perception of the problems of the environment is different for each individual. Furthermore, the authors show that most students still consider water pollution and waste as environmental problems.

As the minority of students have shown that the themes, "clean energies" is the point that should be most addressed, due to the news they have access to, about the energy crisis in the country. This demonstrates that the theme should be studied and presented to students through EE more expressively, this point can be deeply studied and be aggregated as an intervention medium (SOUSA et. al., 2017).

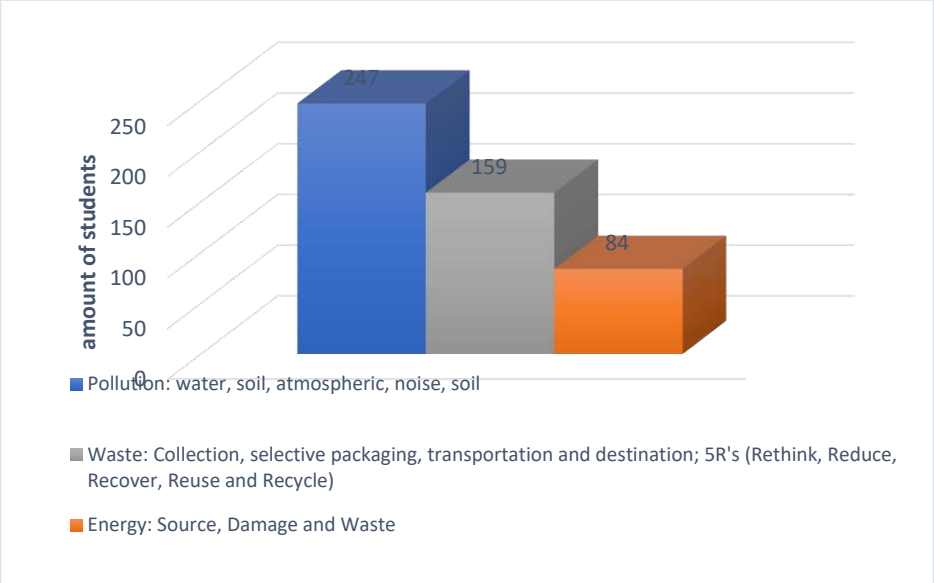


*Fig.5: "Do you remember the last project your teacher worked on Environmental Education?"*

Figure 6 shows the opinion of students about sustainable attitudes towards the conservation of the environment. Although students have demonstrated at the beginning of the research a total lack of knowledge about the topics that address THE, it is perceived that in fact the theme is seen in schools and is still shown by, but students do not demonstrate that the theme is part of their daily lives. However, as a little clarification on the subject happens, they realize what it is about.

Thus through EA it is possible to work on current topics such as Water Pollution, soil, atmospheric, sound (Figure 6) through a simple approach. On the other hand, Santos (2019) demonstrates that the practices of various themes related to AS, which can be applied to elementary school students in a simple and playful way, such as lectures and games, with this addressed about waste solids exemplifying the correct means of disposal and still performing the fixation of the subject through questions.

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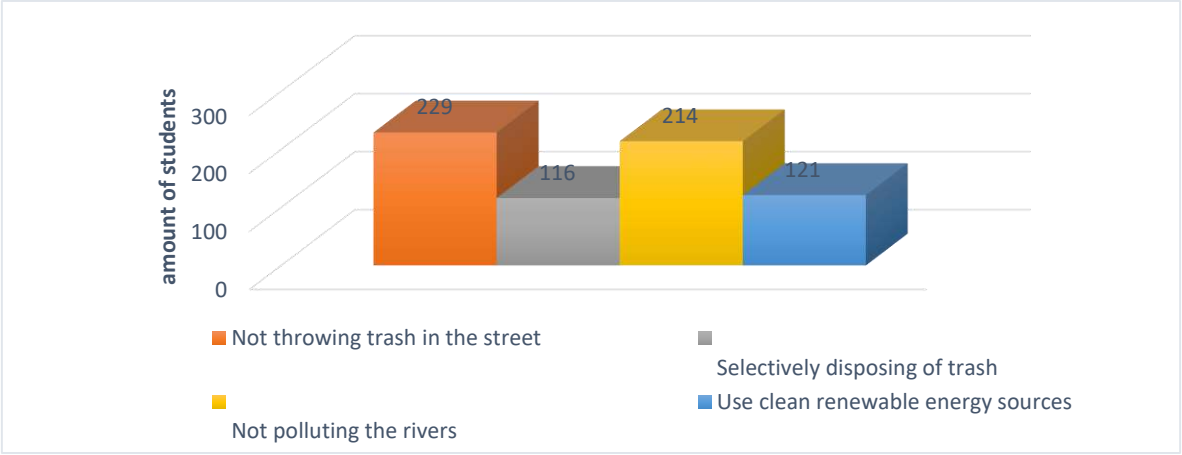


*Fig.6: "How do you think people can collaborate to improve and/or conserve the environment in which they live?"*

## IV. FINAL CONSIDERATIONS

This study showed the results of a research on the knowledge of students from five municipal schools in the south-central area of Manaus. The results showed that the day-to-day practices of students can improve Actions of EE. Changes in conduct can awaken in students a certain commitment to discover for environmental problems.

In addition, they should be inserted and discussed by education professionals during a pedagogical plan, where they can adopt the role of agents of transformation in any context and situation. On the other hand, through learning students will be able to disseminate elements on the environmental theme to those around them, such as their friends and family. However, these actions are not determined by students in their daily lives, and it is essential that schools progress even more.

It was also found that the objectives of this research were obtained satisfactorily, and it is intended to expand research for schools in other neighborhoods of the city.

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# Analysis of the Paths covered by discarded tires in rubber stores of Manaus City: Market Niche alternatives for this Pneumatic Waste

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***Abstract*****—** *The evolution of consumerist tendencies of the human being, always seeks to satisfy their needs with new products, and has significantly impacted all segments related to human behavior and their interference within biological cycles has significantly impacted all segments related to human behavior and their interference within biological cycles has increasingly dispertated the curiosity of the specialists in the most varied areas of knowledge. Oil products have never been more abundant because of their features and significant cost. Tyres are one of these consumerist aspects, which stands out in Brazil for the efficiency in the collection and reuse of this liability, in other processes by industry and with effective performance of organizations linked to the sector for logistics efficiency Reverse. Here we show and describe the behavior of small service providers that have a significant role in the segregation and direction of pneumatic waste. In order to understand its realities and present its possible potency in the continuation of the unit value of the tyre so that it becomes not only a good practice of reverse efficacy but also in a facilitating activity in the destruction of income among the population with lower income and low schooling, through an interpretation of environmental laws that guide the activity, demonstrative tables and graphs that present the reality of a week in the routine of rubber stores in the city of Manaus.*

***Keywords*****— Solid waste; reverse logistics; sustainability.**

## I. INTRODUCTION

After the industrial revolution in the 19th century, there was an increase in consumption of industrialized products. Parallel to this growth, came the need for large-scale production, in addition, there was a change in the profile of solid waste production discarded by the population (LEAL et. al., 2008; PEREIRA and CURI, 2012). In the study of (VIVEIROS et. al., 2015), the author shows that the decades that followed the industrial revolution, the thought was that natural resources were unlimited and was not thought of controlling these resources.

With the reduction of natural resources, scarcity of raw materials in some sectors of industry and the increase in the volume of waste produced, new perspectives are pointed out as a solution to this problem, such as the development of mechanisms to reduce environmental impacts caused by the disposal of solid and liquid waste (PAULIUK and HERTWICH, 2015; ZURBRÜGG et. al., 2012). This issue is even more worrying in third world and emerging countries, where the lack of financial resources and public policies prevent efficient waste treatment.

In Brazil, the Law of the National Slidos Waste Policy (PNRS) was created in 2010, which addresses the main environmental, social and economic problems arising from inadequate solid waste management (DEMAJOROVIC and MIGLIANO, 2013). Studies have shown that despite the emergence of PNRS, the business sector still finds it difficult to apply reverse logistics models to its products (STOCK and MULKI, 2009).

Enumerates are sustainable initiatives, which seek to mitigate the effects of human behavior, related to their rampant consumption, motivated by corporate strategies to expand into a consumer market and frenzied of the new times. This behavior is driven by growth policies; especially in developing countries, which tend to compensate for years of stagnation and see in new technologies these possibilities (MULHA, 2006; TINOCO, 2006; SHIBAO, 2010).

Thus, the main factor acting in the increase in the amount of waste arises, but against departure, a range of possibilities to be used in the treatment of this problem.

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Making a potential by-product issue with an ecologically correct strand, with the aim of reducing the costs of exploring new raw materials and producing new products (SOUZA, 2009; GONÇALVES and TEODÓSIO, 2006).

Above all, practicing initiatives that require a change of behavior in relation to the discarded tire always seeking to convey environmentally committed actions to sustainability, integrating society in a way that realizes the importance of valuation of this liability by making the rubber store business an incubator of sustainable practices and businesses (INSTITUTO AKATU, 2017; CAMAROTTO, 2009).

Other experiments showed that the amount of rubber stores accompany the exponential growth of metropolitan cities in the country. The city of Manaus naturally follows this trend, due to its similarities with emerging metropolises, which is related to the increase in the vehicular amount of recent decades (XIMENES, 2008). Nevertheless, the amount of materials generated and the place where they are produced do not present a pattern, showing that regions with a high number of establishments are associated with the socioeconomic profile of the region.

Some experiences similar to that developed by Carvalho (2018), in the city of Humaitá in Amazonas. The author related sustainable practice and waste management as essential tools for the development and improvement of the quality of the communities involved in the processes of dealing with their waste. During his work, we had the opportunity to disseminate the concepts and regulation of sustainable businesses, thus obtaining an overview of the effective efficiency of activities and the functioning of reverse logistics (CARVALHO et. al., 2018; SILVA et. al., 2017).

In this new opportunity the work seeks to show an initiative to observe the existence or not of the reverse logistics process for the tires discarded in small rubber stores in the city of Manaus. Thus, it was an opportunity to formulate issues relevant to this theme, which is part of the percentage of residue that participate, of the reverse policies of large importers and distributors of tyres in Brazil. With the prospect of consolidating a reality analogous to what happens to the aluminum can market throughout the country.

## II. METHODOLOGY

This work shows the relationships that occur between vehicle users, rubber stores, and disposal. The methodology was applied in the neighborhoods São José, Cidade Nova, Coroado, located in the east of the city of Manaus / AM, as shown in Figure 1.

For the development of this study, on-site visits were made in the period of two months (September and October 2019). During the visits, the weekly routine of 3 rubber stores per patio was monitored. The objective of following the routine was to check the state to which the tires are discarded; whether they are recoverable (maintenance); otherwise if the disposal will be with the exchange for the steppe or for some other specific reason inherent to the patio. Also, from this action it was possible to analyze the destination of waste. After this, estimate the volume of waste per captas generated in a certain time and path; with the nominal description through graphs and tables of these volumes by previously selected patios and described in Table 1.

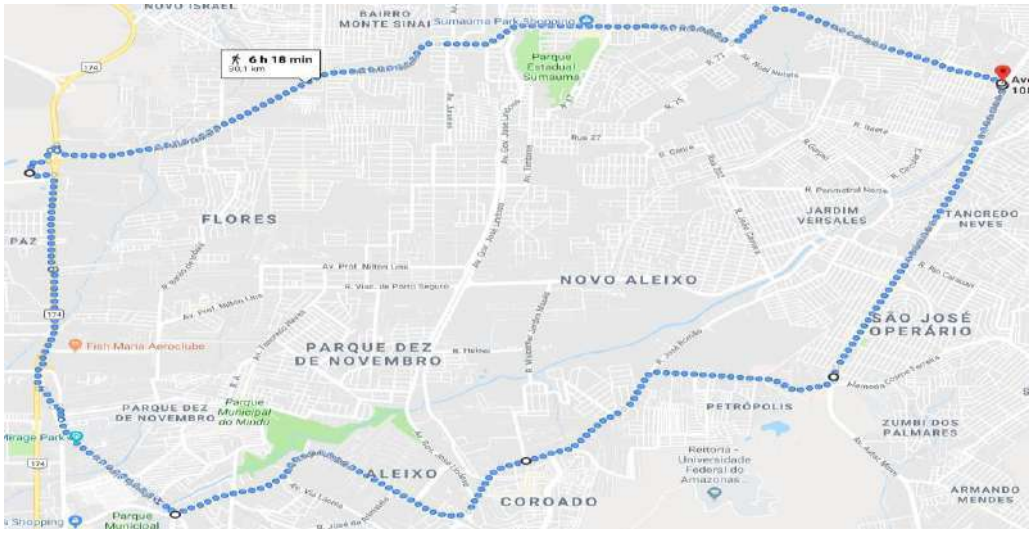


*Fig.1: Dotted blue line shows the location of the study área*

Due to the variability in the number of rubber stores, the three chosen by patio, we tried to standardize the number of locations for the analysis, in order to seek a uniformity in the number of parameters analyzed by

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establishments in each route. Thus, the chosen routes shown in Table.1 are: Al. Cosme Ferreira (A.C.F), Av. Altaz Mirim (A.M.M), Av. Camapuã (A.C), Av. Noel Nutels (A.N.N), Av.Torquato Tapajós (A.T.T).

| Evolução no cumprimento da meta de destinação nacional pelos fabricantes de pneus (2009 - 2017) | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2009/10 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| 105,88% | 101,79% | 105,31% | 106,93% | 106,98% | 101,17% | 100,09% | 101,78% |


*Fig.2: Target of national destination by tyre manufacturers from 2009 to 2017. Source: IBAMA (2018).*

*Table 1 services in rubber stores in the city of Manaus.*

| **STUDY AREA CONTAINING REFERENCE RUBBER STORES. ( values for a weekly journey )** | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rubber ware | **Patio** | **Zone** | **Exchange(mant.)** | | | | | | | **Disposal** | | | | | | | **Recovery** | | | | | | | **Total** |
| | | | S | T | Q | Q | S | S | D | S | T | Q | Q | S | S | D | S | T | Q | Q | S | S | D | |
| B1 | **A.C.F** | **L** | 5 | 4 | 1 | 2 | 0 | 6 | 8 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 5 | 2 | 4 | 1 | 3 | 6 | 2 | 46 |
| B2 | | | 5 | 2 | 0 | 1 | 2 | 1 | 4 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 2 | 1 | 2 | 0 | 3 | 2 | 32 |
| B3 | | | 7 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 0 | 0 | 2 | 0 | 1 | 0 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 30 |
| B1 | **A.A.M** | | 8 | 3 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 7 | 2 | 1 | 2 | 1 | 3 | 2 | 42 |
| B2 | | | 5 | 3 | 2 | 2 | 2 | 2 | 4 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 2 | 2 | 2 | 2 | 34 |
| B3 | | | 7 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 4 | 1 | 2 | 1 | 2 | 1 | 3 | 32 |
| B1 | **A.C** | **N** | 4 | 2 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 30 |
| B2 | | | 3 | 1 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 3 | 1 | 1 | 1 | 2 | 0 | 25 |
| B3 | | | 2 | 0 | 1 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 25 |
| B1 | **A.N.N** | | 7 | 1 | 2 | 2 | 1 | 3 | 2 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 1 | 3 | 1 | 1 | 1 | 2 | 3 | 34 |
| B2 | | | 6 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 2 | 2 | 1 | 1 | 29 |
| B3 | | | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 2 | 23 |
| B1 | **A.T.T** | **O** | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 21 |
| B2 | | | 7 | 2 | 0 | 2 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 26 |
| B3 | | | 8 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 1 | 0 | 0 | 29 |

In addition, questionnaires containing questions related to the routine of the services provided by each establishment were used in a period of 24 hours. The geographic coordinates of each rubber store were inserted

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in ARQGIZ (version 10.3), which provided the geo-referenced images of the study area.

Among the questions elaborated and applied in the establishments, we highlight the destination of the useless tires discarded in the workshop. A surprising fact during the application of the questionnaire, it was noticed that small establishments participate in reverse logistics idealized and practiced by large importers and manufacturers of tyres. Despite its structure in many cases, it is a backyard background business, and they mostly have neither documentation or legal authorization to work as a service provider. And that agrees with the figures presented in the 2018 IBAMA tyre report, in compliance with Conama Resolution Nº. 416/09.

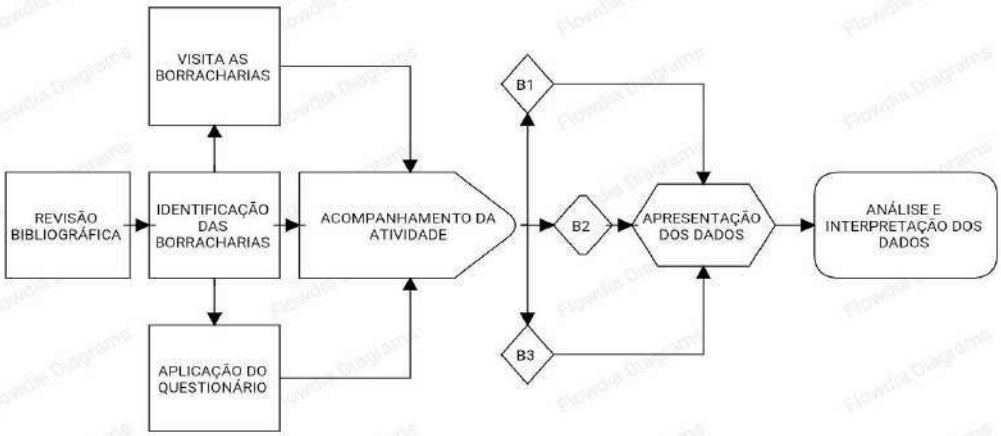


*Fig.3: Descriptive flow chart of on-site actions in the study area.*

## III. RESULTS

In this section will be shown the results of the work on the reverse logistics of rubber stores in a neighborhood of the city of Manaus / AM. It was observed that the points of the highest number of services are located in the east of Manaus; Al. Cosme Ferreira (A.C.F) and Av. Altas Mirim (A.A.M), as shown in Figure 4. These roads have more intense traffic, which was observed all along the road, and thus a high density of rubber stores as soon as it is routed. If we consider the volume of waste collected, we could denote a unit value and thus the monetary gain to each insertable tyre. Establishing unit value, it would be possible to use it as a mechanism for transferring income, since the executors of the activity are mostly people with low schooling, that has in the office its principal or if not the only source of income.

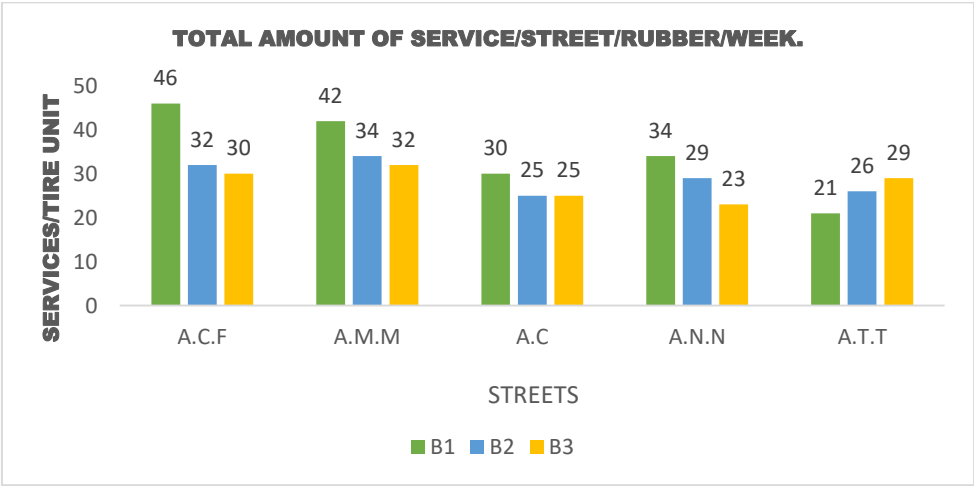


*Fig.4: Total services per street in the week.*

In the other areas of the city there is a greater uniformity in the routines of rubber stores, this is due to the fact that the establishments are not geographically concentrated, as happens in the east of the city.

Regarding the amount of services performed shown in Figure 5, they are very significant revealing the importance of rubber stores as an insertable tire capture tool,

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avoiding becoming a public health problem and a liability that later would demand large investments for its mitigation.

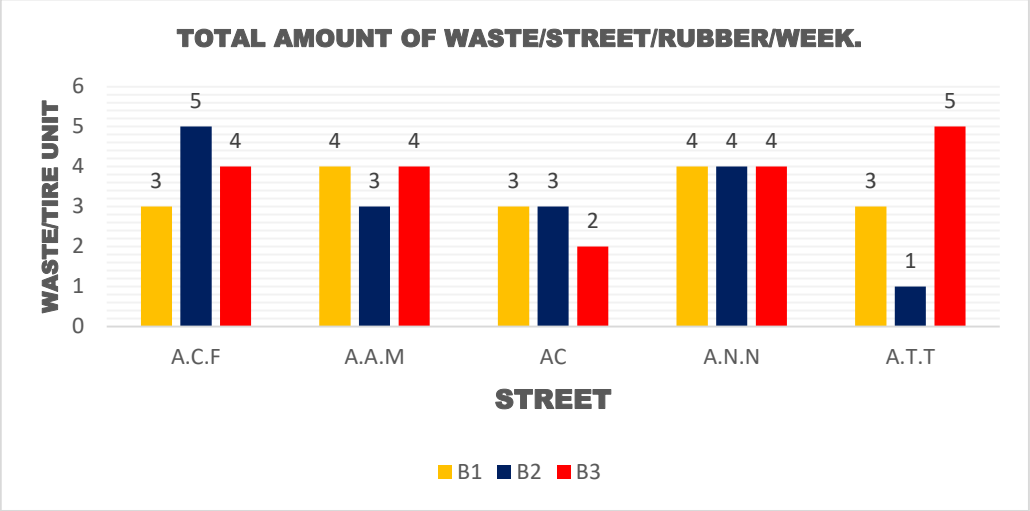


*Fig5 : Total waste generated per establishment in the study.*

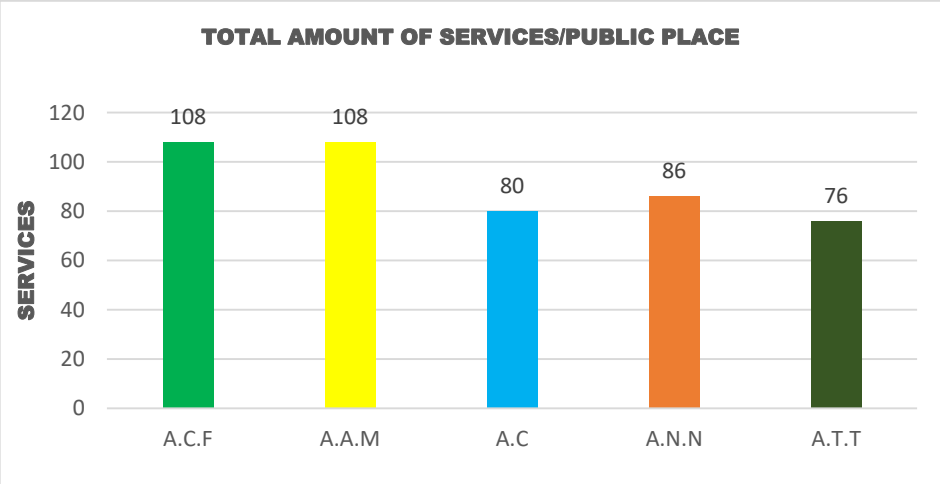


*Fig.6: Total amount of waste generated per week in each street.*

And finally, with the information shown in Figure 5, it is possible to verify that the waste generated is not entirely despicable. According to the information obtained weekly, it would be possible to obtain a constant volume generated by a rubber store of 208 unit / month, and also, 2496 units / year.

If we consider that the city of Manaus now has approximately 50 rubber stores officially registered and visible by Google tools, it will be possible to measure in a simplified way, a total per establishment of 124,800 units/year. Also, according to the manufacturer's specifications the average weight of each tyre is between 5.5 and 7.0kg. Considering the cartons from the lowest weight (5kg), it will be possible to obeter an amount of 624,000kg/year (624Ton/year). This demonstrates a promising construction of sustainable business and income transfer.

The results observed in this study show that urban growth, the difference in the level of environmental awareness, the differences in infrastructure, and lack of scope of reverse logistics policies are determinant to characterize efficiency initiatives, semelenate to those presented by Carvalho (2018).

## IV. FINAL CONSIDERATIONS

During the monitoring of rubber routines, we observed that there is an awareness of the basic concepts of reverse logistics. This awareness comes from the disposal of waste generated, as in the effective action of reverse logistics plans designed and practiced by the organized institutions of producers, importers and resellers of tyres in headbutt by the recycling. In fact, the collection work has its relevance, but it would be interesting to use this potential to foster the waste business in the city, decentralizing the

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collection activity and giving infrastructure, so that small entrepreneurs manipulate the process of production of the raw material of the liability, and for them to take the head of the initiative and consolidate the market for pneumatic waste in the city, in order to become a reference in the management of solid waste and Sustainable business.

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# Possibility of using chip burning ashes and chicken slaughterhouse effluent sludge as soil concealer

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***Abstract*****—***The objective of this study was to analyze the composition of the ashes generated in the boiler of a slaughterhouse that slaughter ninety thousand chickens per day and to evaluate the possibility of using the ashes as a conditioner and soil fertilizer. The research was conducted in the largest slaughterhouse and birds of Espírito Santo. The ashes were collected directly from the boiler after cooling, a one hundred and fifty gram sample was separated and sent to a soil chemical analysis laboratory. The following parameters were evaluated: hydrogen potential (pH), phosphorus (P), potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), aluminum (Al), cation exchange capacity at pH 7 (T), base saturation index (V), effective cation exchange capacity (t), exchangeable base sum (SB), aluminum saturation index (m), nitrogen (n) and total or potential acidity (H + Al). The results of the ash characterization showed the presence of beneficial nutrients such as potassium, phosphorus, magnesium and calcium, but the calcium content was considered low, medium magnesium and good for cultivation, high potassium and phosphorus. Regarding the possibility of using natural ash as an aid in soil improvement, the results showed that the concentrations are in disagreement with the recommended. The pH value obtained was considered high 9.78, above the recommended for use as a conditioner in soil fertilization, which would be a more neutral pH around 5.5 to 6.0. However, most Brazilian agricultural soils have medium to high acidity, which results in low crop yield. Thus, the use of ashes can be considered in specific cases of known very acidic soils. However, annual soil analyzes should be performed to monitor the evolution of the behavior of these nutrients, as well as the pH in the areas used for deposition of this material. These reviews are a good suggestion for future long-term research.*

***Keywords*****— chip burning ashes, chicken slaughter, soil concealer.**

## I. INTRODUCTION

Brazilian poultry has shown high growth rates. Its main asset, chicken, has conquered the most demanding markets. The country has become the third world producer and leader in exports (SINDIAVIPAR, 2015). It is an area in constant and rapid development in the agrifood industry and generates significant amounts of waste, which characterizes a constant challenge regarding its recycling (MIERZWA-HERSZTEK et al., 2016). At the end of the process of processing the production chain are the modernized slaughterhouses that guarantee the quality of the product,

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from the arrival of birds in the place where they will be slaughtered, until the dispatch of the product (CPT, 2014).

It is an area in constant and rapid development in the agrifood industry and generates significant amounts of waste (BEUX, 2005; GARCIA, 2016). Blood is considered the most problematic and complex component, which hinders efficient effluent treatment as a way to reduce environmental impacts (MORÉS, 2006).

An effective form of wastewater treatment is coagulation followed by flotation. Flotation is a complex physicochemical process, where countless variables affect its efficiency, the size of the bubbles and the size of the particles having the greatest impact on the process (SENA, 2005). This process increases the efficiency of removing organic matter, oils and greases from water by adding coagulants and coagulation aids, followed by the adhesion of these particles to the float bubbles; However, this form of treatment generates a large amount of residual sludge to be treated for its proper destination (VIRMOND, 2007).

One of the ways to reduce the volume of sludge generated is heat treatment, and one option for heat treatment of sludge is pyrolysis, which is defined as the thermal decomposition of oxygen-limited organic matter, which forms useful by-products as : the liquid called bio-oil and the solid called biochar (VIEIRA NETO, 2012). According to Meneghini and Proinelli (2015) the burning of primary sludge under favorable conditions can contribute significantly to the energy production through combustion in wood boiler. For this reason, its main use is as fuel in furnaces (BARBIERI et al., 2014).

The aim of this study was to analyze the composition of the ashes generated in the furnace of a slaughterhouse that slaughtered 100,000 chickens a day and to evaluate the possibility of using them as soil fertilizer. The refrigerator is located in the south of the state of Espirito Santo. These ashes are generated from the burning of pine and eucalyptus chips and the primary refrigeration sludge.

## II. REVIEW

Brazilian poultry presented high growth rates, where chicken conquered the most demanding markets (GARCIA, 2016). Poultry activity in Brazil is more concentrated in the South and Southeast, which together account for 75% of the country's total production.

The broiler production chain in Brazil has competitive advantages due to the fast production cycle, the fact that it has the possibility of a vertical and technological organizational structure, besides the low cost protein, attracts consumers from different social classes (RECK; SCHULTZ , 2016). The incorporation of new technologies enables the improvement of production and control systems, the reduction of energy and raw material costs, the diversification of the energy matrix and the variety of industrialized products offered (ESPÍNDOLA, 2012). However, this increase in production needs increasingly efficient refrigerators with high effluent production and large sludge generation.

In slaughterhouse sludge, high levels of microbiological contaminants are found (MÉNDEZ-CONTRERAS et al., 2009). Cammarota (2011) reports that primary effluent treatment aims to remove existing solids in the effluent with the aid of additives such as coagulants and coagulation adjuvants, followed by particle adhesion in the rising air bubbles in the flotation tanks. Flotation processes as primary treatment are commonly used in effluents that have a high load of suspended oils and greases such as slaughterhouses and meat processing industries, and aim to increase the efficiency of organic matter removal from water (SENA). , 2005).

The floated sludge is basically composed of carbon, oxygen and nitrogen, due to its process of being exclusively organic. However, some substances from the physicochemical treatment process contribute to its formation, such as coagulants and coagulation aids (FERREIRA, 2016). During the effluent treatment process, an organic or inorganic coagulant such as aluminum polychloride, ferric chloride or aluminum sulfate is added (MAGNAN, 2010).

According to Vieira Neto (2012), an option for the thermal treatment of sludge is pyrolysis, which is the thermal decomposition of organic matter with limited oxygen supply, where a useful by-product such as the biochar solid is formed. This process can be an option for treatment and utilization of poultry slaughter sludge (GARCIA, 2016). The ash content is related to the nutrient content present in the material. This material component is determined after its complete combustion, when all organic elements are volatilized (ENDERS et al., 2012). Biochar is a carbon-rich product obtained when a biomass or organic material undergoes thermal decomposition under limited oxygen supply (LEHMANN; JOSEPH, 2009).

Vegetable ash is a residue from burning wood and sludge that, depending on its origin, may have high levels of Potassium, Phosphorus, Calcium and Magnesium, and may be used as a nutritional supplement, depending on the balance presented by the soil and requirements of culture (ZHANG; YAMASAK; NANZYO, 2002).

Ash recycling reduces the need for commercial fertilizers, contributing to reduced soil acidification and increasing the supply of calcium and potassium to plants (SOFIATTI et al., 2007). Bonfim-Silva et al. (2015a) argue that using plant ash for fertilizer purposes contributes to plant development. However, Mukone et al. (2013) warn that the potential and effectiveness of using biochar as a source of some nutrients

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varies according to the chemical characteristics of the material that composed it; In its composition, ash usually contains high concentrations of calcium and potassium.

Vegetable ash typically has high pH, nutrient concentration such as phosphorus, potassium, calcium and magnesium and essential micronutrients for plant growth (ZHANG; YAMASAHI; NANZYO, 2002). Ferreira, Fageira and Didonet (2012), also observed the positive effects of vegetable ash in Cerrado soils, the results pointed to the significant improvement of some chemical properties such as pH, potassium and magnesium. Bonfim-Silva et al. (2015a) found a linear increase in soil pH, and the values increased from 6.3 to 7.2 by the application of 20 g $dm^{-3}$ (approximately 40 t ha) of eucalyptus wood ash in a Cerrado Oxisol, collected in Rondonópolis Mato Grosso.

Bonfim-Silva et al. (2011a) observed, studying plant ash as a soil corrective and fertilizer for marandu grass, that the use of this residue may contribute to soil fertility, especially in tropical and low fertility soils. Thus, there is a substantial reduction in weight, essentially associated with losses in gaseous forms of water, carbon and nitrogen, with insignificant amounts remaining in the gray (OBERNBERGER; BRUNNER; BÄRNTHALER, 2006). The application of vegetal ash in Dystrophic Red Latosol provided significant increases in Crotalaria juncea cultures, increasing the shoot dry matter production by 89.38% (BONFIM-SILVA et al., 2011b). Wang and Wang (2019) state that biochar, as it is also called biochar, has been used for soil remediation and improvement as well as carbon sequestration. Pereira (2019) reports that biochar is rich in stable carbon, being one of the alternatives for reducing long-term greenhouse gas emissions, as well as improving the chemical, physical and biological characteristics of soils.

Lopes et al. (2005) stated that research carried out, including experiments in greenhouse and field conditions, has shown that the recycling of nutrients contained in vegetable ash through the farm has great practicality, but it is necessary to know the chemical composition. of this residue and the appropriate dose for each culture, avoiding nutritional toxicity or deficiency due to the excess of some nutrients such as Calcium and Magnesium that compete significantly for the active absorption sites. ). Biochar is considered a material with an effective bioadsorption. (CHEN et al., 2018). Under controlled and field conditions, the recycling of nutrients contained in vegetable ash through the farm presents great practicality; However, they also warned that it was necessary to know the chemical composition of this residue and the appropriate dose for each culture, avoiding nutritional deficiency or toxicity due to the excess of some nutrients (OSAKI; DAROLT, 1991). Bonfim-Silva et al. (2015), verified positive response of cotton plants cultivar FMX 910 regarding the application of biomass ash to a Red Latosol. For PIVA et al. (2014), ashes may serve as an alternative to easily accessible fertilization, usually with reduced cost and a high sustainable contribution to the environment. Chenlu Fu et al. (2020) state that the porous structure of ash supports and hosts fine particles of organic matter and is thus a good soil conditioner.

Regarding toxic metals, several studies have shown the efficacy of biochar in the immobilization of cadmium, copper, lead, arsenic and zinc, as well as reduction in bioavailability and phytotoxicity of these metals to plants (PARK et al., 2011; BEESLEY; MARMIROLI , 2011). Liu, Liu and Zhang (2014) showed that although biochar increased the concentration of toxic metals in the soil as a result of the higher adsorption of these metals, the presence of biochar made the metals unavailable to plants. In this sense, the sustainable use of biochar must consider the characterization of the material of its composition and the place of application, such as the physicochemical properties of the soil and climate (VERHEIJEN; MONTANARELLA; BASTOS, 2012).

Meneghini and Proinelli (2015) warn that the refrigerated waste generated by the effluent treatment, from the slaughter process of chicken, pork and meat industrialization, have high costs of disposal to landfills. Seiffert (2000) states that according to the legislation this material must have an appropriate disposal or final disposal that does not pollute the environment, making it impossible to dispose directly in landfills without proper treatment. This has promoted research aimed at a smaller generation, or better, use of this material.

However, not everything is an advantage when using Biochar. According to Mukherjee and Lal, (2014), experiments that evaluate biochar as a soil conditioner present scarcity in the amount of field-level data for plant growth responses, soil quality and environmental impact. The authors further comment that biochar responses as a soil conditioner are based on a short time and laboratory or greenhouse studies, and are sometimes contradictory. Wang and Wang (2019) claim that biochar has a broad prospect of application in environmental remediation, but its long-term effect on soil microbiota should be further investigated.

Adding biochar could also promote rapid loss of forest humus and soil carbon in some ecosystems during the first decades (WARDLE; NILSSON; ZACKRISSON, 2008). In addition to having the presence of PAH (polycyclic aromatic hydrocarbons) in biochar, which may be a limiting factor for its use as a soil conditioner (DE GRYZE et al., 2010). In the process of producing biochar, pyrolysis also provides the formation of bio-oils, which may have small levels (PAH) (SOHI et al., 2009). The potential presence of heavy metals and other hazardous elements in biocarbons

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may endanger their use as a soil conditioner (BRACMORT, 2010; DE GRAYZE et al., 2010). However, Kavita et al. (2018) state that biochar due to its high surface area, porosity and functional groups provide excellent adsorption capacity of heavy metals and organic pollutants.

## III. METHODOLOGY

The research was carried out in the largest poultry slaughterhouse and slaughterhouse in Espírito Santo and at the São Camilo University Center, Espírito Santo. The refrigerator is located in Aracuí, municipality of Castelo, under the coordinates 24k 2707703 / UTM 7715353.44.

According to the administration of the refrigerator in question, it generates 950 direct jobs and 350 indirect jobs, without taking into account the employees who work in feed mills and in the chick production sector. The company has a farinheira, which reuses production residues such as nails, beaks, viscera, blood, feathers and oil; These materials benefit and become raw material for the production of feed. The refrigerator has an installed slaughtering capacity of 100,000 birds per day with a daily consumption of two million four hundred thousand liters of water a day, generating a large amount of effluent.

The ashes were collected directly from the boiler after cooling, it was placed in a plastic bag with a capacity of ten liters, the bag was sealed so that the sample did not lose its moisture and taken to the Engineering Laboratory of the University Center São Camilo - ES. . Figure 1 shows the ashes leaving the boiler.

*Fig.1: Ashes leaving the boiler.*
Source: Elaborated and Adapted by the author.

After collecting the material directly in the refrigerator furnace; In the Engineering Laboratory of the University Center São Camilo - ES, the residue was dried in an oven at 121 ° C for two hours, revolving the sample at 30-minute intervals (ANDREOLI; SPERLING; FERNANDES, 2014). After this a sample of 150 grams was separated and sent to the Raphael M. Bloise Soil Chemical Analysis Laboratory of the Federal University of Espírito Santo (UFES), Alegre campus - Center for Agricultural Sciences. At this site, the following parameters were evaluated: hydrogen potential (pH), phosphorus (P), potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), aluminum (Al), cation exchange capacity a pH 7 (T), base saturation index (V), effective cation exchange capacity (t), exchangeable base sum (SB), aluminum saturation index (m), nitrogen (n) and total or potential acidity (H + Al).

The equipment and procedures used to quantify the parameters were, for each: 1- pH (by soil-water relation); 2- phosphorus (by Mehlich-1 extractor and determination by colorimetry); 3- potassium and sodium (by Mehlich-1 extractor and flame spectrophotometry); 4- calcium and magnesium (based on KCl 1 mol L-1 extractor and determination by atomic absorption spectrometry); 5- aluminum (1 mol L-1 KCl extractor and titration determination); 6- total acidity (by 0.5 mol L-1 calcium acetate extractor); 7- nitrogen (by the kjeldahl method by sulfuric digestion and steam distillation). The Organic Matter parameter was not analyzed due to equipment problems during the analysis period.

After obtaining the parameter values, the results were analyzed, according to current legislation, for possible applications for cultivable soils. Each parameter was specifically studied according to its concentrations or values required for use as fertilizer or soil correction, as well as consultations in the literature considered, as presented in Tables 1 and 2.

For sum of exchangeable bases (SB) and nitrogen (N), classification tables were not adopted and, therefore, their values were framed according to research in the literature considered as in Cruz, Pereira and Figueiredo (2017), Embrapa (2010) and Grant (2001).

In the Engineering Laboratory of the University Center São Camilo - ES, analyzes were made to know the pH of the ashes and compare with the result obtained by the Raphael M. Bloise laboratory of the Federal University of Alegre. Nine analyzes were performed to obtain the pH of the boiler ashes, through the methodology of maceration, sieving, dissolution of two grams of ashes in 50 ml of distilled water for 24 hours and use of pH meter.

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*Chart 1 - Patterns or nutritional levels for each parameter, except SB, n and H + Al.*

| Element/Unit | Description | Low | Medium | High |
|---|---|---|---|---|
| pH (acidity) | Hydrogenionic potencial | < 5,0 | 5,0 – 1,0 | > 6,0 |
| Al (cmolc/dm³) | Alumínum | < 0,5 | 0,5 – 1,0 | > 1,0 |
| Ca (cmolc/dm³) | Calcium | < 1,6 | 1,6 – **3**,0 | > 3,0 |
| Mg (cmolc/dm³) | Magnsium | < 0,4 | 0,4 – 1,0 | > 1,0 |
| K | Potassium | < 30 | 30 – **60** | > 60 |
| CTC (cmolc/dm³) | Effective cation exchange capacity | < 2,0 | 2,0 – 4,0 | > 4,0 |
| CTC a pH 7,0 (cmolc/dm³) | Cation exchange capacity at pH7 | < 5,0 | 0,5 – **15** | > 15 |
| M (%) | Aluminum saturation index | < 30,0 | 30,0– 50,0 | > 50,0 |
| V (%) | Base saturation index | < 50,0 | 50 – 70 | > 70,0 |

Source: Procafé Foundation (2015).
Note: Adapted by the author.

*Table 2 - Nutritional standards or levels for exchangeable base sum (H + Al).*

| Element / Unit | Description | Low | Medium | High |
|---|---|---|---|---|
| H + Al (cmolc/dm³) | Total or potential acidity | < 4,0 | 4,0 – 2,0 | > 2,0 |

Source: Procafé Foundation (2015).
Note: Adapted by the author.

## IV. RESULTS AND DISCUSSIONS

The pH value obtained was considered high 9.78 (Table 1), which is above what is recommended for use as a conditioner in soil fertilization, which would be a more neutral pH around 5.5 to 6.0 (Table 1). 3) as stated by EMBRAPA (2015). However, Veloso et al. (1992) stated that most Brazilian agricultural soils present medium to high acidity, which results in low crop yields. Thus the use of ashes could be considered in specific cases of very acidic soils.

The results of the ash characterization showed the presence of beneficial nutrients such as potassium, phosphorus, magnesium and calcium, but the calcium content was considered low, medium magnesium and good for cultivation, high potassium and phosphorus. Regarding the possibility of using natural ash as an aid in soil improvement, the results showed that the concentrations are in disagreement with the recommendations by EMBRAPA (2015).

*Table 1 - Physical and chemical characterization of natural ash.*

| Result of Physicochemical Characterization of Natural Ash | | | | | | |
|---|---|---|---|---|---|---|
| **PH** | **Phosphor (P)** | **Potassium (K)** | **Sodium (Na)** | **Calcium (Ca)** | **Magnesium (Mg)** | **Aluminum (Al)** |
| 9,76 | 759,46 mg dm-³ | 779,00 mg dm-³ | 109,00 mg dm-3 | 0,61 Cmolc dm- ³ | 0,52 Cmolc dm- ³ | 0,0 Cmolc dm-³ |
| **H + Al** | **Sum of bases exchangeable (SB)** | **Capacity and exchange effective cationic (t)** | **Capacity and exchange cationic at pH 7 (T)** | **Saturation index in bases (V)** | **Saturation index aluminum (m** | **Organic Material g / Kg** |
| 0,0 Cmolc dm-³ | 3,60 Cmolc dm-³ | 3,60 Cmolc dm-³ | 3,60 Cmolc dm-³ | 100,00 | 0,0 | 0,0 |

Source: CCAE-UFES Soil Laboratory "Raphael M. Bloise". Center for Agricultural Sciences (UFES, 2019).
Note: Adapted by the Author.

Table 2 below was used to interpret the results regarding the acidity levels regarding the possibility of using the material.

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*Table 2 - Interpretation classes for active soil acidity (pH).*

| **Chemical classification** | | | | | | |
|---|---|---|---|---|---|---|
| **Very high acidity** | **High acidity** | **Medium acidity** | **Weak acidity** | **Neutral** | **Weak alkalinity** | **High alkalinity** |
| < 4,5 | 4,5 -5,0 | 5,1 – 6,0 | 6,1 – 6,9 | 7,0 | 7,1 – 7,8 | > 7,8 |
| **Agronomic classification** | | | | | | |
| Very low | Low | | Good | High | Very high | |
| < 4,5 | 4,5 – 5,4 | | 5,5 – 6,0 | 6,1 – 7,0 | >7,0 | |

**Source: Ribeiro, Guimaraes and Alvarez (1999).**
**Note: Adapted by the author.**

The results obtained in the analyzes at the Engineering Laboratory of the University Center São Camilo - ES regarding the pH of the ashes were compatible with the results obtained by the Raphael M. Bloise laboratory of the Federal University of Alegre. Table 3 shows the result of the nine analyzes performed using the pH meter.

*Table 3 - Found pH values of the ashes.*

| **Date** | **Temp. Water analyze pH** | **pH initial water** | **pH of water with ash after 24 hours** |
|---|---|---|---|
| 28/06/2019 | 25º | 6,37 | 9,78 |
| 28/06/2019 | 25º | 6,35 | 9,78 |
| 28/06/2019 | 25º | 6,36 | 9,77 |
| 04/07/2019 | 25º | 6,36 | 9,78 |
| 04/07/2019 | 25º | 6,35 | 9,78 |
| 04/07/2019 | 25º | 6,36 | 9,76 |
| 08/07/2019 | 25º | 6,36 | 9,77 |
| 08/07/2019 | 25º | 6,36 | 9,78 |
| 08/07/2019 | 25º | 6,36 | 9,78 |

Source: Elaborated and Adapted by the author.

After all analyzes, an approximate average pH value for the ashes of 9.78 was obtained, obtained directly from the boiler, which Riberio; Guimarães and Alvarez (1999) and EMBRAPA (2015) classify as high alkalinity, as shown in Table 2. Figure 2 below shows one of the samples being tested at pH meter.


*Fig.2 - Ash pH result.*

Source: Elaborated and Adapted by the author.

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Second Riberio; Guimarães and Alvarez (1999) an alkalinity above 7.8 should be considered high and therefore caution should be exercised regarding actions regarding the use and disposal of materials with pH similar to these values (Table 3). However, Silva (2003) states that pH should not be considered as a limiting factor regarding the use of materials in relation to their increase in soils and composting, since self-regulation results from microbial activities in the composting process and that the pH is higher. favorable for most microbial activities in composting activities is 6.0 to 7.5 for bacteria and between 5.5 and 8 for fungi. Santos (2007) working with organic waste composting products also states that the optimum value for pH is between 5 and 8.

Ash from vegetable residues presents high pH values, corroborating the results of this work, besides being good soil conditioners, increasing the yield of several crops and reducing fertilizer costs (ZHANG; YAMASAHI; NANZYO, 2002; LAIRD et al. , 2009).

The refrigerator has an area of 11 hectares in pasture areas in addition to environmental restoration areas. Soil analyzes of the pasture areas in question, which were carried out during the formulation of their fertigation project, found a pH of 4.9 considered high acidity according to Riberio; Guimarães and Alvarez (1999) and Embrapa (2011). Therefore, the addition of ash from the boiler could be considered as a factor of pH improvement of these areas and consequently of better soil conditioning.

The company also has 38 hectares of environmental restoration areas in a secondary stage of regeneration, considered as capoeirões, these areas have a naturally low pH soil, in soil analysis made in these areas the average pH found was 3.9 and thus considered as soils with very high acidity. This result is in agreement with that found by authors such as Rodrigues et al. (2010) who found soils with a pH average of 3.85 very high acidity, these results were obtained in areas of capoeirões. Miranda, Canellas and Nascimento (2007) obtained similar results by analyzing areas of Atlantic Forest fragments in secondary stage.

These two areas, the restoration and the pasture, could be used for the deposition of these ashes, thus helping to correct the pH of these remarkably acid soils. According to Ribeiro et al. (2015), ashes of plant origin have reasonable amounts of macro and micronutrients, as well as acidity corrective characteristics, thus having potential for their use in fertilization and correction of soil acidity. This would reduce annual spending by $ 24,000 a year to send ashes to the landfill.

## V. FINAL COMMENTS

The ash characterization presented concentrations of some beneficial nutrients, but there are concentrations of other non-favorable factors such as pH, which obtained a result of 9.78, considered high above the ideal, since the ideal pH for most cultures, between 5.5 and 7.5.

Regarding the possibility of using ashes in nature as an aid in soil improvement, the results pointed to the presence of favorable nutrients such as potassium, phosphorus, magnesium and calcium, but the calcium content was considered low, medium magnesium, good for cultivation and high potassium and phosphorus. Therefore, it is suggested that long-term research be carried out regarding the evolution of soil dynamics behavior regarding the components present in the ashes as well as the soil biota responsible for nutrient cycling. The company has pasture areas and environmental recovery areas, which has 38 hectares of planted forest, currently in the secondary stage; plots to follow the evolution of ash in the soil could be set up in these areas and monitored.

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# Evolutionary Analysis of Tarumã Açu Degradation by Urban Growth

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***Abstract*****—** *Tarumã açu is a neighborhood located in the west of the city of Manaus, in which in recent decades we have accompanied the progressive increase in pollution and degradation from anthropic actions that occurred in the city, making it difficult to preserve resources water and its green areas, which maintains its ecological chain of the region through the maintenance of fauna and flora, in addition to preserving the natural characteristics of the site. For the research, a set of LANDAT-8 satellite images, operational terra imager (TERRA) sensor, in geotiff format, colored composition of RBG bands, with spatial resolution of 30 x 30 m, was selected. The scene of the study area were the orbits from 231 to 262. The ArcGis version 10.3 tool, used as an aid to obtain images to detect the types of degradation occurred and in which areas were most affected by anthropomization in 2010,2013, 2015 and 2017.*
***Keywords*****— Degradation, classification, anthropoization, arcmap.**

## I. INTRODUCTION

During the last decades the city of Manaus has experienced rapid population growth, denominated by many as the metropolis of the Northern region. This denomination is partly due to its economic and historical importance, in addition to providing services and products, through the free zone. In addition, the capital of Amazonas opens opportunities for residents of the interior of the state, where the chances are lower.

However, urban and industrial development has caused the expansion of the urban perimeter of the city over the years, which has caused negative impacts on the environment. For Araújo (2004), cities are mischaracterized by the exaggerated increase in the population which lose their original essence. On the other hand, this mischaracterization and lack of infrastructure are exposed to environmental and socio-environmental problems, such as difficulty accessing basic health, violence, discrimination and leisure (MARICATO, 2002). In addition, this growth is capable of triggering a series of changes in the quality of the environment, deteriorating the physical, biological and chemical qualities of the sites, by increasing materials such as waste thus negatively impacting the city ( GAUVEA, 2012).

Also, Fernandez (2004) verifies that ambient modifications are caused by various causes, resulting from the action of anthropic, natural and community cultures activities, which has contributed to the changes in physical characteristics and biological diseases of the ecosystem in which we live. Environmental degradation can be understood as occurrences of cases that end up deteriorating and depleting the environment (DEL GROSSI, 1991; LEMOS, 2011). A recurrent factor in the growth of urban areas and environmental degradation is the reduction of native vegetation cover that, in addition to affecting thermal comfort in tropical, arid and semi-arid regions, reduces surface flow, water infiltration, and also surface and groundwater quality (TUCCI, 2008; FELIPE et. al., 2012).

Deforestation is considered one of the factors that cause environmental impact. The forest has as its role to care for and maintain biodiversity thus safeguarding all living species present on site, water cycling, and carbon storage (FEARNSIDE, 2006). For Freire (2004) when natural biodiversity is lost by the process of human occupation, evidence of destruction of riparian forests, water resources, loss of fauna, contamination of resources occurs, are visible factors that disorderly occupation can cause the municipality.

On the other hand, the quality/quantity of water resources in the areas modified entropically is not only an environmental problem, but it is also a public and economic health problem for municipalities (SILVA et. al., 2007; TUCCI, 2008). Therefore, changes in the natural environment lead to the stocking of these areas, increasing water turbidity,

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in addition to groundwater contamination by construction and solid/liquid waste dumps, which increases the costs of treating these waters.

However, the studies of Felipe, et. al., (2012) showed that at various times, the absence of an Environmental awareness is a determining factor in water contamination, because without the knowledge of environmental education residents often throw debris into river beds, without passing due treatment. The release of sewage into water bodies modifies physicochemical characteristics, such as a large part of suspended materials, such as the presence of organic matter, phosphorus, oils and greases and biological stemming from the decomposition of organic matter.

One way to monitor irregular occupations and impacts caused by them to the environment is through the use of high-resolution remote sensors such as LANDSAT images. These sensors study at the logo of time the change of surface characteristics, also the phenomena that occur in space, besides monitoring the cities, agricultural areas and Permanent Preservation Areas (APP) (DELATORRE et. al., 2011). The relationship between deforestation and population density was addressed by Wood and Skole (1998), through the use of satellite images. The authors showed that deforestation in the Amazon region is more closely linked to the settlement of rural areas with low population density.

Currently, satellites have been a major ally in monitoring deforestation and fires. Applying the methodology of supervised classification of modis satellite images, Machado et. al, (2004) located deforestation areas in the Brazilian Cerrado, showing an annual average of 1.5%, equivalent to three million hectares. The authors estimate the Cerrado may disappear by 2030 if the development model is maintained. At the same time, Shimabukuro and Almeida-Filho (2008) applied the supervised classification of landsat-5 images from 1987 to 1996, to map the degraded areas in the Amazon region, identifying a growth of 341 hectares to 1,986 hectares of agropastoral activities in forest areas.

In recent years, water resources have been found to be scarce worldwide. And one of the causes has basically been the way man's water reserves are used, which make them unusable for healthy consumption due to pollution of water resources and the growing demand for use that is associated with population growth (PEREIRA, 2009).

Thus, this work will show through the classification of images of the LANDAT-8 satellite, Operational Terra Imager sensor (TERRA), during the period from 2010 to 2017 an analysis of soil cover, increase of deforested areas and the effect of anthropomization in the Tarumã and Puraquequara basin region are located in the urban network of the city of Manaus/AM (MELO et. al., 2006).

## II. MATERIAL AND METHODS

The methodology developed in this work is similar to that used in Preste (2018), applied at the Giant Creek in the municipality of Manaus/AM. On the other hand, at this time it will be developed in the Tarumã Açu Neighborhood, in the west of Manaus, near the microbasin of the giant stream, located in the southwestern part of Manaus, on the left bank of the Tarumã River, delimited by the coordinates -2,954º latitude and -60.160º Longitude, covering 133,756.40 hectares. Figure 1 shows the delimitation of the Tarumã basin, which is located the neighborhood to be studied. According to the Brazilian Institute of Geography and Statistics (IBGE, 2015) the population was around 13,763 inhabitants, considered one of the three largest neighborhoods in Manaus. First, an on-site visit was made in order to know the situation surrounding the creek, through photographic records of the place and thus, if it obtains characterization of the study area.


*Fig.1: Location of the Tarumã Açu basin.*

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After the site's reconnaissance visit, the selection of the set of satellite images was selected. The images used in this work are the images of landat-8, operational terra imager sensor (TERRA), in geotiff format, colorful composition of RBG bands, with spatial resolution of 30 x 30 m. The scene of the study area were the orbits from 231 to 262. The images are part of the collection of the PRODES project of the National Research Institute (INPE). Due to the rapid growth of the city of Manaus in the last decade, we opted for the use of images in the years of 2010, 2013, 2015 e 2017.

After the selection of images in the years mentioned above, these were processed with the assistance of the Tool ArcGis version 10.3. Thus, it was possible to perform an supervised classification of the images and finally obtain the information of the surface type, change and determine the degradation levels that occurred in each area. By classifying the images, we tried to identify the possible causes of environmental degradation of surfaces during the years analyzed.

## III. RESULTS AND DISCUSSION

The increase in irregular occupations in large metropolises is combined with the progressive increase in environmental pollution and contamination of seas, rivers and streams. The preservation of natural resources maintains the ecological chain of the region through the maintenance of fauna and flora, in addition to the preservation of physicochemical and biological characteristics.

In order to obtain a detailed analysis of the situation, a technical visit was made as shown in Figure 2. The figure portrays the current situation of the neighborhood, where visibly many areas of irregular occupations were visibly detected, it was also possible to find areas where vegetation is preserved, and deforestation, erosion, streams with the presence of materials in suspension among others that are not positive qualities and that cause visual, physical, biological and chemical pollution.

*Fig.2: Vision of the main changes suffered in Tarumã*

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Through supervised classification. Through the supervised classification it was possible to visualize the evolution of the processes analyzed in the years 2010, 2013, 2015 and 2017, besides defining the polygons that configure the classes of land use and occupation, where pixels represent each of the types of and their occupation at different points (JENSEN, 2009). Through the satellite image it was observed that the year 2010, represented by Figure 3a, the Tarumã Açu area still predominated large-scale vegetation at the site, but with the expansion of interventions that occurred on site, ended up annihilating part of what was Saved. It is verified that urban expansion did not predominate in the region. On the other hand, Figure 3b shows through a histogram the sum of pixels related to each type of soil use classified.

In 2010, the dense ombrophilic forest had the greatest success with 16,000 pixels, along with the predonymous vegetation with just over 14,000 pixels, while the soil exposed on the site totaled about 14,000 pixels. It is verified that some areas that were previously covered by forest and vegetation have undergone changes through deforestation. It is observed in the following years that these deforested areas gave rise to irregular occupations, thus collaborating negatively for the environment. In addition, it is verified through the histogram that the amount of suspended materials is high, around 14,000 pixels. This high amount of materials in suspenation are a consequence of the increase in anthropoized areas, as shown by Shimabukuro and Almeida-Filho (2008).

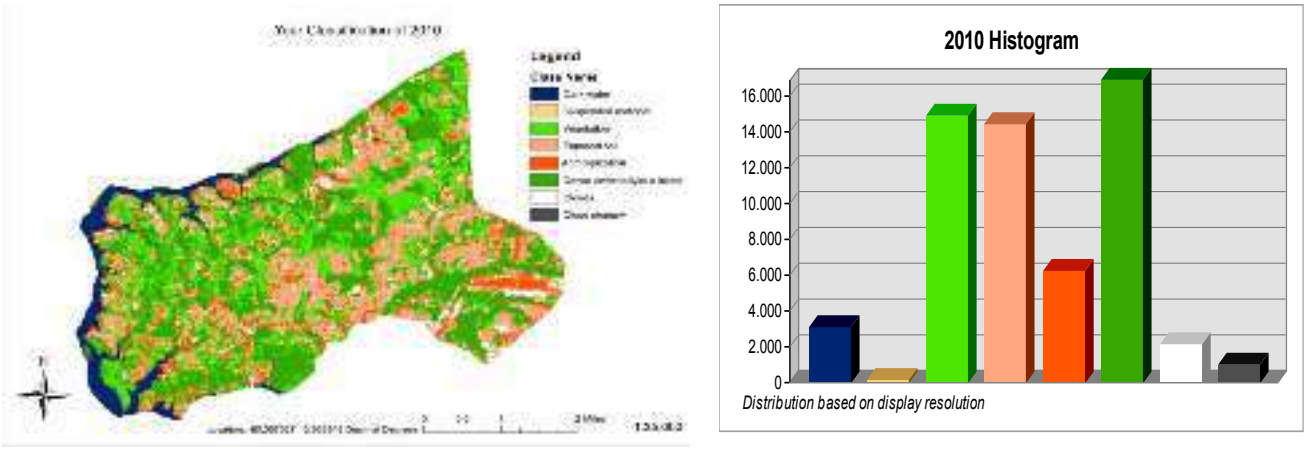


*Fig.3 : Year 2010; a) Site map; b) Histogram of classes*

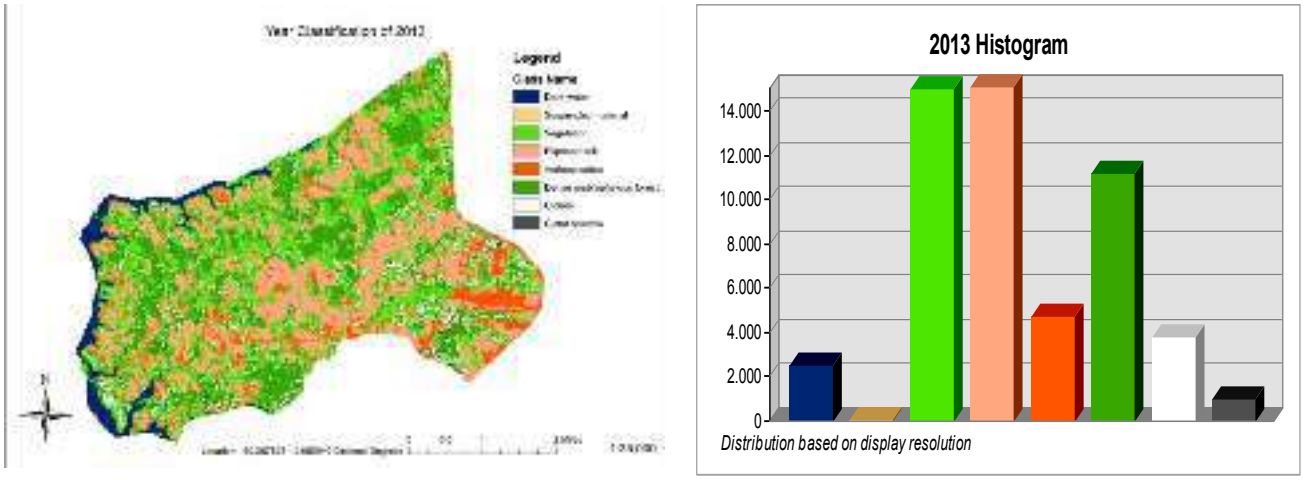


*Fig.3 : Year 2013; a) Map of the tarumã Açú neighborhood; b) Histogram of the year 2013*

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In 2013, it was observed that vegetation reached 14,000 pixels on the map and the exposure of the soil at 14,000 pixels (Figure 4a). In relation to the previously analyzed year, the dense ombrophilic forest decreased the number of pixels from 14,000 to approximately 11,000. Due to the large area of forest in the region one of the forms, it is noted in relation to 2010, that 2013 showed a drop in the rate of human activity at the site had a temporary drop of 6,000 pixels, but on the other hand, there was a decrease in the areas covered by vegetation, these impacts were also analyzed in Ricklefs (1996). The author showed that such impacts caused by increased deforestation occur years before population growth. And at the same time, increases the consumption and disposal of solid waste.

In 2015, the location map showed significant differences compared to previous years. The presence of exposed soil grew above 14,000 pixels due to construction of homes, residential, school among others. At the same time, over the years the area was uncharacterized by the loss of the natural landscape by anthropic action, causing an increase in direct and indirect pollution. Anthropomization is related to human activities at the site doubled compared to the previous year, amiting to 12,000 pixels. Another interesting fact was the presence of a high number of residences compared to 2013. On the other hand, the vegetation showed a decrease in the amount of pixels classified in the image, rising to 10,000. The forest has as its role to care for and maintain biodiversity thus safeguarding all species of living beings present on site, besides assisting in water cycling, and carbon storage, indispensable for flora fauna. When analyzing Figure 5, it is verified that the decay for 10,000 pixels of dense ombrophilic forest indicates that deforestation may cause a loss of biodiversity of the site, in addition to pollution caused by construction practices, and inadequate exposure to the ground, harming the environment.

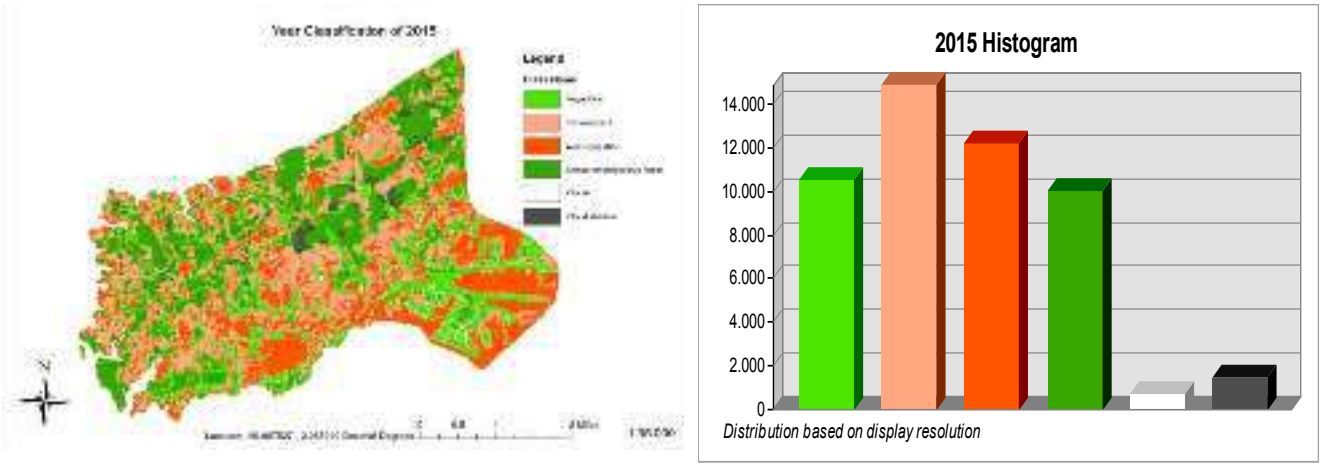


*Fig.5: Year 2015; a) Map of the tarumã Açú neighborhood; b) Histogram of the year 2015*

In relation to previous years, 2017 clearly shows the exponential growth process of occupation of the area, increasingly evident, this fact can also be seen in Daniel (2018). The author showed through the geoprocessing technique the reduction of green areas in the Giant's watershed in Manaus/AM due to the occupation of the soil improperly, completely altering the natural environment. The results in 2017 show that urban growth is the cause for increasing the anthropoized area to more than 12,000. At the same time, the histogram shows that the amount of areas of the exposed soil increased even more, past 14,000 pixels, caused by the removal of vegetation and deforestation for constructions of condominiums, houses, trades among others. Furthermore, the practice of occupation and urban expansion can generate urban and environmental conflicts, and these processes that end up generating a reflection on the search for economic and social development (JESUS, 2011).

The removal of vegetation and forest is one of the main problems causing environmental impact, causing the increase in soil exposure making it susceptible to erosion by the process of ravines and voçorocas and decreased infiltration (TUCCI, 2008). Furthermore, the obrophilic forest has great importance for the hydrological cycle and fauna and flora still maintains its classification with 11,000 pixels.

It is clear the occurrence of change in the place during the years, which was clear both through technical visits in the region, as through satellite analysis, showing deforested areas giving way to residences, houses, allotment, farms among

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others. Furthermore, it is possible to verify high growth n the exposure of the soil, and the removal of vegetation and the anthropoization of the site making it vulnerable and thus harming the environment in general.

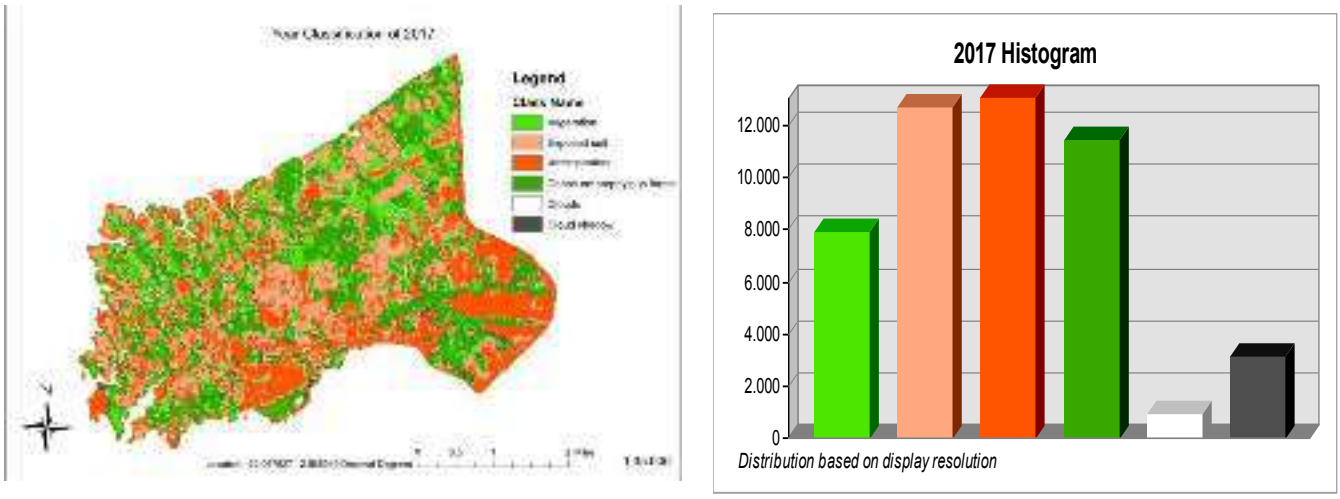


*Fig.6 : Year 2017; a) Map of the tarumã Açú neighborhood; b) Histogram of the year 2017*

## IV. FINAL CONSIDERATIONS

Through the high resolution images of the LANDSAT satellite, a supervised classification study of the use and occupation of the soil was carried out in the Tarumã Açu neighborhood, in the city of Manaus/AM. The desordeno growth of the city of Manaus has led to an increase in areas of irregular occupations in areas of ambiemtal preservation. It was noted that during the period 2010 to 2017 there was a significant decrease in vegetation cover was predominant at the site, soil exposure and anthropoization causes serious environmental problems to the environment.

With this, today we face certain consequences that often visible and easily perceived, such as the degradation of the environment, and pollution in various ways. It is necessary to establish and plan for recovery in the points where the higher impact index is shown, as well as a way to reduce impacts that end up affecting society itself, thus causing erosion and assorements affecting resources water at the site.

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# The use of Coffee Residues in the Cultivation of vegetables

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***Abstract*****—** *Since its discovery, coffee has had a large increase in its consumption, nowadays those who do not usually drink a cup of it, whether at home, at work, coffee is present at the table of many. By the time coffee was born, we know that real wild coffee was born in the interior of Ethiopia. This work was developed from February to October 2019 in the city of Manaus-AM. For the elaboration of the vegetable garden an area was delimited in the urban area in the north of the city, and parallel to this measuring 1x1,20 m was composted using the coffee residues. Instead of disposing of it through the sewage system, which harms both residential plumbing and the sewerage, because the accumulation of sludge in the pipes generates fungi and damages the PVC pipes. Coffee grounds are a product with great potential for use in vegetable cultivation, it is a great outlet for mainly domestic reuse offering an outlet for reuse and avoiding inappropriate disposal.*

***Keyword*****— Coffee waste, Blurs, Compost.**

## I. INTRODUCTION

Due to the high cost of chemical fertilizers, several alternative sources of organic waste have been used, such as animal waste, compound of urban waste, sewage sludge, coffee grounds and etc. In addition to these residues, there is the option of using organic soil conditioners in the production of vegetables, and can be marketed in liquid or solid form according to (DANTAS, 2011).

Composting, a biological process of transfomation of organic waste in humic substances, in other words, from the mixture of food scraps, fruits, leaves, manure, straws, among others, a fertilizer is obtained at the end of the process homogeneous organic, dark color, stable, loose, ready to be used in any crop, without causing damage and providing numerous improvements to the soil (SOUZA, 2009).

In Brazil, coffee is one of the favorite drinks, which is part of the daily life of the Brazilian, which makes the second largest consumer of this drink in the world, as given (EMBRAPA, 2017). It is believed that coffee is one of the organic classes that most favors the Brazilian economy, being also considered one of the seeds that gave the most profitability to the country (DAMASCENA, 2015).

Also Souza (2016) showed that advances in technology combined with rampant population growth often result in an explosion of unsustainable practices of natural resources. Associated with these processes, the lack of control in the final destination of waste from food production is also highlighted. However, what was previously produced on a small scale, with the population increase took large proportions. In fact, the production of global food has increased considerably over the centuries.

Since its discovery, coffee has had a big increase in its consumption, nowadays it is difficult to imagine, who throughout their day, does not usually drink at least one cup of this drink, whether at home, at work, coffee is present at the table of many around the world.

But what can we do with the waste generated during their preparation? An alternative to the use of these waste is their reuse through the composting process. This process is carried out through the reuse of these residues, or through their constituents the qais presents some economic value. Composting is one of the most attractive ways to solve these wastes, both economically and from an environmental point of view, providing a sustainable alternative to disposal (SZNTE, 2010).

Research shows that the use of organic waste provides improvements in the physical, chemical, and biological properties of the soil, favoring an environment conducive to microbial establishment (GULLO, 2010).

In soil organic matter, microbial biomass is the living and most active part, consisting of bacteria, fungi, actinomycetes, protozoa, and etc. Microbial biomass has several functions, such as controlling the decomposition and accumulation of organic matter, and regulating nutrient cycling in the soil (GRUGIKI, 2017).

It is noteworthy that inadequate disposal of coffee residue can generate various damage to the pipes of the

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residences and over time, the waste begins to solidify on the walls of the pipes, which makes it difficult to clear the internal channeling of the Residence. However, coffee preparation residue can be used for various purposes, highlighting its use as fertilizer in plantations, being added to the single or dry soil. The organic composition and mineral composition of coffee grounds can affect its efficiency as fertilizer, however, one advantage we can cite is the high percentage of organic matter and the high amount of potassium (SZNTE, 2010).

Thinking about this problem, this work will show an experience of the sustainable use of waste generated in the preparation of coffee, as a source of organic fertilizer, and thus show it as a source of reverse and sustainable logistics.

## II. MATERIALS AND METHODS

This work was developed during the period from February to October 2019 in the city of Manaus-AM. For the preparation of the vegetable garden, an area was delimited in the urban region in the northern part of the city measuring approximately 1 x 1.20 m, where the composting process was developed using coffee reins.


*Fig.1: a) area used where the composteira mounted; b) amount of coffee waste collected daily.*

At first, the residue was collected, and these were identified to control the collection period, and the amount that was collected, in order to obtain an average consumption in the residence. Subsequently, some by-products such as dried leaves were added to the coffee residues, and eggspeel.

After adding the elements to the residues of coffee preparation that were collected, a measurement of 250 ml was used as a parameter for the mixture.

Thus, we have a fertilizer prepared with 4 measures of 250 ml of coffee residue (lees), along with 1 and a half measure of crushed egg shells (totaling 375 ml), and then this compound will be added to the soil, for the composting process. So that it is dry, because we will not work with the same damp.

*Fig.2 - Collection of eggshells.*

For the use of this type of residue it is important to take some basic care during the handling of waste, do not keep the smudge collected in a closed place in a very long period, as the proliferation of fungi may occur, a fact that is not advisable in the Process. It is noteworthy that in many cases, when preparing the compound, the coffee spray should not be added to the mixture, which in its preparation was added sugar.

## III. RESULTS AND DISCUSSION

Following the measurement of the mentioned compound, for the composting process, the time period of at least 15 to 30 days should be obeyed for the maturation process of the compound. During the composting process there is a sequence of microorganisms that decompose organic matter until the final product appears. For a good use in this process, it is recommended to make a good choice of the area in which there will be the composting process, this site must have a good drainage, receive sufficient solar radiation, but also airy. If the composteira is too exposed to the sun, organic waste may dry excessively, besides being able to harm microorganisms operating in the composting process (fungi, bacteria and actinomics), most of which do not survive under temperatures above 70 °C as (WANGEM, 2010).

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As mentioned above, the coffee compound cannot be added before the fourth week in composting, because it is overhumid, and before this period there is a greater possibility of the emergence of fungi, these are not beneficial, and which in turn will assault the plants and vegetables, for which the compound was used. In addition to oxygen, microorganisms also require moisture to develop and decompose organic matter, however, too harmful moisture is harmful, because excess water occupies the existing spaces between organic particles, making it difficult to Circulation (EMARP, 2019).

The vegetables that the compound was tested were watered daily at 7:00 a.m. in an airy place, and their behavior and growth were analyzed for 45 days. Thus composting could be divided into three phases with respect to temperature. The first phase is mesophic, that is when temperature increases due to the growth of microorganisms. In the second phase, thermophilic, the temperature exceeds 40ºC and that is when the most intense biochemical reactions occur. And the last, is the humification or maturation of organic matter, which corresponds to the degree of stabilization of organic materials, and at the end of this phase, the organic compound will be ready. (OLIVEIRA, 2014).

During the first two weeks, it was noticed that the samples presented an excellent development, which is the initial objective of our work.

*Fig.3 - Chives after 2 weeks*

However, at times in the experiment, some samples of spring onions presented alterations, such as yellowish tips, this may be due to some factors, such as: lack of irrigation, nutritional deficiency, high sun exposure or fungi. As shown (SILVA, 2019), sunlight is one of the factors that directly influences the chives, as well as one of the factors that can cause yellowing of the chives leaves is the lack of water in the correct measure, because it is a plant that does not requires many gas and does not like water very much we can not fail to take into account that chives needs a watering, once or again, during the day, always taking into account the moisture factor as a reference, if the place has good humidity , it is advisable to water once a day.

To prevent fungi from attacking the spring onions, the recommended is to decrease the gas in periods of low humidity and line the floor with dead cover, as in Manaus we went through some periods where the rain is intense, during some moments the gas were controlled. Fertilization is the way to replenish in the soil the nutrients that plants take from it for their development, so in plant cultivation this process is fundamental for the development of them.

Furthermore, it was found that vegetables should be exposed to the sun at most, within up to 4 hours a day, in the primieras hours of the day, between 07:00 and 11:00, because sunlight can directly influence the taste, aroma of our seasonings and development of them , the vast majority of seasonings need to receive at least 4 hours of direct sunlight to develop well and maintain their aromas and flavors, as (SILVA, 2019).

Even though all these measurements were taken, it was noticed that after three weeks they had no sign of improvement, the yellowish tips continued to appear, using the hypothesis that the soil, in which the samples were presenting a nutritional deficiency picture, the baica p concentration drastically affected the root growth of the plant, these presented typical visual symptoms of P deficiency, with small plant growth and yellowing of leaves, which coincides with the symptoms described by ARAUJO (2016), this measure was taken with corrective effect.

For this correction, a simple and common alternative was used, chicken manure was added to the mixture in the soil, and with the passage of a few days, it was noted that they showed an improvement, the main benefits of the use of avian manure, the highlight is for the potential to provide chemical elements such as nitrogen, calcium, phosphorus, magnesium among others, also the organic matter supplied to the soil favors better soil structuring, causing it to retain more water, plants will suffer less with short periods of lack of water, in addition to favoring the proliferation of beneficial microorganisms as described Araújo (2011). Although chives are a vegetable that does not require a large amount of water, one cannot fail to irrigate them daily during the process, whenever necessary to highlight.

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*Fig.4 - Composting process.*

After exactly fifty days, we were able to realize that the soil and fertilizer managed to enter a balance, the spring onions grew, and hears an accelerated reproduction of them, the yellow tips were no longer present, and even the coloration of the spring onions became more visually trimmed.

For this process, coffee residues with sugar should not be used, because sugar in addition to attracting insects

*Fig.5 - Final result.*

According to the figure above, we observed the final result of this work, the chives went through several processes until it reached the point, as we see in the image. If we obsevar figures 3 and 5 we can see how the development process was, it is percepitible how reproduction occurs high, and they can reach a pleasant size, in a natural way and maintaining a great coloring.

## IV. CONCLUSION

This work showed the great potential of coffee residues in the cultivation of vegetables, it can be an outlet for domestic reuse, avoiding inadequate disposal that most often occurs in homes.

With the use of coffee compound, together with composting we can emphasize the opportunity to generate less organic household waste, because we can add in the process some residues such as fruit peels, dried leaves, but not left over food that they were cooked when prepared, thus compromises the development of plants, it is of paramount importance that some details are obeyed, especially the measure in the preparation of inputs that will compose on the ground. The wrong use of the mixture affects the development of plants such as water and nutrient absorption, and in this case the spring onions end up being compromised, a high amount of coffee smudge on plants generates a layer that ends up solidifying, compromising the absorption of water and other nutrients according to (FERREIRA, 2011) the composting of coffee grounds can be an important and essential practice so that this residue can be used safely as organic fertilizer. There is evidence that, in the process of composting coffee grounds, nitrogen intervenes in the mineralization of organic matter, thus the coffee blur when applied directly to the soil may reduce the availability of this chemical element for plants. Instead of adducting, the coffee grounds remove this element that was already present in the soil. Therefore, the process of composting coffee grounds is important, before the cultivation is carried out, so that it is dry and does not compromise the plants.

reducing disposal in landfills, which is the final destination in many cases. Coffee residues offer various nutrients to the soil, in addition to protecting (eliminates bacteria and other soil-damaging microorganisms) and makes plants more productive, always when used respecting the amounts needed for soil.

During our experiment we had some problems, and with our learning we left some recommendations, whenever we use coffee waste to prepare the fertilizer, obey the composting period, because it is fundamental to obtain good results in plant development. For the higher nutritional efficiency of the soil prepare the site always checking the type of soil in which planting will be done, prefer the use of green fertilization, using leaves, wood remains, animal manure and etc.

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# The Disposal of E-Trash in the east zone of Manaus: The Disposal of Analog TVS

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***Abstract*****—** *The disposal of thousands of electronic devices and waste in Manaus by the repair shops of electrical and electronic appliances in the peripheral districts of the city's East Zone and by the population in the public places where they are abandoned is a worrying phenomenon for the environment due to randomly, without the attendance to a public policy prioritizing the selective collection, or the reverse logistics to minimize or eliminate the damages caused by its components constituted by highly polluting substances such as mercury, cadmium, arsenic, copper, lead and aluminum that penetrate soil and groundwater contaminating plants and animals through water. This contamination can reach man through the food chain by ingestion of these foods. Studies on the potential contamination of these substances attest that the consequences of contamination can be a simple headache, vomiting, nervous system damage and cancer occurrence. The data obtained from the field research and its analysis allow us to conclude that this process is even more serious, as a consequence of the absence of public policies, or the existence of inefficient public policies, to promote selective collection and reverse logistics as tools to reduce impacts environmental impacts. Focusing on this reality, this paper presents a proposal for the adoption of a Program for the Selective Collection of Electrical and Electronic Products (PCSEE) to carry out joint actions between public authorities and workshop owners, motivated through public incentives.*

***Keywords*****— Environmental Impact; Reverse logistic; Electrical and Electronic Waste.**

## I. INTRODUCTION

This article is the result of a research carried out in the East Zone of Manaus about the environmental impact caused by the disposal of waste from electronic products by workshops and families, to which questionnaires were applied to obtain the information necessary to carry out the study and indicate a proposal aimed at solving the problem.

The reverse logistics system aims to return a product that has been used and completed its cycle of use and durability, or irreparable damage with the need for disposal by the consumer, by break, expense or perhaps because it has been technologically overcome. According to Leite (2009, p. 15) it is "impossible to ignore the reflections that the return of these increasing amounts of after-sales and post-consumption products causes in business operations".

In Brazil, about 500,000 tons of electronic waste are discarded per year in inappropriate places and some toxic materials that make up this type of residue contaminate the environment. The situation could get worse with the introduction of the process called "scheduled obsolescence", in which the industry "programs" products to become obsolete faster. Rodrigues (2008).

Currently the problem of waste is one of the main concerns regarding urban population growth and the habit of consumption of society. Among the various places for the destination of man-generated waste, we can find one of the most impactful, as is the case with dumps. Siqueira and Morais (2009). The problem worsens with the disposal of e-garbage randomly, in common dumpsters, springs and public laurels.

However, this concern is not the focus of this work, since the difficulties faced by companies are only part of the problem that is addressed by the environmental impact caused by the disposal of these products in full, or their waste, in the public spaces, addicted dumpsters, scraprias and water springs. The increase in electronic waste represents a challenge of difficult confrontation as a result of the impacts generated by "e-trash", or electronic waste directly related to technological evolution and scrap disposal.

Additionally, in the city of Manaus, thousands of analog televisions, with glass image tube began to be discarded after the shutdown of the analog signal of open television and beginning of digital TV broadcasts in the year 2017. This event encouraged several inhabitants to purchase new televisions, leading some residents to dispose of old equipment incorrectly.

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The study aims to evaluate the condition of the disposal of electronic waste by workshops and families in the East Zone of Manaus and indicate strategies to address the problem through the adoption of a permanent selective collection and logistics program Reverse.

To meet this goal, procedures were performed to collect estimative data of the disposal of e-garbage and the consequent environmental impact, through field research and bibliographic, due to the problem and based on the subsequent methodology.

## II. METHODOLOGY

To perform this research, a bibliographic survey was conducted in order to have greater theoretical basis, for this, several works were analyzed (articles, dissertations and theses) in order to understand the analyses before carried out by other experts who also discuss this theme, where they allowed the work to identify negative environmental impacts characterized by the environmentally incorrect disposal of electronic waste in the Zone East Manaus, Amazonas.

For field research, the "check-list" method, according to Silva (1999), in the glimpse and listing of sequences (environmental impacts), when considering the transformative potential of the biotic and anthropic physical environment, of causes (known impact activities).

With a way of presenting these environmental impacts analytically, the descriptive check-list was used, also recommended by Silva (1994), Arruda (2000), Ludke (2000) and Brito (2001), for this type of research.

Next the researcher performed the application of semi-structured questionnaire aimed at 25 workshop owners (who work concerting e-garbage) in the east of the city of Manaus, as well as to 50 residents, (these chosen randomly).

In this sense, this work proposes a more realistic and in-depth study on an interdisciplinary problem that portrays social behaviors, but that centralizes its focus on the environmental issue which refers as a result of the impact caused by the irregular disposal of waste and electronics and e-garbage in the East Zone of the city, locus of research.

## III. THE E-TRASH AND ITS DISPOSAL AS ORDINARY WASTE

The e-garbage, or e-waste name emerged in the United States to designate garbage consisting of discarded or obsolete electronic products such as PCs, TVs, VCRs, VCDs, mobile phones, stereos, fax machines, copiers, batteries of various types and purposes, televisions, appliances in general, with their circuit boards and components.

According to data from the Municipal Secretariat of Public Cleaning (2019). In Manaus about 250,000 analog televisions began to be randomly discarded, without the existence of an official reverse logistics program and selective collection, from the shutdown of the analog TV signal in 2017. This creates a huge problem for the whole city, because new policies are still being discussed, others are already being implemented to combat this problem, according to images 1 and 2 below.

*Image 1 - Source: Gonçalves (2019)*

*Image 2 - Source: Gonçalves (2019)*

According to IBGE data that recorded a population of 1,802.014 million inhabitants for the city of Manaus in the last sense made in 2010. Assigning the average of five (5) family members it is estimated that at least 200,000 families in the city of Manaus and at least one analog TV set per family to be discarded from the shutdown of the analog signal and its replacement by the Digital TV.

This estimate does not consider the possibility for families to have more than one (1) analog TV set, which is not uncommon, even among the poorest families. Subsequent image shows the distribution of the population of Manaus city:

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*Image 3 - Source: IBGE*

Of one million eight hundred and two and fourteen thousand inhabitants of the city of Manaus, 531,762 live in the neighborhoods of the East Zone of the city and represent about 80,000 families. According to scholars, these families will dispose of at least 100,000 analogue TV sets in domestic dumpsters and public laurels within a year.

This factor worsens, in this region where the material has been discarded together with ordinary waste, in the streams and green areas, due to the lack of recycling and reverse logistics programs, the simple ineffectiveness of existing programs and the lack of programs the population's disciplined use and disposal of electronics, with the objective of reducing environmental impact. Research data shows that most families have never received any kind of guidance to dispose of their electronic devices. When not discarded so, the TV sets are taken to existing workshops in the region for repair and abandoned by the owners forcing the owners to seek solution for disposal, or simply abandoning them on the sidewalks of the neighborhood (Image 4 and 5).


*Picture 4 - Source: Gonçalves (2019)*

*Picture 5 - Source: Gonçalves (2019)*

According to physicist Délcio Rodrigues director of GREENPEACE – NGO responsible for actions in defense of the environment around the world, these materials, among which stand out the e-garbage presented in the image above, are not biodegradable and cause serious damage to the environment environment indicating recycling and reverse logistics as viable options for solving the problem.

Through the reports of residents and store owners who use e-trash, it was found that there is a thought of sensitization and availability of actors to adopt recycling, or reverse logistics, but there is no institutional program through which is recycling can be practiced.

This absence of public policies and practical actions cause embarrassment to the owners of electronics workshops that accumulate a large volume of obsolete appliances abandoned in their workshops by owners who prefer to acquire new equipment to rescue old equipment.

This random disposal process without the existence of public policies capable of minimizing environmental impact can be translated through the statistical data of the research that present the reality of this phenomenon into reliable indicators of the dimensions of

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the problem, according to the demonstration in the subsequent chapter.

## IV. RESULTS

To quantify the field research on the environmental impact of electronic waste by the workshops of the East Zone of Manaus, the capture of images used in the previous chapter and the application of a check-list for the collection of data reported in Table 1 below.

*Table 1: Result of the research conducted with the residents of the neighborhood.*

| | | | | |
|---|---|---|---|---|
| They have Analog TV | Yes | 41% | No | 59% |
| Where Analog TV Sets Are Discarded | Dumps | 43% | Workshops | 57% |
| Know Selective Collection | Yes | 58% | No | 42% |
| Know How to Set CS Colors | Yes | 29% | No | 71% |

The data show people who have analog TV only 41% of them still have and that 59% have already replaced analogs with digital equipment.

In the second item of the table it was found that among those who have already discarded the analog devices, 43% of them placed the appliances in domestic dumpsters in front of the residences, or in addicted dumps existing in public street spaces, water springs (streams), or green areas. According to them "there is no suitable place to place these materials".

The survey found that none of the interviewees disposed of the devices through a process of selective collection, or reverse logistics, without obtaining any guidance on the correct way to discard the e-garbage and that 57% of families abandoned the devices obsolete in workshops, after taking them for repair, without returning to the site to rescue them.

According to shop owners, we do not participate in any Selective Collection program, or reverse logistics. Thus, the exit is to turn to the scrap dealers that transit in the neighborhood collecting scraps to sell in recycling deposits, however, only some materials, such as copper and aluminum are in the interest of the scrap dealers. According to shop owners, the city's sweepers claim that they are instructed not to collect any type of junk, leaving the owners without the option of disposal of the e-garbage.

This procedure contradicts current legislation that manufacturers are required to receive obsolete or residual materials by creating a collection mechanism.

Article 1, CONAMA resolution, paragraph 257 of 30 June 1999, provides that batteries and batteries containing in their lead, cadmium, mercury and their compounds, necessary for the operation of any types of appliances, vehicles or systems, mobile or fixed, as well as the electro-electronic products containing them integrated into their structure in a non-replaceable way, after their energy exhaustion, will be delivered by users to the establishments that market them or to the authorized service network by their respective industries, for transfer to manufacturers or importers, so that they adopt, directly or through third parties, the procedures for re-use, recycling, treatment or final environmentally appropriate provision.

The standard established by CONAMA is part of reverse logistics, in which obsolete materials make the reverse route to their origin to be recycled. In the East Zone of the city, where field research was carried out there are many scrap deposits that carry out recycling and commercialize metals, copper, paper, plastics, iron and other waste, but it is a simple marketing process and not a organized LR system.

Despite the massive disclosure of damage caused to the environment by the disposal of e-garbage, no participation in recycling programs was recorded among the interviewees, or selective collection and most of those who reported knowing selective collection stated not know how to define the colors intended for waste in cs bins.

This factor statistically indicated in the above tables demonstrates that the population does not practice selective collection, where 58% say they know what selective collection is and 42% do not know how to define. Confirming the trend of random and inadequate disposal of electronic waste and others that are not collected by public collection in domestic dumpsters, such as pieces of wood, plastics, glasses, and so an..

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*Picture 6 - Source: Gonçalves (2019)*

Among the interviewees who reported knowing the selective collection represented by the colored collectors in the image above, 71% said they could not define the specific colors of the recycle bins for each type of residue and only the remaining 29% stated that they knew the destination of colors.

According to Gonçalves (2007), the paradox exists in the problem of an increasingly growing production in a market that offers increasingly affordable high tech equipment, with a high level of waste of natural resources and contamination of the environment caused by the production process and the rapid and increasing disposal of the same.

The research indicates that most families are not oriented enough to avoid environmental damage and live with the reality of the production described above and the consequent intense disposal of e-waste-generating goods.

In addition to the restriction of city collector cars that do not collect this type of material limiting the collection only to household waste packed in bags and the absence of public policies and institutional programs of reverse logistics and selective collection are determinants for the worsening of environmental damage caused by the random disposal of e-waste expanded by the disposal of thousands of analog televisions in the city of Manaus.

This chapter presents the results obtained from the visits to the homes of some residents of the neighborhoods of the East Zone of Manaus and workshops of the Neighborhoods for the application of the questionnaire with the families that were part of the research.

Families are all low-income, residents of internal streets in the neighborhoods. And the workshops visited present common characteristics regarding the size and legal constitution, being in full micro informal enterprise, without formal hiring of labor working mainly with the work and personal administration of the Owner.

Through this work, we sought to collect data necessary to analyze the flow of disposal of these materials by the workshops randomly, considering the lack of a public service (inefficient) intended to collect these materials, since the domestic garbage collector cars do not collect electronic waste that ends up being deposited in dumpsters addicted to public rentals, according to the following images.

*Image 7 - Source: Gonçalves (2019)*


*Image 8 - Source: Gonçalves (2019)*

### 4.1 RESULTS OF ENVIRONMENTAL IMPACTS

The results related to the identification of negative environmental impacts and human health, caused by electronic and e-garbage waste in the eastern part of the city of Manaus / AM are presented in the form of listing (check-list), in tables 2 and 3 below:

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*Table 2: Chek-list method application.*

| Ord. | Negative Environmental Impacts | Origin |
|---|---|---|
| 01 | Contamination of surface and groundwater | Muitas das vezes esses materiais (tv analógica e e-trash) são descartados em terrenos de preservação onde existem nascentes consequentemente poluindo as águas superficiais e subterrâneas. |
| 02 | Possible damage to public health | Possible contamination with chemicals existing in these materials. |
| 03 | Depreciation of soil quality | Contamination caused by waste (Arsenic; copper; aluminum; mercury, and so an.) from analog TV and e-garbage. |
| 04 | Depreciation of soil quality | Decreased fertility because of the chemicals of these materials (analog TV and e-garbage). |
| 05 | Possibility of attacks of venomous animals | Permanence of debris and debris of these materials (analog tv and e-garbage), in inadequate places. |
| 06 | Degradation of the natural landscape | The way in which these materials (analog tv and e-garbage) are abandoned often in preservation areas consequently end up changing the landscape. |
| 07 | Risk to human health | People (sateiros) removing the materials to recycle without any protection. |

*Table 3: Cheklist method application.*

| Ord. | Chemical | Where they are found | Made to health |
|---|---|---|---|
| 01 | Mercury (Hg) | Analog tv and e-trash | It can harm the brain, liver, development of fetuses and cause various neuropsychiatric disorders. (SILVA, 2010). |
| 02 | Cadmium (Cd) | Analog tv and e-trash | In chronic intoxication can generate bone decalcification renal injury in addition to teratogenic (fetal deformation) and carcinogenic (cancer) (FERREIRA and ROSOLEN, 2013). |
| 03 | Arsenic (Ar) | Analog tv and e-trash | In humans it produces effect on the respiratory, cardiovascular, nervous and hematopoietic system. (SILVA, 2010) |
| 04 | Covers (Cu) | Analog tv and e-trash | damage to organisms associated with copper include damage to the gastrointestinal epithelium associated with centrilobular necrosis in the liver and tubular necrosis of the kidneys, metabolic changes in the body (OLIVEIRA e CAMARGO, 2009). |
| 05 | Lead (Pb) | Analog tv and e-trash | Soil contamination with Pb is a virtually irreversible cumulative process thus increasing the contents of this metal on the soil surface, indicating an availability of absorption of it by plant roots (SILVA, 2010). |
| 06 | Aluminum (Al) | Analog tv and e-trash | Iron deficiency anemia; chronic intoxication (ARAUJO and PINTO FILHO, 2010). |

**PROPOSAL TO COMBAT AND ENVIRONMENTAL DEFENSE**

To address the problem caused by the disposal of electronic waste by workshops and families in the East Zone of Manaus and its consequent environmental impact resulting in risks to public health, soil contamination, resources water and atmosphere this work proposes the implementation of the SPECIFIC COLLECTION PROGRAM - PCE, by Manaus city all.

The PCE should be inserted in the current system of public garbage collection, with the use of collection trucks scheduled to collect waste in electronic workshops and strategic points, where families can deliver the equipment giving waste the correct disposal, rather than

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leading them to the landfill, where they will cause irreversible damage to the soil, ground water sheets and water systems of the city that flow into the Negro River, leading to this its high potential for Contamination.

The proposal is in line with the need for immediate and efficient action by the government that cannot remain omisso to the confrontation of this problem that will be aggravated with the disposal of thousands of obsolete appliances, due to the definitive shutdown analog signal by Amazon TV stations.

In addition to the natural disposal due to wear, these equipment had their disposal accelerated by its obsolescence, after the shutdown of the analog signal in Manaus, or because they were damaged, with the disposal of the landfill of the City Hall and other places Inappropriate. According to what has been exhaustively demonstrated in this work, when there is recycling of these materials, it is always occurs in a rudimentary and precarious way.

Another aspect to be observed is the absence of a policy of regularization of the collection of these debris. "What actually exists is just a shy set of legal devices that do not meet the real environmental preservation needs at all, enabling irreparable damage to the environment and human health itself" (GONÇALVES, 2007).

## V. CONCLUSION

With the present research work it was possible to realize that there is still a need to work new public policies that aim to bring more efficiency to the services offered by the city, as well as more information the population, so that we can solve this problem that every day only increases in our city.

This phenomenon of disposal of the e-garbage object of this study is concern of Environmental Engineering due to occur randomly, without the existence of a public policy prioritizing selective collection, or reverse logistics aimed at avoiding, minimizing and eliminate damage caused by its highly contaminating components such as mercury, cadmium, arsenic, copper, lead and aluminum that penetrate the soil and groundwater contaminating plants and animals through water until it reaches man through the chain food by the intake of these food and water.

Unfortunately, in recent years the problem has only worsened with the process of shutdown of analog signal by amazon TV stations, without public sectors of environmental preservation manifested and adopted initiatives to solve the problem preferring the silent permissiveness to dispose of thousands of analog TV sets in the city without guidance or any public policies to avoid the environmental impact caused by it.

Therefore, it is concluded that the damage to the environment caused by this phenomenon is a priority concern of all, and determines the urgent implementation of the Specific Collection Program - PCE by city hall Manaus to face the problem that has been causing and will also cause irreversible damage to the environment the quality of life in the city of Manaus if an effective activity of raising awareness of the population is not carried out.

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# Solid Waste management in the riverside Community vila do Itapuru - Municipio de Beruru – AM

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***Abstract*— *With economic development and population growth, the amount of waste generated by humanity has dramatically increased. Many Brazilian municipalities face problems related to the issue of waste, especially when it comes to small municipalities that are difficult to access such as the municipality of Beruri. This work aimed to propose a solid waste management plan in the community located in the municipality of Beruri village of Itapuru. The work was carried out in 4 stages with the use of tools such as questionnaires, lectures and recycling workshops at the Osvaldo Nazaré Veríssimo school. After data collection and analysis, it was concluded that the inhabitants of the village have little knowledge regarding the treatment of solid waste. As a mitigating measure he proposed application of environmental education in school and association, elaboration of a waste management plan, creation of recycling cooperative and with posts.***

***Keywords*— Waste; Recycling; Collection.**

## I. INTRODUCTION

The problem related to solid waste due to population increase and the process of uncontrolled urbanization, has been discussed in recent decades in relation to impacts on the environment and public health. With economic development new consumer profiles arise, and consumerism has been treated as an aggravating factor for increasing waste production that often does not have an adequate final disposal (RODRIGUES, 2015).

The national solid waste policy dealt with in law 12,305/10 provides for the reduction of waste, with a proposal the practice of habits and sustainable consumption and a set of instruments to promote increased recycling and reuse of solid waste. However, the concern about solid waste issues has been highlighted since the 1970s, observing the disorderly growth of waste, there was a need for a meeting where economic development was discussed and has met environmental education aimed at issues about the generation of solid waste. Selective collection and fundamental importance in the environmental context of the population, so that the collection has a good result is for residents to seek involvement together with recycling programs and environmental education to improve the population's life and a pleasant environment (BELTRAME and LHAMBY2013)

For Holzer (2012) recycling is an important way of reusing waste, avoiding incorrect disposal, thus seeking to involve programs and campaigns focused on the environment, development and sustainability, in order to bring knowledge to the society on the importance of recycling and selective collection. Scholars of the theme such as Tavares and Tavares (2014) conceptualize solid waste as 'all material that cannot be reused for consumption and are despised or abandoned in streets causing problems for the environment.

Thus, the village community of Itapuru falls into this problem because there is no adequate management of its waste, and the same burned daily causing damage to the environment mainly with the emission of greenhouse gases. The forest people and the main character when referring to the Amazonian scenario, these families survive from fishing and agriculture because there is no other means of work because it is an area far from large cities as well as the lack of opportunities also and precarious to lack of knowledge. The school is fundamental for the riverside population where they approach disciplines and activities focused on environmental education, the dimension of education and the construction of school that is motivation for riverside people to change their qualities of life (SANTOS and TREIN 2010)

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For Munhoz (2004), the most effective ways to bring environmental education to the community is through the teacher's direct action in the classroom and in activities such as reading, schoolwork, research and debates. Only in this way can students understand the problems that affect the community where they live, and thus seek to improve their attitudes about the environment. This environment which carry out their activities on environmental conservation and respect for nature transforming them into citizens aware and committed to the preservation of the environment.

Thus, this project is justified by the importance of raising awareness and raising awareness among community residents to reduce the waste generated; gaining knowledge about the importance of preserving the environment and encouraging the community through recycling.

Thus, a Solid Waste Management Plan (PGRS) was proposed in the village community of Itapuru municipality of Beruri/AM, where it took knowledge about the importance of correct disposal seeking to raise awareness and raise awareness among the local population regarding the treatment of waste generated in the community. Also, actions were carried out such as lectures at the school and craft workshop focused on the theme in question and later a questionnaire was applied to verify the level of knowledge of residents regarding the environment and environmental impacts related to solid waste.

## II. MATERIAL AND METHODS

The present work will be development in the period of full of Amazonian rivers, comprising the months of June and July of this year. The space chosen was the Community of Vila do Itacuru located in the municipality of Beruri on the banks of the Purus River, distant straight from Manaus 173 km. The aforementioned community is home to 750 inhabitants who organize themselves in three villages being Vila Araújo, Vila Itapuru which is located more in the center and last Vila Miranda. The logistics of arrival in the village of Itapuru, with departure from Manaus takes about 24 hours in the river modal (regional boat).

Also, it was developed of environmental education with students of the public network, in a municipality in the interior of the state of Amazonas, from June to July 2019. The space chosen was the Community of Vila do Itapuru, considered a Sustainable Development Reserve (RDS), located in the municipality of Beruri on the banks of the Purus River, distant straight from Manaus 173 Km (Figure 1).

*Fig.1: Beruri location map in the Amazon*

Technical visits were made for the application of questionnaires and photographic records in order to trace the profile of the community. Thus, one can identify the means that could be degraded by incorrect disposal of waste. In addition, it was attended by the department of the environment of the Municipality of Beruri during the process of collecting, transporting and treating the respective waste.

The activities were carried out in June and July 2019, being divided some stages, the first through lectures related to the preservation of the environment, correct treatment of solid waste, through recycling. A second stage, occurred through lectures, recycling workshops for recycling with waste brought from their homes and turn them into new products, thus avoiding incorrect disposal, such as burning these waste.

Finally in the third stage, it was an artistic workshop, in which students will apply all the acquired knowledge about recycling and sustainable practices during the project, in the construction of toys, utensils and fantasies. At the end of the workshop, the products generated will be presented to the community and other participants through an exhibition.

## III. RESULTS AND DISCUSSIONS

It was found that the population of Villa do Itapuru did not have a system of correct disposal of waste generated in the community, thus bringing serious risks to

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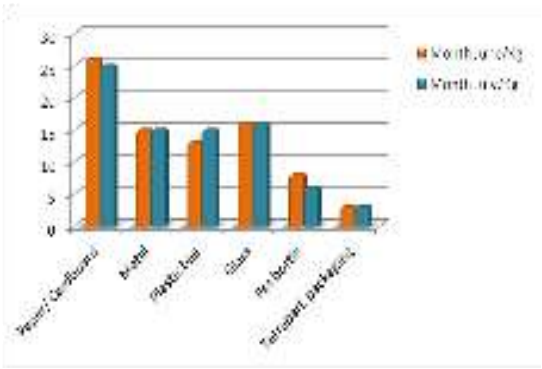
the health of community members, impacts on the environment and social. It was also observed that the locality does not have waste collection services generated, which demands concern about the quality of life of its residents, given this situation the amount of waste that is burned daily motivated the elaboration of this project aimed at managing local solid waste.

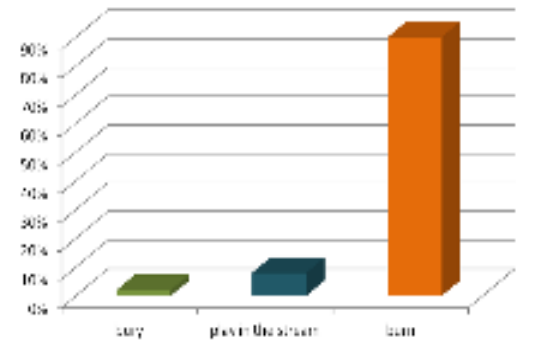
Through the survey conducted during the months of June and July it was possible to evaluate the amount and type of waste generated in each residence (Table 1). It was found that residents of the village of Itapuru produce around 1 kg of waste daily, which the final destination is burning.

*Table 1- Sampling of the quantity of solid waste.*

| Material gerado | Mês Junho | Mês Julho |
|---|---|---|
| Papel\|Papelão | 26 kg | 25,3 kg |
| Metal | 15 kg | 15 kg |
| Sacolas Plásticas | 13 kg | 15 kg |
| Vidro | 16 kg | 16,7 kg |
| Garrafa Pet | 8 kg | 6 kg |
| Embalagem Tetrapark | 3 kg | 3,7 kg |



a)



b)

*Fig,2: a) quantitative waste in the community of Itapuru; (b) behaviour in relation to waste disposal.*

According to Table 1 the amount of paper and cardboard generated in June in the community is 26 kg, tetrapark packaging 3 kg and metal 15 kg, these values are close to those found by Rodrigues (2016), in his study on solid waste management communities amazon riverines, where the amount of paper waste reached 25kg per month, tetrapark packaging 2 kg and metal 14 kg.

Figure 2 shows that Community members do not have many alternatives to the final destination of waste, and that 90% of them adopt non-recommended measures, such as burning. Unlike Lima (2017), which found where only 8% and 3% of the population of Princess Isabel (PE) and Quixaba (PE), respectively. Meanwhile, Souza (...) in his analysis in the community of Our Lady of the Rosary in Parintins-AM showed that 80% were destined for burning, 10% used for fertilizer and 10% for other purposes.

a)

b)

*Fig.4: a) residues are burned daily by the community population; b) waste is burned daily by the community population.*

With the burning of waste can occur a number of problems both to the environment and the health of the population and air pollution. In addition to harming the soil with the burning of these wastes can cause fires of large proportions destroying the forest and nearby residences, the smoke harms the health of residents mainly those who have breathing problems. To Santiago et. al.,

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(2012) waste generated by riverside communities is usually burned for lack of adequate place for final destination.

*Table 2: students' knowledge of solid waste recycling before action.*

| Issues | Yes (%) | No (%) | Did not answer (%) |
|---|---|---|---|
| 1. Have you heard of recycling | 60 | 40 | ----- |
| 2. You know what the importance of recycling | 70 | 30 | ----- |
| 3. Knows the difference between solid waste and tailings. | 90 | 5 | 5 |

The results in Table 2 show the level of knowledge of community students in relation to garbage recycling and sustainability. It was observed that 60% of the students showed familiarity with waste recycling, while 40% answered that they never heard about the topic. In addition, when asked about the importance of recycling waste, 70% of respondents answered yes, while 30% did not know (Table 2).

Collaborative questionnaires were elaborated to understand the dynamics with which solid waste is discarded. With the information obtained by the questionnaires, it will be possible to obtain information that helps in the implementation a system of collection of solid waste. For this, on-site visits were made that allowed us to observe the generation of waste per captas in the city. In addition, the questionnaire allowed us to observe how solid waste is discarded, a state of decomposition of them and above all, the environment in which the population of the neighborhoods live. Furthermore, if asked if they knew the difference between waste and tailings (Table 2), 90% of the students answered yes, and only 5% answered no, and 5% answered. The results are similar to the 95% found in Souza (2012).

Finishing the on-site research, we observed the need to raise awareness among students of the Osvaldo Nazaré Veríssimo School. Thus, during the months of June and July 2019, actions were carried out through lectures on solid waste management and environment for students of the three shifts. In addition, awareness, play and gymkhanas were incorporated, where the target audience were teachers, students and other people in the community. The students of the osvaldo Nazaré Veríssimo school understood one of the main problems and the issue of waste, and through this work realized that most students had no knowledge about what is referring to the collection, treatment and final destination of waste.

a)

b)

*Fig.5: a) Public network classrooms, where awareness about the environment was carried out; b) Public network classrooms, where awareness of the environment was carried out.*

After the awareness activity, each of the students performed an illustration based on the topics addressed during the activity as a way of fixing the topics addressed (Figure 5). After the activity, the students participated in a task force for collecting household waste: plastic, packaging, cardboard, cans and pet´s bottles, as a way to awaken environmental awareness and the practice of selective collection. With the end of the task force, the collected objects were selected to perform a recycling workshop for the transformation of waste into toys, utensils and costumes. The process was addressed in a playful and objective way, and thus, it was possible to massify the concepts of sustainable practices presented throughout the workshop (Figure 6).

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a)

b)

*Fig.6 - a) Couple winner of the recycling contest; b) exhibition of the manufacture of briquettes, utensils and fantasies through recycling.*

**Mitigating measures**

During the work, some aspects and impacts on the environment were found in the study area. Due to the treatment and incorrect disposal of solid waste, the soil is contaminated by infiltration. However, soil contamination is not the only consequence, as groundwater and surface contamination is also occurring around the community. Also, due to the effect of burning waste, the smoke generated by this can harm the health of the population, especially children and the elderly.

As a contribution to the community, some mitigating measures such as: insertion of the discipline of environmental education in schools and associations are suggested; implementation of selective collection programs; preparation of a selective collection and recycling program; implementation of composting plant for organic waste.

## IV. FINAL CONSIDERATIONS

This work showed that, through actions in school and in the community, it was observed that knowledge about the consequences of incorrect disposal of waste can reduce the amount generated today and thus improve the quality of life of the community. The questionnaires applied showed that 90% of residential and commercial waste is burned, 8% discard in rivers and streams, and only 2% discard in areas far from their homes. Among the mitigating measures, it is possible to promote the awareness of community residents, through lectures and courses related to waste separation, propose a way of correct disposal and raise awareness of the decrease in consumption. Furthermore, by diagnosing the environmental impacts caused by waste in the community, preventive actions can be avoided through preventive actions.

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# Assessment of Risk and Safety Management on Building Construction Project in Case of Jimma Town

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***Abstract***— *Health and safety risky issues have always been a major problem and concern in the Construction industry. Due to its nature and complexity of the work and relatively labour intensive environment, construction works provide opportunities for occupation for a wide range of people skilled, semi-skilled and unskilled. Wherever reliable records are available, construction is found to be one of the most dangerous on health and safety criteria, particularly in developing countries. However, knowledge on how health and safety risks are managed in Ethiopia construction sites is limited.This study therefore, aims to find out the current practice of health and safety risk assessment on building construction site in Ethiopia context specifically in Jimma town. The study was based on individual judgement, educational background, existing journals and available regulation. Questionnaires were designed and distributed to potential construction industry players; interview sessions and site observation have been conducted to meet the objective of the study. In addition, structured interviews were carried out with selected managers, daily workers and site engineers from a selection of government construction site. Descriptive analysis was used to summarize and interpret the data by using MS-excel and SPSS software.*

***Keywords***— ***Risk and Safety Management, SPSS, Construction Project.***

## I. INTRODUCTION

Construction is and always has been the largest single sector in the industry of every country in the world, once there is any degree of industrialization with the development of an infrastructure. From then on it forms a vital sector in the country's economy and its prosperity is a measure of the economic progress of the country.

The construction industry has invested much time, effort and money in trying to improve its health and safety performance. This investment has had success in the past in achieving significant improvements in the industry's record.

## II. LITERATURE REVIEW

**Sermolo, 2014**suggested that Poor working conditions/environment and lack of personal protective equipment (PPE) are the cause of accidents in construction industry.and striking, crushing.

**(Taylo**r, 2004)2A similar view is held by (Lubega, 2001)who found that the causes of construction accidents in Uganda include a lack of knowledge about safety rules, engaging an inexperienced workforce, and lack of respect for safety. with this view and suggests that the main factors affecting safety in China were managers' poor safety awareness, lack of training, reluctance to commit resources to safety, and reckless operations.

**Dejus, 2007** conducted a study in the Lithuanian Republic and identified that the major reasons for serious and mortal accidents are inexperienced employees, lack of qualifications and understanding risk on a construction site. carried out a survey in Malaysia to identify the causes of accidents on construction sites; they found that unsafe methods, including incorrect procedures, knowledge level, and disobeying procedures are the most frequent reasons for accidents on construction sites.

**Pillay and Haupt, 2008**in his paper mentioned that The direct costs of injuries are those that are most observable and are typically referred to as insurable costs. Direct costs may include: medical cost, premiums for compensation benefits, liability, and property losses. The direct costs can generally be quantified with reasonable accuracy. Indirect cost; -which are borne by contractors, include reduced productivity for both the returned worker(s)and the crew or workforce; clean-up costs; replacement costs; stand-by costs; cost of overtime; administrative costs; replacement worker orientation; costs resulting from delays; supervision costs; costs related to rescheduling; transportation, and wages paid while the injured is idle.

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## III. OBJECTIVES& METHODOLOGY

**OBJECTIVES**

1) To identify the major factors affecting the safety and health practice in building construction project.
2) To analyze the effect of safety and health practice in building construction project.
3) To recommend remedial measurement and to reduce hazard in the building construction project site.

**METHODOLOGY**

1) Collection of Literatures
2) Site Visits.
3) Quantitative Research Approach.
4) Study Population and Sampling Techniques
5) Recommendations and Conclusions.

The above-mentioned methodologies were implemented in the following private and government construction industries with effective manner to get the conclusion and recommendation.

a. Jimma City Administration Office.
b. Vavnero Construction PVT Limited.
c. Jimma university Project Construction Office.
d. Yotek General Construction PLC.

## IV. RESULTS & DISSCUSION

### 4.1 Technical risk related:

As Table 4.8 show that 13(34.2%) of the respondents of the company highlighted that Inadequate Site is the most frequent factor on building construction sites followed by 15(39.4%) of the respondent's storage and handling were under very frequent factors. Were as 14(36.9%), of the respondents Poor Jointing Machine were moderate frequent factors and 17(44.7%) of the respondents Maintenance and Repairing categorized under frequent factor.

### 4.2 Logistic Risk related

As Table show that 12(31.6%) of respondents Insufficiency of equipment availability is the most frequent factor and 12(31.6%) of respondents Insufficiency of transportation facilities is very frequent factor of construction hazards were as 12(31.6%) of the worker's construction site Non-availability of maintenance facility is frequent factor risk.

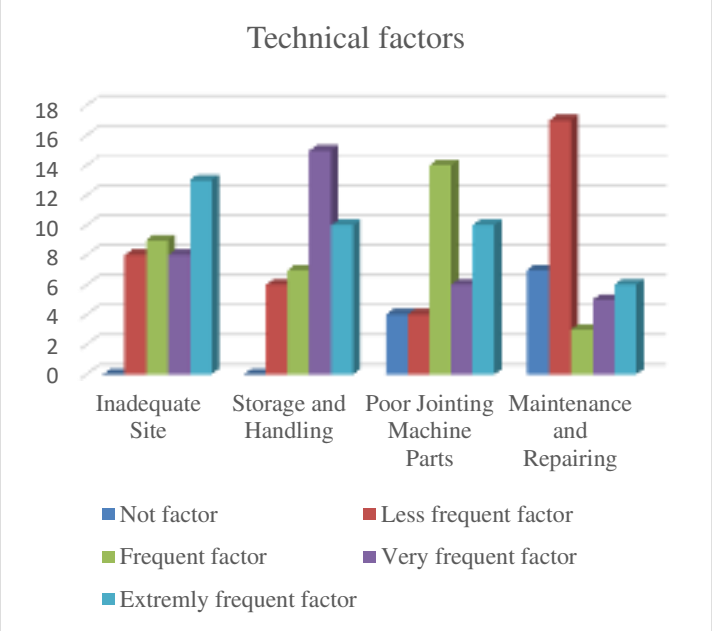


*Fig.1: Technical Factors*

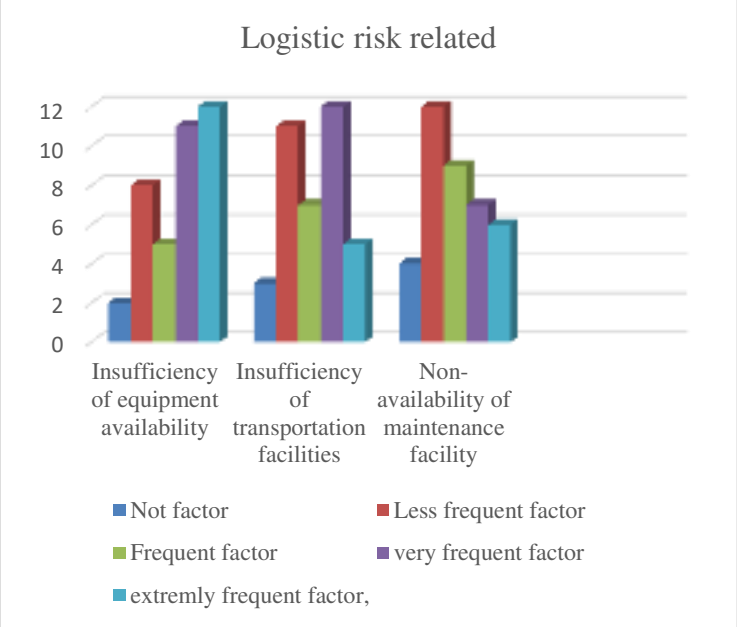


*Fig.2. Logistic Risks*

### 4.3 Management Risk related

Table shows that 13(34.2%) of respondent's co-ordination with subordinates is the very frequent factors, 13(34.2%) of the respondents primary planning were moderate frequent factor followed by 12(31.6%) of the answer of respondents were communication among all stakeholders of the construction.

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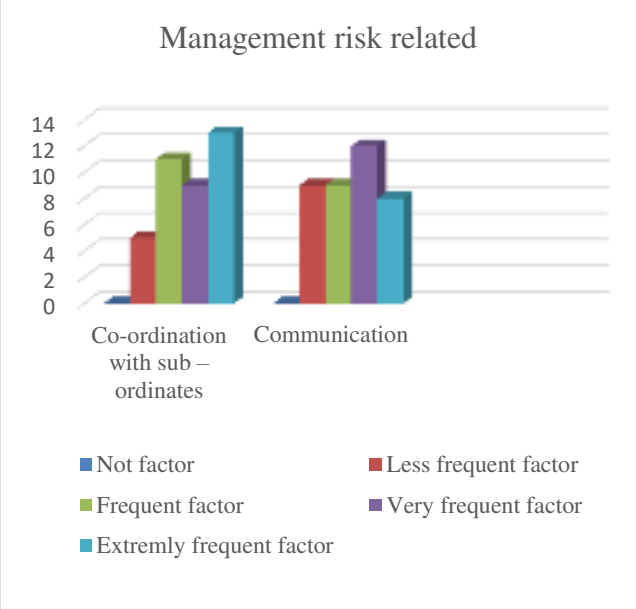


*Fig.3. Management Risks*

**4.4 Environmental related risk:**

As table 4.8 show that, 15(39.5%) of the respondents believed that Weather Implication were very frequent factors.

Table 4.8 result show that the environment could poses risk on the construction site. Workers on construction sites are often exposed to hazards due to unexpected bad weathers during working time. For example, here in Jimma town it's difficult to construct or demolish at summer season, due to the bad weathers of the towns workers who are working under rain could be exposed to several hazards.

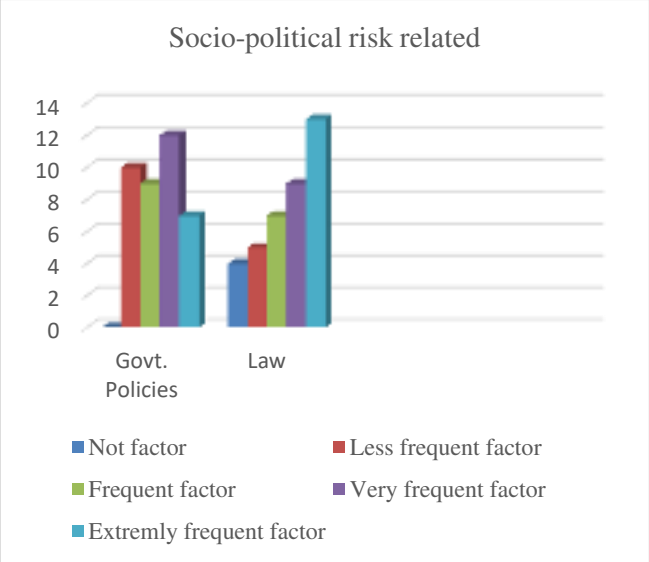


*Fig.4. Socio – Political Risks*

## V. CONCLUSIONS& RECOMMENDATIONS

### CONCLUSIONS

This study demonstrates the assessment of safety and health on building construction project and highlights the factors affecting safety and the major causes of hazards on building construction projects.

Most of the results are consistent with the former literature in other developing countries the researcher draws the following conclusions.

### RECOMMENDATIONS

- Safety and health should be included as a project parameter, which means it should be considered during all phases of a project. Procurement systems should be evaluated in terms of their impact on safety and health prior to their selection for projects. Prospective contractors should not be placed on tender lists unless they can show competence in the management of safety and health.
- To ensure a safe and accident free construction site, management must understand, undertake and implement all or some of the following measures which are regular supervision and inspection by safety officials and leaders on site, constant training on the use of tools and equipment, proper use of safety items and attire, signs and notices should be provided on construction sites and should be located at strategic areas on site, training programs should be provided regularly.
- The researcher suggest that no hazard consequences should be completely ignored, therefore government should give priority to reducing the risks associated with the above most discussed, From this perspective the most consequence hazardous needs in-depth study in the future study.

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# The approach of the Economy of Experience for the rural Tourism: A systematic review of the literature

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***Abstract*— *The objective of the present study is to analyze the application of the concepts that involve the theory of economy of experience in rural tourism in the international literature. To this end, a systematic literature review was performed, seeking to draw from international databases studies already presented on this subject. The databases consulted were Web of Science and Scopus, with research in scientific articles. The number of papers selected was thirteen articles, which somehow address the theme presented here, which demonstrate field research conducted in countries such as Portugal, Austria and Germany on the experiences of visitors and visitors, in the light of the theory of economics of experience. Of these selected articles, only two are theoretical works. The results show that there is still little research worldwide that contemplates the theory of the economy of experience in the context of rural tourism, both in applied research and in theoretical research.***
***Keywords*— *Systematic review; Economics of experience; Rural tourism.***

***Resumen*— *El objetivo que permea el presente estudio es de analizar la aplicación de los conceptos que envuelven la teoría de la economía de la experiencia en el turismo rural en la literatura internacional. Para esto, se realizó una revisión sistemática de literatura, buscando levantar en bases de datos internacionales estudios ya presentados sobre esa temática. Las bases de datos consultadas fueron Web of Science y Scopus, con investigación en los artículos científicos. El número de trabajos seleccionados era de trece artículos, que incluyen alguna manera el problema que aquí se presenta, que muestran las investigaciones de campo llevado a cabo en países como Portugal, Austria y Alemania en las experiencias entre visitantes y visitados, a la luz de la teoría de la economía de la experiencia. De estos artículos seleccionados, sólo dos son trabajos teóricos. Los resultados demuestran que aún son exiguas las investigaciones a nivel mundial que contemplan la teoría de la economía de la experiencia en el contexto del turismo rural tanto en investigaciones aplicadas como en investigaciones teóricas.***
***Palabras clave*— *Revisión sistemática; Economía de la experiencia; Turismo rural.***

## I. INTRODUCTION

The development of scientific production and research techniques has enabled new approaches to the history and future of the economy and, as a consequence, of humanity. Post-industrial economic theory was followed by the economics of experience and its approach to concepts related to co-creation (Rotariu, 2009). Demonstrating that the experiences of consumption of goods and services may be linked not only to economic and rational factors, but to behavioral factors, linked to customer attitudes and feelings

In reference to international databases, it was observed that the term economics of experience arose from the late 1990s, until then when researching the term, only studies in the sense of economic theory and economic development related to certain markets and countries.

Early studies on the economics of experience were prepared by authors such as Joseph B. Pine, James H. Gilmore, and Rolf Jensen in the late 1990s, and the concepts presented by these authors broaden the idea that

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people would be willing to devote much of their earnings to enjoy good life experiences. Their desire for emotional experiences would be linked to the consumption of creative products and services that should be specific and differentiated.

In the conception of the economy of experience, it isn't enough to provide only quality services, it's necessary to create economic value, because at the moment when a person pays for a certain service, he also buys a series of activities that will be linked to that service. In the case of experience, the customer, consumer, user, tourist / visitor acquires a series of memorable events that will affect him in a particular way (Kale & Poulsson, 2004).

An experience can be seen as a real offering of any service or good. In today's service-based economy, many organizations try to link experiences to their products as a kind of way to increase sales. The big difference with buying a product or hiring a service is the level of involvement that the experience demands, as well as the focus on personal needs. These differences are partly linked to what experience can offer (Kamel & Souza, 2012).

This experience can be experienced in various service activities, such as those related to tourism and, more specifically, rural tourism. Rural tourism is expanding (Silva, 2015), worldwide and in Brazil (mainly in the three southern states - Paraná, Santa Catarina and Rio Grande do Sul), standing out as a non-agricultural activity, but which uses it as an attraction, with the potential to promote local development, favoring the social and economic dynamization of rural areas. Rural tourism can also be useful as an instrument for the conservation of cultural and environmental heritage (Silva, 2015).

However, although Brazil is an agriculturally based country and the practice of rural tourism has been expanding significantly in its different regions, in consultation with the Brazilian databases Ibict (Instituto Brasileiro de Informação em Ciência e Tecnologia, nomeadamente na Biblioteca Digital Brasileira de Teses e Dissertações), Spell and Capes, no studies were found in the country relating the economics of experience to rural tourism.

Worldwide, studies have sought to address this theme (Kastenholz, Carneiro, Marques & Loureiro, 2018; Kastenholz, Eusebio & Carneiro, 2016; Carneiro, Lima & Silva, 2015; Sidali, Kastenholz & Bianchi, 2015; Loureiro, 2014; Agapito, Valle & Mendes, 2014; Kastenholz, Carneiro, Marques & Lima, 2012), highlighting Portugal as one of the countries that investigates the theme.

From the above, the following question is defined as a research problem that will guide the present study: What is the application of the concepts of the economy of experience in rural tourism in the world? To answer this question, the main objective is to analyze the application of the concepts that involve the theory of the economics of experience in rural tourism, through a systematic review of the international literature.

Given this, in theoretical context, the relevance of this study is justified by the need to increase the number of research conducted worldwide, and especially in Brazil, on the economy of experience and its approach in the context of rural tourism. This demonstrates the contributions of studies on this subject, so that it 's possible to survey in the scientific databases what has been studied about the economy of experience and its application in activities involving rural tourism in other countries.

The presentation of this work is divided into five sections, the first one, in which an initial presentation is made about the researched subject. The second section contemplates theoretical research, raising concepts and definitions on the economics of experience and rural tourism. The third section deals with the methodological procedures used and the fourth section presents the results of the study, obtained through a systematic literature review. The fifth and last section presents the final considerations of the study and its main contributions.

## II. REFERENTIAL THEORETICAL

### Rural tourism

The pursuit of sustainability has guided tourism activity planners and organizers towards establishing guidelines and principles for tourism, including harmonious integration between peoples and communities and environmental sustainability (Neiman & Rabinovici, 2010). According to the authors, sustainability can be "taken as a reference and opportunity for the resizing of spaces, landscapes, cultures and economies that generate benefits" (Neiman & Rabinovici, 2010: 30).

In this sense, the sustainability and preservation of the natural and cultural environment, as well as the multifunctionality of agriculture, some tourism typologies meet these principles, such as rural tourism.

In a simplistic definition, rural tourism could be seen as tourism that occurs in rural areas (Souza & Elesbão, 2011). According to the authors, rural tourism must meet the following criteria: be located in rural areas; be functionally rural; be rural in scale (preferably small scale); be traditional in character and be controlled by local people. Types of rural tourism are associated with the

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specific characteristics of each destination, region or rural property.

In terms of sustainable development, rural tourism can make an important contribution as it improves the exploitation of rural areas and local natural conditions, conserves rural heritage and traditions, creates opportunities for income complementation through the various activities that can be traditional cuisine with specific products and menus based on local recipes, strengthening local and / or regional customs and culture. In addition, other reasons justifying the implementation of tourism initiatives in rural areas would be to increase the permanence of young people in the countryside and the efficiency of the local economy (Leonte, Chiran & Miron, 2016).

The development of tourism in rural areas did not happen automatically, it resulted from the needs of farmers, who lived and still often live with a low valuation of work in the countryside. Thus, farmers gradually adapted to the new conditions of production and work, thus shaping the characteristics of rurality or the so-called new rural (Tonini, 2013).

According to the Brasil Rural Institute (2018), rural tourism uses as a vital element the cultural resources of the rural territory, which takes the trip to the environmental, historical and living universe, and also allows the integration with the daily life of the farm and the read from the field. Rural tourism has fundamental principles such as territorial enhancement, preservation of rural roots, authenticity of the product, environmental sustainability, and local and regional identity and community involvement. A region will only be able to establish itself in the rural tourism scenario, if there is cooperation between members of the entrepreneurial community, spreading a local and regional entrepreneurial culture.

The practice of rural tourism has been expanding significantly, standing out as a non-agricultural activity, but using it as an attractive one, with potential to promote local development, favoring the social and economic dynamization of rural areas. It may also be useful as an instrument for the conservation of cultural and environmental heritage (Silva, 2015).

Rural tourism can be developed regardless of the size of the property, hence the notion of rural tourism in family farming, defined as a tourism activity that occurs in the production unit of family farmers who maintain typical family farming activities, willing to value, respect and share their way of life, cultural and natural heritage, offering quality products and services and providing well-being to those involved (Zen, 2005).

Family farmers may have in rural tourism a form of income supplementation, as the livelihoods of farmers, according to Padilha, Souza, Vasconcelos Neto & Wittmann (2017), can become economically fragile by relying on a single activity, which may be insufficient to keep families in rural areas.

The Ministry of Agrarian Development through the Rural Tourism in Family Farming Program (2004/2007) says that rural tourism in family farming is characterized by the use of the productive activities of the property as the main tourist attraction in the form of demonstrations, explanations and experience of techniques, in which tourists can interact as part of the process (Brasil, 2016).

Some activities that can be developed in the rural tourism in the properties, in addition to the more traditional and known as horseback riding, wagon rides and hiking trails, can be cited the production of food. The food produced can be consumed during the visit or stay of the tourist on the property, or commercialized, thereby improving the connection or reconnection between producer and consumer.

In this context, is in line with the study carried out by Melzer & Meyer-Cech (2014), on the quality of the experience in rural tourism, pointing out that it is in a location that is destined to the rural tourism, it can be included in the premises for the purposes of accommodation, food and drink, traffic, and leisure-time activities. As for the accommodation, we consider the cellars to store wines and other beverages, companies with activities of milk derivatives, pumpkin seed oil and others.

In this sense, Loureiro (2014) points out in his studies related to the application of the theory of economy of experience in rural tourism and highlights its importance for rural areas, which must innovate and offer activities to attract a demanding and differentiated public, without losing the characteristics of the rural environment. The author points out that the activities go beyond accommodation, observing landscapes, fairs, historical sites, it is enabling the visitor to insert themselves in the process of elaboration of certain activities and activities of the field, such as: reap the fruits, make and taste the wine. Learning to make cheese and crafts, feeling the difficulties and needs of each place becomes a different experience for each visitor.

Parallel to the expansion of rural tourism activities and the new perception of the rural environment is a more reflective urban society, concerned with the quality of life, environmental preservation, health, leisure and food safety. Consumers are increasingly seeking awareness of the food production system, although their

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perceptions of agricultural production are often inaccurate. Therefore, practices that provide the connection or reconnection between producers and consumers are important strategies to enable greater awareness about food production (Silva, Schinaider, Dorneles & Silva, 2017).

Also for the authors cited, local resources exploited through rural tourism generate additional income to producers, and tourism is a possible promoter of the valorization of local products. This direct marketing between visitors / consumers and producers establishes bonds of trust and creates new market opportunities for producers.

It is also important to highlight, in the context of the direct relationship between visitors and producers / visited, the experiences lived at the moments of the service meeting, when it is possible to taste the flavors of the food in the place where they were produced, involving the local customs and culture, can make those moments memorable. It's the return of the link once lost between man and the land, the landscape, the flavors, the rural space, with all its riches and specificities.

**The economy of experience**

Pine and Gilmore (1999), in their work *The Experience Economy*, on the economy of experience, use metaphors that relate to a play during which actors perform their work. Actors mean in this case all the people who will participate in some way in the experience that will be experienced, and the stage can then be an organization, a city, a place.

From an economic perspective, the economy of experience could be viewed as a natural progression in the value chain of the creative economy. In the economy of experience, business can make subtle differences according to cultural diversity, each individual's experiences, memories, desires. This also applies in areas such as arts, culture, architecture, tourism (Brazil, 2010).

In the conception of the economy of experience, it isn't enough to provide only quality services, it's necessary to create economic value, because at the moment when a person pays for a certain service, he also buys a series of activities that will be performed linked to that service. In the case of experience, the customer, consumer, user, tourist / visitor acquires a series of memorable events that will affect him in a particular way (Kale & Poulsson, 2004).

In business, organization, viewed from the concept of the economy of experience, is a staging sensation, as it not only provides goods and services, but also the resulting emotion, the sensations it causes in the customer. All economic activities are outside the buyer, while the sensations are eminently personal. They actually occur within anyone who has been involved emotionally, physically, intellectually or even spiritually. Each experience takes place in the interaction of the event, situation or staged moment and the previous state of mind that experienced it (Pine & Gilmore, 1999). Within the economy of experience, the process of planning the production of goods and services aims to meet the needs, expectations and wants of the consumer, user or customer, making the consumption experience memorable.

As pointed out by Kamel & Souza (2012), an experience is a real offering of any service, good or commodity. In today's service-based economy, many organizations simply try to tie experiences to their products as a kind of way to increase sales. The big difference with buying a product or hiring a service is the level of involvement that the experience demands, as well as the focus on personal needs. These differences are partly linked to what experience can offer.

Customer feelings and involvement in the experiences of buying a product and service may differ in some ways. Service experience occurs during consumption, that is, at the moment when the customer receives the service they have purchased. According to Blackwell, Miniard & Engel (2005), feelings and sensations occur in different ways during the consumption experience. They can be positive (arousal, pleasure, joy, etc.) or negative (anger, annoyance, guilt, etc.).

The economics of experience has spread in several segments. This spread also occurs in tourism, specifically in some of its various typologies. However, it's noted that in rural tourism there are still few studies that address the assumptions or principles of the economy of experience.

In this context, the economy of experience and tourism, encouraging the visitor to participate more actively in the tourist activities of the places visited can facilitate the construction of meanings about the product and the service, thus generating a greater number of unforgettable experiences and moments that favor visitor / tourist satisfaction (Tonini, 2013). The positive feelings and emotions felt when the visitor is consuming a tourism product or service are ways to add value to it.

## III. METHODOLOGICAL ASPECTS

In order to identify possible answers to the problem raised, the methodological procedure used was a systematic literature review, which seeks to raise in databases, studies on the theme of the study.

Systematic reviews provide the researcher with a comprehensive and robust view of what has already been studied on a particular topic or area. Research results can

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be better interpreted on the basis of the literature framework and may contrast or complement previous research findings (Dresch, Lacerda & Antunes Junior, 2015). For the authors, systematic literature reviews "are secondary studies used to map, find, critically evaluate, consolidate, and aggregate the results of relevant primary studies on a specific research question or topic [...]" (Dresch, Lacerda & Antunes Junior, 2015: 142).

Through systematic literature reviews, it's possible to have access to a wide range of material already prepared, that is, research that contemplates the proposed theme, assisting researchers in the raising of theories, empirical and exploratory studies, among others, thus allowing the identification of gaps not yet studied.

The databases consulted for this systematic review were the *Web of Science* and *Scopus*. The types of works selected were scientific articles. The initial search was done using keywords and the second filter used was the summary. As keywords were used, as follows, the English terms: *economy of experience and tourism*; *economy of experience and rural tourism*. These terms served as the basis for research on the *Web of Science* and *Scopus*. The *Web of Science* found 781 articles using the terms *economy of experience and tourism* and 110 articles on the search using the terms *economy of experience and rural tourism.* Through the second filter, which was the reading of the abstracts of the works, only six studies were selected, which presented some kind of relationship between the experience economy and rural tourism.

At *Scopus*, in relation to the first filter, using the terms *economy of experience and tourism*, 823 works were found, and with the terms *economy of experience and rural tourism*, the result was 125 works and, of these, only seven works were selected after the second filter, which was the reading of the abstracts. In view of this, the total of works that deal with the theme of economy of experience and its application in rural tourism, in the two selected databases, were thirteen works.

Then, after the selection of the scientific articles that were directly associated with the theme and which would be analyzed, the objectives, methodology and results of each selected study were verified, so that it was possible to identify their contributions, as well as the gaps, which allow further investigations or studies complementary to what has already been investigated.

The frame 1 presents the steps used to gather information in the databases searched.

*Frame 1: Steps for Gathering Information*

| Sequence of steps | Raised information |
|---|---|
| Stage 1 | Search the databases using the following keywords: *economy of experience and tourism; economy of experience and rural tourism.* |
| Stage 2 | Reading the abstracts of the works, as a second filter, to verify if they dealt with the theme in question. |
| Stage 3 | Exclusion of works that did not specifically address the topic in question. |
| Stage 4 | Selection of the thirteen papers used for the review. |
| Stage 5 | Reading of the introduction, results and conclusions and analysis of the main contributions of the work to the proposed theme. |

Source: Prepared by the authors

Through systematic literature review it was possible to survey the studies already carried out on the research theme proposed here, selecting the works that served as the basis for presentation and analysis of data on the proposed theme.

## IV. RESULTS AND DISCUSSIONS

### Search result

The thirteen papers selected in the systematic review were prepared by researchers from various countries, and some of these works had their field research carried out in the countries of origin of their authors, among which Portugal, country in which more studies were conducted on aspects related to the economy of experience and its application in the field of rural tourism, in relation to the other countries (Frame 2).

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*Frame 2: Overview of selected papers, considering country, authors and year of publication*

| COUNTRY WHERE THE STUDY WAS CONDUCTED | AUTHORS PER ARTICLE | YEAR |
|---|---|---|
| Portugal | Kastenholz, E., Carneiro, M. J., Marques, C.P., Loureiro, S. M. C. | 2018 |
| | Kastenholz, E.; Eusebio, C.; Carneiro, M. J. | 2016 |
| | Carneiro, M. J.; Lima, J., Silva, A.L. | 2015 |
| | Sidali, K. L.; Kastenholz, E.; Bianchi, R. | 2015 |
| | Loureiro, S. M. C. | 2014 |
| | Agapito, .; Valle, P.; Mendes, J. | 2014 |
| | Kastenholz, E.; Carneiro, M.J.; Marques, C.; Lima, J. | 2012 |
| Poland | Idziak, W.; Majewski, J.; Zmyslony, P. | 2015 |
| Austria / Germany | Melzer, V., Meyer-Cech, K. | 2012 |
| USA | Quadri-Felitti, D.; Fiore, A. M. | 2016 |
| | Quadri-Felitti, D.; Fiore, A. M. | 2012 |
| | Smith, W. L. | 2006 |
| China | Huang, B. W.; Yang, Y., C. | 2011 |

Source: Prepared by the authors

Two papers presented in the frame above don't contemplate applied or field research. The works by Sidali, Kastenholz & Bianchi (2015) and Quadri-Felitti & Fiore (2012), according to nature, are basic research or theoretical studies.

In the following frame, we sought to present contiguous works that have some similarity, according to the objectives proposed in each one. To this end, the works were grouped considering five sets of constructs related to the economy of experience and rural tourism, namely: Rural tourism clients and suppliers; Memories, emotions and lived experiences; Marketing and quality of experience; Community, heritage and landscape; Segmentation. These sets are shown in Figure 1.


*Fig.1: Construct Sets*

Source: Prepared by the authors

Of the researched articles, two deal with the tourist experience in the perception of rural tourism providers and tourists. The work of Kastenholz, Eusebio and Carneiro (2016) seeks to analyze the impact of the tourist experience on the decision to buy local products and the expenses incurred by visitors, based on research data on rural tourists in Portugal. The article by Quadri-Felitti and Fiore (2016) investigates the alignment of the

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design economy priorities and perceptions of the experience of rural tourism providers (ie winery owners, restaurant retailers, lodging providers, tourist attractions) with the experiences perceived by the tourists. Another Quadri-Felitti and Fiore article on wine tourism (travel motivated by the appreciation of wines), which was published in 2012, is contemplated in frame 3.

*Frame 3: Rural Tourism Customers and Suppliers*

| Authors | Objectives of the studies |
|---|---|
| Kastenholz, E.; Eusebio, C.; Carneiro, M. J. | 1 - Analyze the impact of the tourist experience on the decision to buy local products and the expenses incurred by visitors, based on research data on rural tourists in Portugal. |
| Quadri-Felitti, .; Fiore, A. M. | 2 - Investigate the alignment of the design economy priorities and perceptions of the economy of experience of rural tourism providers (that is winery owners, restaurant retailers, lodging providers, tour operators) with the experiences perceived by tourists. |

Source: Research Data

The frame shows that the studies carried out by the authors were, first, with a focus on tourist decisions when buying local products, and the second was based on the perception of the economics designs of the experience of rural tourism providers.

Also found two articles that present a relationship between the economy of experience and some behaviors of tourists, such as emotions, memories, excitement and satisfaction. Loureiro's (2014) article empirically explores the effect of experience economics in place of attachment and behavioral intentions through emotions and memories in the context of rural tourism. This survey was conducted in the Alentejo region of Portugal, with tourists visiting rural properties. This first study was the basis for a second article by Kastenholz, Carneiro, Marques and Loureiro (2018), which validated a scale of tourist experience and analyzed the relationship between experience, excitement, memory and satisfaction.

*Frame 4: Memories, emotions and lived experiences*

| Authors | Objectives of the studies |
|---|---|
| Loureiro, S. M. C. | 3 - Empirically explore the effect of economy of experience in place of attachment and behavioral intentions through emotions and memory in the context of rural tourism. |
| Kastenholz, E.; Carneiro, M.J.; Marques, C.P.; Loureiro, S.M.C. | 4 - Validate, in the context of rural tourism, a scale of tourism experience previously proposed and analyze the relationships between experience, excitement, memory and satisfaction. |

Source: Research Data

Regarding articles 3 and 4, the authors' proposal was to analyze the behavior, memory, emotions and satisfaction in relation to the experiences of tourists in rural areas. The papers address scales to measure, through the evaluation of some attributes or variables, the relationship between the economy of experience and rural tourism. This scale may be used in new studies that intend to analyze the experiences lived by visitors in activities related to rural tourism.

In the systematic search, also found an article about marketing and an article about quality. Sidali, Kastenholz and Bianchi (2015) present a theoretical framework for niche marketing in food specialties in rural tourism, combining two different consumer behavior theories, the “economy of experience” and the “model of intimacy”, representing a reorientation of Classic marketing thinking. Already, the work of Melzer and Meyer-Cech (2014) identifies how rural tourism initiatives highlight their regional characteristics and which quality components contribute to a high quality tourism experience.

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*Frame 5: Marketing and Quality of Experience*

| Authors | Objectives of the studies |
|---|---|
| Sidali, K. L.; Kastenholz, E.; Bianchi, R. | 5 - Present a theoretical framework for niche marketing in food specialties in rural tourism, combining two different consumer behavioral theories, the "economy of experience" and the "model of intimacy", representing a reorientation of classical marketing thinking. |
| Melzer, V.; Meyer-Cech, K. | 6 - Identify how rural tourism initiatives highlight their regional characteristics and which quality components contribute to a high quality tourism experience. |

Source: Research Data

Frame 5 shows a work that deals with niche marketing associated with food in rural tourism, analyzing consumer behavior through two theories, the economy of experience and the "model of intimacy", bringing new reflections on marketing (Sidali; Kastenholz; Bianchi, 2015). The article by Melzer and Meyer-Cech (2012) seeks to demonstrate the relationship between quality and tourism experience by identifying rural tourism initiatives that use regional characteristics and quality components to enhance the rural tourism experience.

The article by Carneiro, Lima e Silva (2015) focuses on tourists' perceptions of the rural landscapes used in two villages in Portugal, while these tourists were still in the villages experienced in the experience. In this sense, another article published by Kastenholz, Carneiro, Marques and Lima (2012), analyzes a rural tourism experience by a small village in central Portugal, which uses its heritage and traditions to offer such experiences. To this end, the resources of the destination were analyzed, a tourist experience lived by tourists and by tourism service providers or tourism offer.

*Frame 6: Community, Heritage and Landscape*

| Authors | Objectives of the studies |
|---|---|
| Idziak, W.; Majewski, J.; Zmyslony, P. | 7 - To analyze the origins of the concept of thematic villages in the creation of new experiences of rural tourism and to explore issues in the implementation of the concept. Also discuss the role of community involvement in the development of theme villages by probing and testing existing models of local participation in tourism development in the context of five theme villages in Poland. |
| Carneiro, M.J.; Lima, J., Silva, A.L. | 8- Assess visitor perceptions of rural landscapes based on two villages in Portugal while visitors were still in the villages. |
| Kastenholz, E.; Carneiro, M.J.; Marques, C., Lima, J. | 9 - Analyze the experience of rural tourism offered by a small village in central Portugal, which uses its heritage and traditions to offer such experiences. |

Source: Research Data

Frame 6 presents two articles dealing with thematic villages (term used by the authors), which can be understood as properties or rural communities. These studies analyze visitors' experiences and perceptions of rural landscapes, heritage and traditions. The article by Idziak, Majewski and Zmyslony (2015) focused on thematic villages in Poland, analyzing concepts about the term, as well as discussing community involvement in the development of these villages, testing models of local involvement or participation.

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*Frame 7: Segmentation*

| Authors | Objectives of the studies |
|---|---|
| Agapito, D.; Valle, P.; Mendes, J. | 10 - This study follows a holistic approach to the five external human senses, aiming at capturing sensorially informed themes suitable for segmenting rural tourists . |
| Quadri-Felitti, D., Fiore, A.M. | 11 - The present study proposes the use of relevant constructs of the experience economics model to explain the experiential nature in wine tourism. |
| Huang, B.-W.; Yang, Y.C. | 12 - This study applies the concept of experience savings to analyze the factors that affect *value for money* valuation. |
| Smith, W.L. | 13 - This paper presents the results of an exploratory study on the perceptions of a group of rural tourism providers in Kansas (USA) for a set of experiential tourism patterns. |

Source: Research Data

Frame 7 presents four articles, which deal with the following themes: the first seeks to segment the profile of rural tourists through the human senses, analyzing sensory experiences. The article by Quadri & Fiore (2012) uses constructs of economy of experience (escapism, education, aesthetics, memory, identity ...) to analyze the economic value that is linked to the satisfaction of tourists, presenting a theoretical framework contextualizing the literature on wine tourism, using an experience-based model, based on the theory of economy of experience proposed by Pine and Gilmore (1999). Huan & Yang's (2011) article applies the concepts of economy of experience to analyze factors related to rural tourism providers' perception of value-related experience patterns in the economic sense.

Noteworthy is the article published by Agapito, Valle & Mendes (2014), which follows a holistic approach to the five human senses, aiming to capture sensory impressions regarding the experience of tourists in Southwest Portugal. The study seeks to report the sensory experience of tourists who visited the region, to demonstrate that the five human senses are responsible for a large number of references.

Regarding the thirteenth article, which was a paper by Smith (2006), it presents the results of an exploratory study on the perceptions of a group of rural tourism providers in Kansas (USA) for a set of experiential tourism patterns. . This article has taken a small step towards a better understanding of service standards for experiential tourism.

## V. DISCUSSION OF RESULTS

From the exposed in the selected works it can be said that, in some way, the attributes contemplated in the theory of experience economics can be applied in the rural tourism segment, mainly in order to know the perceptions of tourists regarding what they experience or experience during rural tourism practices. This interconnection between the two constructs (economy of experience and rural tourism) is shown in Figure 2.

The attributes related to memories, emotions, feelings, satisfaction, etc., are directly linked to the perception that tourists have about the landscape they visit, or the identity of the place and its characteristics, the culture, customs and traditions of suppliers. of activities related to rural tourism, which we call here visited, and visitors to tourists who travel to visit these rural tourism spaces.

According to Barretto (2004), the meetings between visitors and visited occur when they share the spaces, which in this case is the place where activities are focused on rural tourism, is the space of the field and land. And during this sharing experiences occur, which can be memorable to visitors when well planned and organized by those visited.

The purpose of this study was to survey works that applied the concepts of the theory of economics of experience in rural tourism, contemplating the experiences lived by visitors. One of the studies presents a survey with those visited, trying to demonstrate through the perception of visitors what rural tourism providers could improve, both in terms of physical structure as well as the services offered.

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The articles investigated highlight some attributes that are fundamental in studies that contemplate the economics of experience and rural tourism, such as memories, emotions, feelings, place identity, local and / or regional characteristics, food specialties, culture and tradition. However, it's noted by the results that these attributes aren't contemplated jointly in the articles surveyed, because each work tries to investigate and evaluate separately only some of these attributes, notably in those who conducted field research.

In the Brazilian bases Ibict, Spell and Capes were found three works that deal with the economics of experience and tourism, being these master's dissertations. No work was found in the query using the keywords "Economy f experience and rural tourism". In view of this, it is possible to observe that in Brazil there are still incipient research on the theory of economics of experience applied to tourism and especially to rural tourism. This finding paves the way for important investigations in this regard.

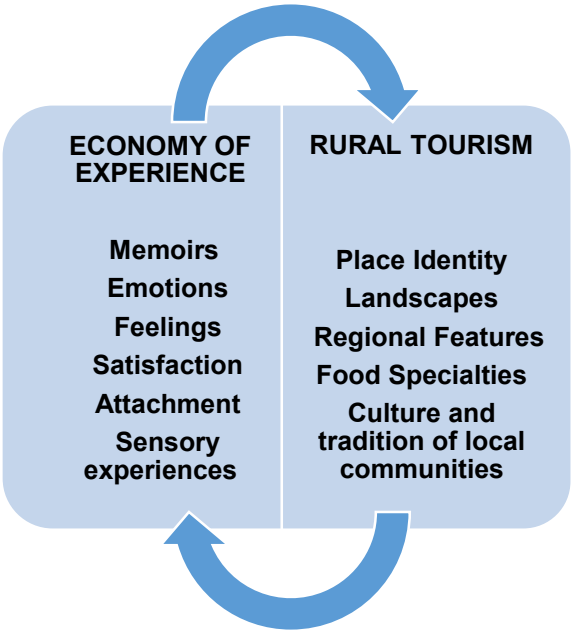


*Fig.2: Relationship between attributes of experience economy and rural tourism*
Source: Prepared by the authors

## VI. FINAL CONSIDERATIONS

The systematic literature review, used in the present study, focused on analyzing published works that refer to the theme related to the concepts of economy of experience applied to the rural tourism segment. The studies began from the publications of the authors Joseph B. Pine, James H. Gilmore and Rolf Jensen, in the late 1990s, which present concepts in which people are willing to live good experiences, as well as enjoy the provision of goods and services offered by different market segments.

From this time to the present, several studies have been done contemplating the theory of the economy of experience in various market segments, especially services. However, it was possible to realize with the results of the present study, that in the segment of tourism services, more specifically rural tourism, there are still scarce researches that seek to relate these two contents, both in applied and theoretical research, worldwide.

Literature review studies are relevant because they contribute to scientific knowledge in a given area. Therefore, this work has an important theoretical contribution, as it demonstrates the level of scientific research within the theory of economics of experience applied to the context of rural tourism.

Thus, it is believed to have achieved the proposed objective and responded to the research problem when, in the results and discussions section, data were raised from the literature review that demonstrate, to some extent, the relationship between the economy of experience and tourism. rural. Through the review it was possible to raise a set of constructs, which will serve as the basis for further studies, or to demonstrate the gaps or gaps on this theme.

In view of this, it is possible to verify that the existing gaps in the economy of experience and its relationship with rural tourism, indicate the viability of future studies that corroborate in order to engender

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researches contemplating the presented constructs, such as memories, emotions, feelings, identity of place, among others, jointly, applied to localities or regions that have rural tourism itineraries or, in particular, in each property that develops rural tourism, to know the specificities of tourist experiences.

Another gap is to investigate the economy of experience and its relationship to quality and value creation as a way to improve the products and services offered by family farms that develop rural tourism. Thus, another study suggestion would be to bring together these constructs (economy of experience and rural tourism) value co-creation, to assess whether visitor participation and involvement, as well as dialogue and direct communication with the visitor can improve the experience, favoring new opportunities for value creation. In the meantime, works that address this theme can contribute to improve the experiences of both visitors and visited, as well as provide alternatives for developing a more sustainable tourism typology.

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# Regional Heterogeneities and their Potentials for Regional Planning: The case of Vale do Rio Pardo Territory

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***Abstract*****—** *The regions are composed of immense diversity and potentialities. Therefore, the territorial cut,* adopted *in Brazil only in 2003, was an important delimitation for discussion and construction of public policies. The Vale do Rio Pardo Rural Territory (TRVRP) has a peculiar history in relation to its demand to be recognized and become a member of PRONAT. This article aims to analyze the strategy adopted by NEDET with the Territorial Collegiate to carry out the process of planning regional actions in the TRVRP. The process of elaborating the plan provided several stages of discussion, through participatory methodologies, so that the actors formulated proposals to reach the rural development of the Territory. It is concluded that the most coherent way of maintaining the articulation of territorialized public policies and mobilized social actors is to maintain the advisory services to the Collegiate and maintain PRONAT*

***Keywords*****—** *Territorial development; social actors; planning.*

## I. INTRODUCTION

This article aims to analyze the strategy adopted by the Extension Nucleus in Territorial Development (NEDET) with the Territorial Collegiate (CODETER) to carry out the process of planning regional actions in the Vale do Rio Pardo Rural Territory (TRVRP). Considering the heterogeneity of the social actors that make up this region and the different productive and economic realities that integrate it.

The regions are composed of immense social, economic, cultural, environmental and political diversity. According to Limonad (2004) the region is understood as a category of analysis, but before that it is a social construction that is formed by a heterogeneous social fabric, in a space where diversity predominates. The society is printing its identity in the territory, giving its form and characteristic to a certain geographic space. The region, in this sense, can be understood as an intermediate space between local and global, added to interests that end up molding regional characteristics.

In Brazil, regional development only received academic attention in the second half of the 20th century. However, the development of the regions can be seen in many ways, for example, with economic bias, organization of productive chains that are often anchored in the interests of transnational corporations, in this way, considering the regions in a hegemonic way. Another way to understand the regions is to recognize regional heterogeneities as possible potentialities, which will be used from 1990 (ETGES, 2013).

For a long time the territorial approach has been outside

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the academic research and the focus of Brazilian public policies, both in the state and nationally. Only a few local initiatives. As a result, there was a gradual impoverishment of theoretical contributions on the subject and a scrapping of organizations that worked to reduce regional inequalities (CARGNIN, 2014). The Brazilian rural environment underwent several transformations throughout the period of democratization experienced by Brazil from the 1980s, a process that legitimized a federative agreement of autonomy between Union, States / Federal District and municipalities that defines the functions of federated entities and the financial source that will subsidize such responsibilities. This change, on the one hand, was innovative, but on the other hand, it created a series of difficulties of relations between the federated entities, showing the need for articulation and creation of new institutions that would bring together the municipalities and reach the three spheres of government. In the universe of states and municipalities, there were initiatives and experiences of non-governmental organizations (NGOs), social movements, rural unions, and other civil society organizations in the construction of inter-municipal and intersectoral development projects and articulations, seeking to value the regional potential of family agriculture . At the same time, there was an academic debate on territorial development that arises from the need to think about development in a territorial perspective, incorporating the interaction between the countryside and the city and the valorization of the spatial dimension of the economy and the local resources of a Territory, making critical to the rural-urban dichotomy and the urbanization rates of the country (Veiga, 2002). On the other hand, criticisms of PRONAF-Infrastructure began, with respect to the weaknesses of the Municipal Rural Development Councils (CMDRs), which were often predominantly led by the public power, legitimizing local hegemonic power and somehow delegitimizing the emergence of new articulations of local actors. With this, one felt the necessity to break with the limits placed by the barriers (NIEDERLE, 2014).

In this context, the Territory presents itself as a strategy for the discussion and construction of rural development, characterized as a productive inclusion process, through the articulation of public policies destined to the rural environment, and considered as a space that goes beyond the geographical delimitation, and should highlight social participation and intersectoriality in the structuring, performance and proposal of public policies (MDA, 2015). In this period, the agricultural policy for family agriculture was increased by the creation of another Secretariat, which started to work specifically with territorial development - the Territorial Development Secretariat (SDT). It was created in 2003, through PRONAT and implemented through the creation of Rural Territories in practically all regions of the country, with the objective of promoting the protagonism of social actors for the governance of the development of their Territories and also impacts and the results obtained through the territorial policy (DELGADO, LEITE, 2015). It is perceived that the program was taking amplitude; in Rio Grande do Sul, for example, reached a total of 18 Rural Territories. Around 400 Gaucho municipalities are included in the Territories, which means more than 80% of the State Territory (MDA, 2016).

The arrangements resulting from this policy, however, face challenges to its effectiveness and implementation. Among these, is the conformation of the territorial cut-off adopted for each Territory in the country, as well as, meeting the demand of the social actors involved in the construction of this space, taking into consideration the culture, economy, social and environmental relations present in each Territory , which is a necessary condition for social protagonism and for the continuation of the development processes of the Territories. Therefore, it is of fundamental importance to establish strategies to achieve these goals, because the Territories are spaces of life, history, strategies of cooperation and also of conflict. These dynamic spaces experience and involve local institutions, networks of actors, collective platforms, games of interest and ideas that are established in a real arena.

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The spatial clipping and object of study of this article is the TRVRP, which in its formation and search for recognition of its territorial identity along the territorial policy of the MDA, obtained a peculiar trajectory. Following will be presented the history of TRVRP, then the role played by NEDET and CODETER to mediate regional conflicts and finally some considerations about the perspective of territorial planning.

## II. METHODOLOGY AND THE CASE OF THE VALE DO RIO PARDO TERRITORY

The Vale do Rio Pardo Rural Territory (TRVRP) - a spatial clipping object of study - has a peculiar history regarding its demand to be recognized by the Ministry of Agrarian Development (MDA) as a Rural Territory and become part of the National Program of Sustainable Development of Rural Territories (PRONAT). In order to achieve this purpose, the leaders of eleven municipalities in the Vale do Rio Pardo region, in November 2011, met to formalize the Vale do Rio Pardo Pre-Territory. The intention was to press the MDA for the creation of the Territory, among the organizations present were 23 representatives of civil society and 16 of the public power (SCHMITZ, 2014).

However, only in January 2013, the MDA recognized the Pardo River Valley as a Rural Territory, establishing it with a new geographical delimitation. In addition to the two distinct macro-regions, the southern region of the Territory (referring to the Rio Pardo Valley proper) and the North region (referring to the Alto do Serra do Botucaraí region, now included in the new territorial delimitation determined by the MDA) Territory. This information, to a certain extent, demobilized all the work of articulation, organization and data capture of the region, causing a strong disinterest among the representatives of the various entities in continuing the work, in view of the understanding that there were no inter- relationships or identity (SCHMITZ, 2014). Therefore, withthis new territorial arrangement, todaythe TRVRP iscomposedof 28 municipalities, which are: Alto Alegre, BarrosCassal, Boqueirão do Leão, Campos Borges, Candelária, Ernestina, Espumoso, Fontoura Xavier, Gramado Xavier, Herveiras, Ibirapuitã, Itapuca, Mato Leitão, Mormaço, Nicolau Vergueiro, Pantano Grande, Passo do Sobrado, Rio Pardo, Santa Cruz do Sul, São José do Herval, Sinimbu, Soledade, Uncle Hugo, Vale do Sol, Vale Verde, Venâncio Aires, Vera Cruz and Victor Graeff. Together they have a population of 429,236 inhabitants, it has a total area of 12,790.21 km2 (SDT, 2015). It is important to consider that the South region of the current TVRP is strongly based on Family and Peasant Agriculture and has its production base mainly focused on tobacco cultivation and its integrated production system. Already in the North, the predominant agricultural culture is the soybean, even next to the familiar agriculture.

With the intention of strengthening, supporting the organization and articulation of public policies for family agriculture, MDA launched in 2014 a public call, CNPq / MDA / SPM-PR No. 11/2014 to support the implementation and maintenance of Extension Centers in Territorial Development (NEDETs). The objective was to hire for two years an advisory to the area of productive inclusion and another to the area of social management, in partnership with public universities, considering a "possible solution" to solve the issues related to the transfer of resources.

In the TRVRP the project was the State University of Rio Grande do Sul (UERGS) with a unit in Santa Cruz do Sul. The main challenge of NEDET Vale do Rio Pardo was to work on the themes of sustainable development in the midst of the difficulty of territorial cohesion between the actors that make up the Territory in question. Thus, the NEDET Vale do Rio Pardo had as its main goal to build the Territorial Plan for Sustainable Rural Development and Solidarity (PTDRSS) of the TRVRP. With the purpose and challenge of covering and contemplating all the plurality of existing social actors, reducing the sectorization of public policies, making diversity a potential for the development of the Territory, otherwise, according to Brandão (2011, 25) "Sectorialist and

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conservative interests do not allow structural actions to advance."

However, the major challenge of the Extension Nucleus in Territorial Development (NEDET) and the Territorial Collegiate (CODETER) was to contemplate the plurality of social actors in the territory. Thus, together with the Coordination of Territorial Development (CODETER) of the Rio Pardo Valley, NEDET began to use the strategy of subdividing the territory into two macro-regions (North and South) and mobilizing the actors in micro-regional plenaries, bringing them together from sets of municipalities called microregions.

The methodological tool used to gather the empirical data was the Fortresses, Opportunities, Weaknesses and Threats (FOFA) matrix, based on the four dimensions of sustainability - 1. Socioeconomic, 2.Sociocultural and Educational, 3.Political Institutional and 4. Environmental . The FOFA was carried out in all seven microregions of the Territory. In addition, other primary data were collected in meetings with social actors to discuss the proposal and articulate the mobilization of entities that involve civil society and public power.

## III. RESULTS AND DISCUSSION

This strategy of division into microregions served mainly for two phenomena, the first was a mobilization and participation of more social actors of the instances of participation of the Territory. The second was through smaller plenaries, with a higher level of identity, where the actors began to integrate into the Rural Territory Vale do Rio Pardo (TRVRP). This sense of belonging, of defending the region, according to Raffestin (1993) may only be simply to seek meaning, but must be understood as a relation of society to individuals, when individuals allow themselves to belong to such a society, when it is discovered who first belongs to a territory and only then belongs to a society.

They could also understand how the process of demand-building takes place through dialogues and planning that go beyond the borders of their municipalities, and that it is possible to think of actions in partnerships with neighboring institutions and to think of territorial development based on their realities. This methodology is articulated in the pretension to overcome the sectorized vision of the plans, seeking a better inter-relation between the different social segments that make up the region.

In the TRVRP the process of elaborating the Territorial Plan for Sustainable and Solidary Rural Development (PTDRSS) provided several stages of discussion, which ended up contributing to a better understanding of the social actors about the real purpose of the National Program for the Sustainable Development of Rural Territories (PRONAT) . These spaces promoted in the TRVRP placed the social actors in dialogue to discuss their realities, as well as proposals to achieve rural development and projects that enable the sustainability of the Territory. This process took place in four phases of elaboration over two years, from the initial mobilization of the social actors, the accomplishment of the various micro-regional plenaries and the two macro-regional plenaries, ending with the approval of the Plan at the CODETER VRP general assembly in December 2016. This process generated some results, which were obtained from the methodological tool of the Strengths, Opportunities, Weaknesses and Threats (FOFA) matrix. In this analysis, the anxieties for policies planned by the territorial base of the Territory that can be executed in the short, medium and long term were clearly observed. Desired by social actors with the intention of improving the quality of life in rural areas. It was also found that even when changes that threaten their prospects emerge, such as the demise of the MDA shortly after the parliamentary coup that gave rise to then President Michel Temer, these actors demonstrated resistance and confidence that the institutions of civil society and power may require recognition from the government in office. These results could be seen in the proposals elaborated in the microregional plenaries and later debated and prioritized in the macroregional meetings.

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## IV. DISCUSSIONS FROM REGIONAL POTENTIALS IN TERRITORIAL PLANNING

The mobilization of social actors was a collective effort by the Territorial Collegiate (CODETER) to overcome divergences, awaken potentialities and motivate the construction of a Territorial Plan for Sustainable Rural Development and Solidarity (PTDRSS). These spaces promoted in the Rural Territory Vale do Rio Pardo (TRVRP) placed the social actors in dialogue to discuss their realities, as well as to formulate proposals aimed at achieving rural development with projects that make the Territory sustainable. This in a way generated expectations and hope to be able to demand public policies appropriate to the regional reality.

Planning in the South region, by having more civil society organizations, as well as having a history of participation and performance in the regional guidelines and articulations more effectively, pointed as a priority issues such as: to adapt the political pedagogical proposal of the rural schools, so that the pedagogical practice is contextualized according to the local reality; organize a marketing network for products from family farmers; promote agroecology and organic production; expand and qualify the services of Technical Assistance and Rural Extension (ATER); expand and qualify the services of basic sanitation and selective collection in the rural environment. Moreover, for the success of this trajectory, it is important to highlight the support provided by the NEDET, called by the managers of "luxury consultants" because they are linked to the universities and have specialized technical competence, in the mediation of the debates and mobilization of the entities to build this process of planning.

Planning in the South region, by having more civil society organizations, as well as having a history of participation and performance in the regional guidelines and articulations more effectively, pointed as a priority issues such as: to adapt the political pedagogical proposal of the rural schools, so that the pedagogical practice is contextualized according to the local reality; organize a marketing network for products from family farmers; promote agroecology and organic production; expand and qualify the services of Technical Assistance and Rural Extension (ATER); expand and qualify the services of basic sanitation and selective collection in the rural environment. Moreover, for the success of this trajectory, it is important to highlight the support provided by the NEDET, called by the managers of "luxury consultants" because they are linked to the universities and have specialized technical competence, in the mediation of the debates and mobilization of the entities to build this process of planning.

## V. CONCLUSION

In general, as the authors Delgado, Bonnal and Leite (2007) put it, it is possible to intuit that the policy of the Ministry of Agrarian Development (MDA) was successful in promoting the exercise of planning and articulating policies in regions where there was almost no history of intermunicipal articulations. This intuition can be confirmed, in particular, through the process that took place in the Vale do Rio Pardo Rural Territory (TRVRP).

However, it is a fact that the construction path of the Territorial Plan for Sustainable and Solidary Rural Development (PTDRSS) contributed to regional articulation and stimulated the debate for a collective planning. It remains to be seen whether this will contribute to the reduction of the sectorization of access to public resources and whether the actors will actually prioritize collective projects. However, in this context, it is worth considering what Favareto (2010) points out regarding the weaknesses of the composition of the Coordination of Territorial Development (CODETERs), since this refers to the need for articulation with other organizations and other initiatives, alerting the risk of discontinuity of the territorial policy, which would lead to the bankruptcy of these Colleges. However, in a very unfavorable political context for the construction of public policy demands, where these are threatened by the current rulers, the VRP CODETER was able to advance in the process of building its PTDRSS.

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Faced with this uncertainty, due to the inevitable uncertainties due to the country's political and economic crisis, immersed in this cyclical and recurrent process of world capitalism, we come to the conclusion that, in the short term, the most coherent form of maintaining the articulation of territorialized public policies and mobilized social actors consists in maintaining the advisory services to CODETERs, as well as in the transformation of the Territorial Policy into a State policy. According to Brandão (2011, p. 35), "it is necessary to overcome the sectorial and compartmental nature of public policies and to bring about the transversality and their intersectoriality in order to bring them together in the territory." Thus, in the medium and long term, it will be possible to build the autonomy of the social actors, the legitimacy of their protagonism and the effectiveness of the territorial approach in the regional development process.

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# Association between Life Satisfaction and Health Self-Perception of the Elderly in Co-Residence

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***Abstract*** *— Due to aging, physiological changes occur in the human body that bring vulnerabilities and result in the loss of working capacity, autonomy, and impairment of the performance of basic daily activities. In this context, concerns and the need for attention to the elderly increase in various dimensions of their lives, which requires support, often offered by the family. Given this, new family arrangements arise, such as the state of co-residence, which is the living of the elderly with children and / or grandchildren, whose goal is to benefit both younger and older generations. In this sense, the present study aims to analyze the association between life satisfaction and self-rated health of the elderly in co-residence. This is a population-based analytical-descriptive cross-sectional study with a quantitative approach, with 239 co-residing elderly registered in the Family Health Units located in the city of Vitória da Conquista-Bahia. Data were collected using the adapted Brazil old age Schedule (BOAS) questionnaire and the Health Status questionnaire, which were tabulated in Excel 2015 software and analyzed using The Statistical Package for Social Sciences for Windows. The results show a female prevalence, living with grandchildren, children and spouses. In addition, most of the research subjects refer to their own health as fair and are satisfied with life. This paper provided substantial information on co-resident elderly, highlighting a relationship between life satisfaction and self-rated health.*

***Keywords*** *— **Elderly, Family relationships, Personal satisfaction, Self perception, Cheers.***

## I. INTRODUCTION

Human aging is a reality, and can be defined as a process that occurs the organic and functional decrease of the body, not due to disease, but physiological and natural [1]. In recent years there has been an increase in the elderly population worldwide, which has been contributed by several factors such as reduced fertility rates and improved sanitation and basic infrastructure, leading to better quality of life of individuals [2].

Brazil is an aging country, where the life expectancy of Brazilians has been increasing year by year. In 1940, it was just over 45 years old, in 2015 it was 75 years old and by 2050, it is estimated that about 30% of the Brazilian population will be over 65 years old [3].

The increase in the elderly population demonstrates advances for society, but also provides increased concerns, as the aging process brings vulnerabilities that may result in the loss of working capacity and autonomy, especially in the performance of basic daily activities. Such dependence gives rise to the need for a reorganization of society in general and especially of families. In this context, there is the emergence of a wide range of family arrangements, such as the state of co-residence, which is the living of elderly with children and/or grandchildren in the same home space ensuring mutual help [4].

Co-residence occurs due to two main factors: In relation to the elderly, it occurs due to the need for health care and in relation to family members, intergenerational living occurs due to the financial and emotional

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dependence of the children and / or grandchildren towards the elderly. This is due to the instability of the labor market, the greater time spent in school and the greater fragility of affective relationships. In both cases, the co-residence of the elderly and their children appears as a family strategy used to benefit both younger and older generations [5].

On the other hand, this shared living can also lead to conflicts caused by differences in ideals of generations. Therefore, this may interfere with the relationship between the elderly and their families, which often leads to inadequate treatment, and may even raise concerns and not guarantee good health for the elderly [6].

The family is seen as the basis for ensuring the support, development and protection of its members, regardless of how it is structured. Regarding the elderly, historically the family is historically the main source of support and care [7], but some studies analyze that living in co-residence may not be an arrangement desired by all the elderly, since there are negative points, as the elderly face the difficulty in dealing with losses, their autonomy and their social roles, in addition to facing health-related problems. This fact can have an impact on both life satisfaction and self-perception of health [8].

Life satisfaction is based on its own criterion about life [9]. Self-perception of health, besides being considered an important predictor of functional disability, is a reliable method capable of expressing various aspects of individuals' physical, cognitive and emotional health. Studies also show that health perception is an indispensable indicator of mortality, since people with poorer perception of health have a higher risk of death [10].

The elderly interpret the aging process and illness in different ways, depending on their life history. It is guided by the thought that living in family brings only benefits to the elderly, but in many situations this may not occur. In this context, it is important to conduct studies focusing on the relationship of life satisfaction and health self-perception of elderly in co-residence, seeking to contribute to interventions and care aimed at the elderly and their families. Thus, the research aimed to analyze the relationship of life satisfaction and self-perception of health in elderly co-residents.

## II. HEADINGS

The study design is a cross-sectional, analytical and descriptive study with a quantitative approach. A cross-sectional study is an analysis in which exposure to the factor or cause is present to the effect at the same time or time interval analyzed. Descriptive analysis exposes the characteristics of a given population or phenomenon, requiring standardized data collection techniques. The quantitative approach requires the use of statistical resources and techniques, seeking to translate into numbers the knowledge generated by the researcher [11; 12].

This is a subproject of the main project entitled "Family Arrangement of Elderly Residents in Northeastern and Southeastern Brazil", which was carried out through a research proposal in the municipality of Salto da Divisa-MG, Jequié-BA and Vitória da Conquista – BA. However, it is noteworthy that this subproject used data only from the city of Vitória da Conquista-BA.

This study is linked to the Center for Research and Studies in Health of the Elderly of the Independent College of the Northeast (FAINOR).

The main study, of which this study will use the database, was developed in two Family Health Units (FHU) in the municipalities of Vitória da Conquista - BA. The municipality of Vitória da Conquista is located in the southwest region of Bahia, occupying a territorial area of 3705,838 km2, with a population of 341,597 inhabitants, being 30,748 aged 60 years and over and having an average monthly income of 2.0 minimum wages [13]. In this municipality, according to data from the National Register of Health Facilities (CNES), 43 USF are established. These Units were selected through a simple draw.

Included are individuals aged 60 years or older living in the urban area of the municipalities of Vitória da Conquista-BA, in a state of co-residence registered with the USF, and who have cognitive conditions that allow answering the questions according to the application of the Mini Exam of the Mental State (MMSE).

This study considers the elderly in co-residence, who lives and lives with their intergenerational family (one or more generations, that is, children and/or grandchildren and/or great-grandchildren among others) in the same home unit [4].

The MMSE includes 11 items, which require verbal answers to questions of temporal and spatial orientation, attention, reading, memory, calculation, naming, following verbal commands, and copying a drawing (polygons). To evaluate the results obtained through MMSE, the following cutoff points will be adopted: 19 points for illiterate elderly; 23 points for seniors with 1 to 3 years of schooling; 24 points for seniors with 4 to 7 years of schooling and 28 points for seniors with schooling above 7 years [14]. Scores below these scores indicate a risk of cognitive impairment requiring referral for specific neuropsychological assessment.

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Elderly people who were not found at the study site on three days and at alternate times were excluded.

Collection was only initiated after approval by the Research Ethics Committee (CEP) and authorization by the Municipal Health Secretariat. Project data collection is based on access to the main project database in the Vitória da Conquista - BA study field. The collection of the main project took place in two stages. In the first moment, the number of elderly registered in the USF was identified through the consultation of the family registration forms, and the survey of the elderly who live alone and those who correspond with family members was surveyed.

Then, the following instruments were applied to the selected elderly: The interview, through a semi-structured questionnaire containing data identifying the participants, such as age, gender and composition of the family arrangement, the adapted Brazil old age Schedule (BOAS) questionnaire and the questionnaire of State of Health.

The Brazil Old Age Schedule Questionnaire - BOAS is a research tool that investigates multidimensional factors of aging based on other instruments with acceptable standards of validity and reliability. The BOAS was conceived from 8 broad categories (General information, physical health, use of medical and dental services, activities of daily living, social resources, economic resources, mental health, needs and problems affecting the respondent) [14].

The Health Status Questionnaire analyzes self-perception of health. It questions the individual how he rates his health in the last days and allows as an answer option five classification possibilities: very bad, bad, fair, good and very good [15].

The data from the interviews were obtained through the BOAS and the Health Status Scale. These were tabulated and received descriptive quantitative treatment (frequency, mean and dispersion measure) and analytical treatment (Pearson's chi-square test, with reliability set at 95%). %) with the aid of SPSS software. The tables were plotted by Microsoft Excel software. The significance level adopted was 95% ($\alpha$ <0.05).

This study is part of a broad survey entitled "Family Arrangement of Elderly Residents Living in Northeast and Southeast Municipalities of Brazil", and was approved by the Research Ethics Committee of the State University of Southwest Bahia (CEP-UESB), whose Opinion No. 102,641, was issued in compliance with the Resolution of the National Health Council (CNS) 196/96, in force at the time. Therefore, a request was made to CEP-UESB to include this study in the main project in accordance with Resolution No. 466 of December 12, 2012.

The data production was performed after the assent of CEP-UESB of the inclusion of the present field of study, and the authorization of the SMS of Vitória da Conquista - BA for conducting the research in the USF. The participation of the elderly was voluntary, and the acceptance was formalized by signing the Informed Consent - IC.

## III. INDENTATIONS AND EQUATIONS

Among the population approached after applying the inclusion and exclusion criteria, 239 elderly people were in a co - residence state, according to the condensed data in Table 1.

*Table 1. Sociodemographic characteristics of the participants. Vitória da Conquista – BA, 2019.*

| Variable | Mean (± sd[1]) | % de response | no | % |
|---|---|---|---|---|
| Age, *years* | 72,20 (±8,08) | 100 | 239 | — |
| **Sex** | | 100 | | |
| Male | | | 55 | 23,0 |
| Feminine | | | 184 | 77,0 |
| **Read** | | 97,9 | | |
| Yes | | | 143 | 61,1 |
| Not | | | 91 | 38,9 |
| **Schooling** | | 97,5 | | |
| None | | | 81 | 34,8 |
| Incomplete primary | | | 108 | 46,4 |
| Complete primary | | | 28 | 12,0 |
| Complete elementary | | | 5 | 2,1 |
| Medium complete | | | 10 | 4,3 |
| Complete superior | | | 1 | 0,4 |
| **Marital Status** | | 99,2 | | |
| Never married | | | 4 | 1,7 |
| Married / living together | | | 101 | 42,3 |
| Widower | | | 99 | 41,4 |
| Marital Status (a) / separate (a) | | | 33 | 13,8 |

[1] Padrão Sample standard deviation; Source: Research Data

A sociodemographic profile was observed, with a mean age of 72.2 years, a predominance of females (77.0%) and (61.1%) elderly people who read. Regarding education, it was observed that most elderly have incomplete primary school (46.4%). Regarding marital status, 42.3% are married or live together as a partner.

With the results expressed in table 2, it can be observed that the family arrangement of these elderly is

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composed in most cases by grandchildren (57.3%), sons (55.2%) and daughters (54.0%).

*Table 2. Composition of family arrangement of the interviewed elderly. Vitória da Conquista – BA, 2019.*

| Variables | % response | no | % |
|---|---|---|---|
| **Spouse (a) / partner (a)** | 100 | | |
| Yes | | 97 | 40,6 |
| Not | | 142 | 59,4 |
| **Parents** | 100 | | |
| Yes | | 5 | 2,1 |
| Not | | 234 | 97,9 |
| **Children** | 100 | | |
| Yes | | 132 | 55,2 |
| Not | | 107 | 44,8 |
| **Children** | 100 | | |
| Yes | | 129 | 54,0 |
| Not | | 110 | 46,0 |
| **Brothers / sisters** | 100 | | |
| Yes | | 6 | 2,5 |
| Not | | 233 | 97,5 |
| **Grandchildren (as)** | 100 | | |
| Yes | | 137 | 57,3 |
| Not | | 102 | 42,7 |
| **Other relatives** | 100 | | |
| Yes | | 16 | 6,7 |
| Not | | 223 | 93,3 |
| **Other people ( not relatives )** | 100 | | |
| Yes | | 13 | 5,4 |
| Not | | 226 | 94,6 |
| **Satisfied with family relationship** | 93,7 | | |
| Yes | | 219 | 97,8 |
| Not | | 5 | 2,2 |

Source: Research Data.

The literature survey conducted by Bertuzzi, Paskulin and Morais (2012) evaluated the types of arrangements and identified that there was a predominance of elderly living with children and / or grandchildren (50.1%). This family strategy is used to benefit both the elderly and their descendants [5]. It happens due to the needs of the elderly because of their functional limitations and cognitive and / or emotional problems that require more assistance [17]. Moreover, the period in which children spend as economically dependent on their parents has grown, due to the instability of the labor market, the greater time spent in school and the greater fragility of affective relationships [4].

It is observed that this intergenerational living can be marked by conflicts due to divergence of ideas between the elderly and their families, which may affect the health of the elderly. This is because in daily life, by sharing the routine, differences in habits and customs, eventually result in friction such as differences in behavior, increasing the chances of the elderly being mistreated and neglected [18].

Regarding the satisfaction of these elderly with the family relationship was obtained a positive result, about 97.8% are satisfied. Observing you this context, it is noteworthy that the family life makes to create emotional bonds and prevailing love, that despite difficulties, instigates to meet them [19]. Thus, the relationship of mutual support exchange between generations prevails, offering protection and support in difficult times [20]. In this context, the result of life satisfaction found may be associated with the fact that the elderly live with children and grandchildren and despite the possible conflicts generated by the division of space by several generations, these can be resolved in the short term, and in most sometimes it does not lead to the breakdown of relations.

The study has also revealed that among chronic diseases, systemic arterial hypertension (SAH) was the most frequent in the studied sample (80.5%). In addition, there is also the presence of self-reported accidents and rheumatological diseases in a percentage of (38.4%) and (35.1%) respectively, as shown in table 3.

*Table 3. Composition of self-perceived health of respondents. Vitória da Conquista – BA, 2019.*

| Variables | % de response | no | % |
|---|---|---|---|
| **Self - perception of health** | 98,7 | | |
| Great | | 3 | 1,3 |
| Very good | | 10 | 4,2 |
| Good | | 65 | 27,5 |
| Regular | | 127 | 53,8 |
| Bad | | 31 | 13,1 |
| **Health compared to other seniors of the same age** | 84,1 | | |
| Best | | 117 | 58,2 |
| Equal | | 52 | 25,9 |
| Worse | | 32 | 15,9 |
| **Self-reported illnesses/accidents** | — | | |
| Hypertension Arterial syste | | 190 | 80,5 |

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| | | |
|---|---|---|
| mic | | |
| Fall in the last 12 months | 88 | 38,4 |
| Arthritis , Rheumatism , Ar throsis | 81 | 35,1 |
| Diabetes Mellitus | 63 | 26,8 |
| Urinary incontinence | 58 | 25,0 |
| Nervous or psychiatric problem | 28 | 12,0 |

Source: Research Data.

In a way, population aging has the advantage of longevity, but in contrast, the occurrence of morbidity and mortality has also increased due to an increase in chronic degenerative diseases [21]. However, despite the high incidence of diseases, it is noteworthy that the health of self - perception study shows that older people are and refer their health as "Regular" in most cases (53.8%) and compared to health other older people in the same age group (58.2%) consider their health to be better. It is suggested that the fact that these elderly in co-residence still feel active and productive so that they can perform household activities and still help in the care of their children and / or grandchildren, removes the negative view of aging in relation to health [9].

Self-perception of health is based on subjective criteria, considering the individual's perception of biological, psychological and social aspects of themselves. Moreover, when it comes to health in old age, it refers not only to the absence of diseases, but to a balance between multidimensional factors [22; 23]. In 2014, Borges et al. (2014) analyzed self-rated health in the elderly in a municipality in the interior of Rio Grande do Sul, which 34.67% of respondents considered regular health. They also consider that this self-perception of health is related to several factors such as age, gender, education, marital status, family support, health conditions, life style, among others.

According to the condensed data in table 4, about 95% of respondents reported being satisfied with their lives, a result close to the study by Meira et al. (2015 ) with co-residence state in the elderly in a city in Bahia, in which was observed that a greater number of elderly (80.5%) who are satisfied with your life in general.

The life satisfaction is an overall assessment of one's life as a whole, may involve different criteria, such as health, leisure, housing, social relations and so on. Rezende et al. (2006) claim that it is not inversely proportional to age, that is, life satisfaction does not decrease according to the age of the individual, despite changes due to the aging process. Unlike younger generations, older people demand less and are satisfied with emotional support.

*Table 4. Life satisfaction of the elderly co-residents. Vitória da Conquista - BA, 2019.*

| Variables | % de response | no | % |
|---|---|---|---|
| **Satisfaction in life** | 98,3 | | |
| Pleased | | 227 | 95,0 |
| Dissatisfied | | 8 | 3,3 |
| Didn't answer | | 4 | 1,7 |

Source
: Research Data.

The fact that these elderly people report being satisfied with life may be related to home comfort , living and health conditions and the attention they receive from their closest ones [26]. According to Espitia and Martins (2006), the family has the responsibility of caring for the elder, satisfying both physical, psychic and social needs, especially when he loses his autonomy and functionality.

In this sense, it can be seen that the company and emotional support, the satisfaction of the financial and physical care needs of both parents and children are related to the benefits of this type of family arrangement. This may also corroborate the construction of aging as a slower and healthier process [24; 28].

If this coexistence is not harmonious between them, it may result in conflicts with results that affect the health, especially of the elderly. This causes them to generate feelings of vulnerability and insecurity, which reflects both in the performance of their daily activities and in the assessment of life satisfaction and self-rated health [18; 10].

*Table 5. Association of self-rated health with life satisfaction of the sample. Vitória da Conquista - BA, 2019.*

| Variables | Satisfaction in life | | $p^1$ |
|---|---|---|---|
| | Pleased | Dissatisfied | |
| **Self-perception of health** | | | |
| Great | 3 (100,0) | – | |
| Very good | 10 (100,0) | – | |
| Good | 62 (98,4) | 1 (1,6) | 0,02 |
| Regular | 124 (98,4) | 2 (1,6) | |
| Bad | 26 (83,9) | 5 (16,1) | |

[1] Pear Pearson's chi-square test; Source: Research Data.

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From the results in Table 5, p ô to be observed even in this study that there is a statistically significant correlation between life satisfaction and self-perceived health in the elderly co-residence (p = 0.02), so the study supports the the idea that better cases of self-rated health are related to life satisfaction cases and vice versa.

This result can be based on the fact that individuals are happy despite the problems faced, since to be satisfied does not only involve good physical health, but a range of determinants, such as good warmth and comfort, social interaction, autonomy and leisure, for example [29].

## IV. CONCLUSION

This work allowed to obtain with the analysis of the results, expressive and important information about elderly living in co-residence state and can be evidenced the statistically significant association between life satisfaction and self-rated health of individuals. Thus, it is inferred the importance of understanding the factors that are related to psychological, social and family issues, which possibly corroborate the achievement of good life satisfaction and self-perception of health providing better longevity.

Thus, there is a need for greater understanding about the living of the elderly and their families, in order to provide a better quality of life for the elderly and their intergenerational family, which can improve the living conditions and minimize the complications resulting from the aging process.

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# Financial Income and Life Satisfaction of the Elderly Intergenerational Relations

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***Abstract***— *The growth of the elderly population has become increasingly significant and representative in relation to the total population. This increase is due, among other factors, to the reduction in the mortality rate and the drop in the birth rate. However, this fact also presents itself as a challenge for society, requiring a social reorganization mainly by families. New family arrangements have emerged, such as co-residence, where children and / or grandchildren live with their elderly parents, with benefits for both older and younger. Thus, the objective of this study is to verify the financial income and to evaluate the life satisfaction of the elderly in co-residence. The study design is a descriptive cross-sectional, population-based and quantitative approach. A total of 239 seniors living in co-residence living in the area covered by the Family Health Units located in the urban area of Vitória da Conquista - Bahia were included. For data collection we used the semi-structured interview, the adapted Brazil Old Age Schedule questionnaire. Tabulation was performed using Excel 2015 software and data were analyzed in The Statistical Package for Social Sciences for Windows. The results obtained in the study show a prevalence of females, mostly married and / or living together, retired, with a minimum wage, living with children, grandchildren or partners and satisfied with life. It is concluded from this study that the main source of income of the elderly is retirement and that they have good satisfaction with life.*
***Keywords***— *Elderly, Families, Income, Intergenerational Relationship,Personal Satisfaction.*

## I. INTRODUCTION

An individual is considered to be elderly from 60 years of age, in developing countries, and from 65 years of age, in developed countries (World Health Organization - OMS, 2002). The growth of the elderly population has become increasingly representative, increasing by 18% in 5 years, being in 2012 25.4 million and in 2017 30.2 million. Women represent 56% of this group (16.9 million) and men 44% (13.3 million) (Instituto Brasileiro de Geografia Estatísticas - IBGE, 2018).

The increase in this population is the result, among other factors, of reduced mortality rates and falling birth rates, reflecting the improvements in living and health conditions in recent years. However, it is shiw up a need for social reorganization, especially by families. As families are getting older and older, at least one familiar elderly person is present, as a result many forms of family organization are emerging. One is where children and / or grandchildren live with their parents, and may be a benefit to both older and younger[1].

Some of the benefits for the elderly are safety, close contact with family members, because there is a fear of living alone, to facing violence, for fear of losing importance in society, access to leisure and facing low financial income, directly affecting the elderly's life quality. For family members, co-residence is a strategy that benefits in relation to help with housing, financial income, company and caring for grandchildren[2]. Due to such situation, services and public policies seek means of solution, as they are not prepared for this scenario [3].

It is observed, however, that the co-residence with their relatives can present negative aspects, because, often, divergences of ideas arise because they are

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individuals of different times, resulting in conflicts. Moreover, there is no guarantee of support in times of difficulty and can often compromise the quality of life of the elderly [4].

Another aspect to be analyzed is that the financial income of the elderly, usually being just a retirement salary, is also shared with the other cohabiting members of the household[2]. Thus, there are two sides to the income of the elderly, being independence, in which many may choose to live alone, and financial interest, which can bring family members interested in their income[5]. Thus, leading or not to have a good satisfaction with life [2].

It is considered that the life satisfaction of the elderly according to Meira et al. (2014)[6] can be based on the exchange between members residing in the same physical space, generating mutual feelings of trust and gratitude. According to Junior et al. (2016) [7] in addition to the good relationship with the family, psychological aspects and good functional capacity are directly linked to the satisfaction of life aspects.

Thus, the importance of this study is to deepen the knowledge of the reality of financial income and to evaluate the life satisfaction of the elderly in co-residence, so that the country seeks to understand them better, intervening and providing actions for health promotion and prevention through professionals like physiotherapists, enabling care measures that meet their needs and improving their quality of life.

## II. MATERIALS AND METHODS

The study design is a descriptive cross-sectional, population-based and quantitative approach. This is a subproject of the Project entitled "Family Arrangement of Elderly Residents in Northeast and Southeast Municipalities of Brazil", which is linked to the Center for Research and Studies on the Elderly Health of the Faculdade zindependente do Nordeste - FAINOR. It was developed in two Family Health Units (USF) in the city of Vitória da Conquista - BA, which were selected through a simple draw.

We included in the study population all the elderly in co-residence registered at the USF, totaling 239 elderly. This study considers the elderly in co-residence, the one who live with and lies their intergenerational family (one or more generations, that is, children and / or grandchildren and / or great-grandchildren among others) in the same household [1].

Inclusion criteria were individuals aged 60 years or older living in the urban area of Vitória da Conquista - BA and who presented cognitive conditions that allowed answering the questions according to the application of the Mini Mental State Examination. (MEEM). Thus, those who presented cognitive deficit or refused to participate in the research were excluded.

The MEEM provides information on cognitive parameters by assessing functions such as temporal and spatial orientation, attention and calculation, memory, language, and visual constructive ability. With a score that can vary from 0, with greater cognitive impairment, to 30 points, with better cognitive ability [8].

The collection of the main project took place in two stages. In the first moment, the number of elderly registered in the USF was identified through the consultation of the family registration forms (form A), and the survey of those who live alone and those who correspond with family members.

Then the interview took place through a semi-structured questionnaire containing identification data of participants, such as age, gender and composition of the family arrangement. Afterwards, the adapted Brazil Old Age Schedule (BOAS) questionnaire was applied to the selected elderly, considered a research instrument that investigates multidimensional factors of aging, based on other instruments with acceptable standards of validity and reliability. The BOAS was conceived from 8 major categories - general information, physical health, use of medical and dental services, activities of daily living, social resources, economic resources, mental health, needs and problems that affect the interviewee [9].

Data obtained through the sociodemographic questionnaire and the BOAS were tabulated and analyzed using The Statistical Package for Social Sciences for Windows (SPSS 21.0, 2013, SPSS, Inc, Chicago, IL). Means, frequencies and dispersion measures of variables were calculated.

The main research was approved by the Research Ethics Committee of the Universidade Estadual do Sudoeste da Bahia (CEP-UESB), whose opinion No. 102.641, was issued observing the Resolution of the National Health Council (CNS) 196/96, in force at the time. Therefore, a request was made to CEP-UESB to include this study in the main project in accordance with Resolution No. 466 of December 12, 2012.

The participation of the elderly was voluntary, and the acceptance was formalized by signing the Informed Consent Form (FICF), signed in two copies, one of the informant's domain and the other of the researcher's guardian responsible for the study.

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## III. RESULTS AND DISCUSSION

The condensed data in Table 1 reveal the sociodemographic profile of 239 elderly co-residents.

The study showed that the elderly in co-residence have an average age of 72.2 years. This data may reflect the increase in life expectancy associated with better social conditions and basic sanitation, influenced by disease control and reduced mortality rate [10].

Regarding gender there was a prevalence of females (77%). According to research by Silva et al. (2018) [11] and Sampaio et al. (2015) [12] most of the elderly were also female with respectively 60.9% and 60% of the sample. Although more men are born than women, their life expectancy tends to be longer than theirs[13]. The greater proportion of women in the elderly population has triggered the feminization of old age, having a greater social, cultural and health concern [14; 15] . According to studies by Moura et al. (2015) [16] men are more vulnerable and have a higher risk of death from external factors.

*Table 1. Sociodemographic characteristics of the participants. Victory of Conquest - BA, 2019.*

| Variables | Mean (± dp[1]) | % ofanswer | n | % |
|---|---|---|---|---|
| Age,years | 72,20 (±8,08) | 100 | 239 | — |
| **Sex** | | 100 | | |
| Male | | | 55 | 23,0 |
| Female | | | 184 | 77,0 |
| **Read** | | 97,9 | | |
| Yes | | | 143 | 61,1 |
| No | | | 91 | 38,9 |
| **Schooling** | | 97,5 | | |
| None | | | 81 | 34,8 |
| Icomplet primary | | | 108 | 46,4 |
| Complet primary | | | 28 | 12,0 |
| Complet college | | | 5 | 2,1 |
| Complet high school | | | 10 | 4,3 |
| Complet Higher education | | | 1 | 0,4 |
| **Marital Status** | | 99,2 | | |
| Never Married | | | 4 | 1,7 |
| Married / living together | | | 101 | 42,3 |
| Widower | | | 99 | 41,4 |
| Divorced / Separated | | | 33 | 13,8 |

[1] Sample standard deviation; Source: Research Data.

Regarding marital status, it was found that most elderly in co-residence are married or live with their partner (42.3%). According to the study by Meira et al. (2014) [6], 62.0% of the elderly are married. According to Meira et al. (2017) [17] having a partner to share old age transmits greater security, better accessibility to information, protection, making the married state healthier than other relationships. However, the number of widowers was also relevant (41.4%). In the studies by Luchesi et al. (2015) [18] the number of elderly widowers were the majority with 51.8% of the sample. Widowhood can be classified as one of the reasons for co-residence, reducing the lack, longing and loneliness caused by the death of a partner [19].

Regarding the financial situation, the sample is composed of individuals who generally participate in the tertiary work sector (30.5%), and are retired (65.3%), with a monthly income centered on one salary. (64.0%), as shown in Table 2.

*Table 2. Composition of the financial situation of the people interviewed. Victory of Conquest - BA, 2019.*

| Variables | % ofanswer | n | % |
|---|---|---|---|
| **Work Sector** | 98,3 | | |
| Primary | | 70 | 29,2 |
| Secondary | | 48 | 20,1 |
| Tertiary | | 73 | 30,5 |
| None | | 3 | 1,3 |
| Housewife | | 41 | 17,2 |
| **Retirement** | 96,2 | | |
| Yes | | 156 | 65,3 |
| No | | 74 | 31,0 |
| **Pension** | 93,7 | | |
| Yes | | 64 | 26,8 |
| No | | 160 | 66,9 |
| **Monthly Income** | 95 | | |
| A minimum wage | | 153 | 64,0 |
| Between one and three minimum wages | | 65 | 27,2 |
| Greater than four minimum wages | | 4 | 1,7 |
| No income | | 5 | 2,1 |

Source: Research Data.

Regarding social resources, the rate of retired elderly in the sample is lower than in the studies by Dawalibi, Goulart and Prearo (2014) [20] in which 80.2% of the elderly have the benefit of retirement. It is highlighted in the literature that the financial income of the elderly is an important support for families. In certain cases, the elderly seek co-residence for financial needs, while in

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others the financial income of the elderly attracts family members [21].

Retirement is a social resource that ensures a permanent income until death [22]. It means security for everyone in the family, especially in families with low socioeconomic power, since there is an instability of employment for younger people in recent times, and as a livelihood, is now shared by all. Studies point out that this sharing can affect the life and well-being of the elderly, since income, instead of offering better health, food and leisure conditions, is now divided among family members to meet basic needs [23; 19].

*Table 3. Composition of family arrangement of the interviewed elderly. Victory of Conquest - BA, 2019.*

| Variables | % of answer | n | % |
|---|---|---|---|
| **Husband / Wife / Partner** | 100 | | |
| Yes | | 97 | 40,6 |
| No | | 142 | 59,4 |
| **Parents** | 100 | | |
| Yes | | 5 | 2,1 |
| No | | 234 | 97,9 |
| **Sons** | 100 | | |
| Yes | | 132 | 55,2 |
| No | | 107 | 44,8 |
| **Daughters** | 100 | | |
| Yes | | 129 | 54,0 |
| No | | 110 | 46,0 |
| **Brothers/Sisters** | 100 | | |
| Yes | | 6 | 2,5 |
| No | | 233 | 97,5 |
| **Grandchildren** | 100 | | |
| Yes | | 137 | 57,3 |
| No | | 102 | 42,7 |
| **Other relatives** | 100 | | |
| Yes | | 16 | 6,7 |
| No | | 223 | 93,3 |
| **Other people (unrelated)** | 100 | | |
| Yes | | 13 | 5,4 |
| No | | 226 | 94,6 |
| **Satisfied with family relationship** | 93,7 | | |
| Yes | | 219 | 97,8 |
| No | | 5 | 2,2 |

Source: Research Data.

The study analyzed that the monthly income of the elderly usually varies from 1 to 3 minimum wages, and 64% of them live with only one minimum wage. In addition, it was noted that the elderly is often the sole financial provider of the house. Thus, depending on their income, the elderly may feel encouraged to live alone, may motivate family members to become dependent [24] or may even feel compelled to return to the labor market out of necessity [25; 23].

According to Aguiar (2007) [19], the use of the elderly source of income usually varies between personal expenses, home expenses and health insurance payment. Having financial independence is important because it provides greater security, decision-making power, self-support and a sense of self-reliance, improving autonomy and maintaining a positive perception of life.

Regarding the family arrangement of the co-residence, it is observed that it consists predominantly of grandchildren (57.3%), sons (55.2%), daughters (54.0%) and spouse/partner (a) (40.6%). The elderly in co-residence say they are satisfied with the family relationship (97.8%) of the cases, as shown in Table 3.

Co-residence can occur for various reasons, for the elderly due to health conditions and financial income, and for their children due to the difficulty of starting a new family and entering the job market, which favors continuing to live with their parents. In some cases, after divorce and separation, children return to their parents' home or return with their families due to financial difficulties [21].

With adults returning to their parents' home, there is a relevant aspect of co-residence. The elderly who are physically capable help in the care of their grandchildren, enabling their children to go out to work leaving their children under the protection of their grandparents, safely, rather than leaving them with others. However, on the other hand, this entails a lack of privacy and tranquility to the elderly, requiring greater care, attention and increased activities, which can cause stress and excessive worry, as well as physical and psychological exhaustion, bringing risks to the health of the elderly [26; 27; 28].

Regarding satisfaction with the family relationship, 97.8% of the elderly in co-residence feel satisfied with the family arrangement in which they live. Studies by Silva, Júnior and Vilela (2014) [29] show that 96.6% of the elderly say they are satisfied with the family arrangement. According to Luchesi et al. (2015) [18] living with children and / or grandchildren can generate advantages for the relationship between the elderly and their families, but it is not a guarantee of successful relationships, as there is not always a balanced exchange of support. However, despite difficulties, the family is an important means of support, provided that love between members is

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the predominant feeling and that there is mutual help between family members [28].

With regard to life satisfaction, it was found that the elderly co-residents say they are satisfied (95.0%), according to table 4.

In the results of the study by Silva, Júnior and Vilela (2014) [29], 85.8% of this group stated that they were satisfied with life. There is mutual help in this home arrangement, benefiting both the elderly and the family. The benefit of co-residence for many older people has been related to companionship and emotional support, including financial needs and physical care, thus generating healthy aging [23].

*Table 4. Life satisfaction of the elderly co-residents. Victory of Conquest - BA, 2019.*

| Variables | % of answer | n | % |
|---|---|---|---|
| **Life satisfaction** | 98,3 | | |
| Satisfied | | 227 | 95,0 |
| Dissatisfied | | 8 | 3,3 |
| Did not answer | | 4 | 1,7 |

Source: Research Data.

Life satisfaction is based on its own criteria, involving cognitive and subjective assessments, as well as being linked to well-being and happiness [30]. According to the literature, the better the satisfaction with life, the better the physical and mental health conditions, besides the social relations [31]. For Lopes et al. (2015) [32], it is important for the elderly to live in co-residence, as long as this relationship leads to a better life and health condition.

## IV. CONCLUSION

The present study allowed a greater understanding about the family arrangement of co-residence. It is an extremely important factor to be understood and known by health professionals, as there is a greater possibility of improvement in the quality of life of the elderly and their families.

Most of the elderly evaluated lived with children, grandchildren and/or companions and showed satisfaction with life, because there was a relationship of mutual help and affection. In the analysis, it could also be observed that the main source of income of the elderly is retirement, mostly only one minimum wage. Through the observed results, the study favors the reflection on the need for social support through public policies that increasingly favor the lives of these individuals. It is noteworthy the need for further studies and research in this area, with other samples and populations.

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# Abattoir operations and waste Management Options: A review

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***Abstract*** *— Abattoir wastes which are wastes generated during the various operations that are aimed at processing for consumption categorized as solid, liquid or gaseous have the potential to pollute the environment. They are stages in the abattoir operations and the adequacy of the operations is key to healthy products and environment. This study reviews thehandlingstages in an abattoir from animal arrival and temporary storage, stunning/Immobilising, slaughtering/bleeding, skinning, evisceration and Splitting to the roasting and washing operations. The waste handling point was noted to be categorized as solid which consist mainly of bone and compostable material, Liquid waste which include wash water, intestinal fluid and blood and the gaseous waste that includes emission due to the use of fuel for roasting of skin which is used in meals in parts of West Africa. Research on the alternative use of waste from the various abattoir wastes has been suggested in the study. The application of liquid waste and the part of solid waste for biogas production and purification (using charred bone) and deploying of the biogas as fuel for the roasting operation.*

***Keywords*** *— **abattoir, wastewater, waste, blood, bone, biogas.***

## I. INTRODUCTION

The meat industry has experienced crises in the recent past, including the mad cow disease and continental disputes over protein supply from countries to countries, also the bird flu and another influenza that occurred in the recent past wereimportant to make conscious effort to monitor various stages of the meat industry adopting acceptable and amenable global practice.These stagesinclude the slaughter and meat processing stages. The Abattoir is a place where animals are slaughtered for the purpose of production of meat/protein which are supplied to the public. As much as the activity and its individual operations are to provide the needed source of protein, the way and manner it is handled and it's by-products or wastes sadly could constitute hazard when the proper steps are not taken into cognizance(Weobong and Adinyira, 2011; Adelegan, 2002; Adeyome et al., 2009).

The Abattoir facility has various waste and waste generation points and handling options. But in many countries, the abattoirs arenot just crude but the wastes generated are not treated before disposal. Also, the regulatory bodies are never up to their duties to monitor the processing activities and the disposal of the waste (Adzitey, et al., 2010; Mohammed and Musa, 2012).

Abattoir wastes consist of several pollutants such as feaces, blood, bone, hone, fat, animal trimmings, paunch content and urine from operations, stunning or bleeding,carcass processing and by-product processing(Aniebo, et al., 2009; Nwachukwu, et al., 2011). These abattoir wastes can be classified as solid, liquid and gas. Abattoir waste can be detrimental to public health, animal health, and the economy of the country if they are not properly and effectively managed and controlled(Aina and Adedipe, 1991). Abattoirs often have difficulties in disposing, treating and processing of these wastes in an environmentally acceptable fashion. Due to these reasons, there is high risk of environmental pollutions like underground water pollution, air pollution, nuisance, odour, soil pollution and public health risks through the transmission of zoonotic diseases to humans(Osibanjo and Adie, 2007).

Nigeria had a period of boom in agricultural activities with a great export program. Animal rearing and cattle ranching projects were recorded in many states. This increased abattoir activities, therefore, should be complemented with adequate environmental programs to avoid poisoning and damage to the environment(Ezeoha and Ugwuishiwu, 2011).

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Good manufacturing and hygienic practices; solid, liquid, and gaseous waste management practices are highly necessary to minimize the harmful effects of abattoir wastes. Safe disposal, treatment, and processing methods like burying, composting, rendering, incineration, anaerobic digestion, and blood processing are also highly important to guarantee economic benefits from abattoir wastes/by-products rather than controlling public health risks and environmental pollution(Bellow and Oyedemi, 2009).

Most abattoirs in Nigeria do not have proper animal handling and waste treatment facilities. In all the stages that a standard abattoir should have from Arrival to packing, all reports and visits showed crude processes and operations. Animals go through pain when they are being slaughtered, the handling of the meat is too poor and finally, the waste generated gets inadequate treatment (Adewumi.et al., 2016; Bandaw and Herago, 2019)

This review on the operations of abattoir activities and the suggested handling of the waste, therefore, will include the following

- Overview of standard abattoir operations
- Abattoir waste content and handling.
- The handling of abattoir waste operations
- An alternative application of abattoir wastes

## II. STAGES IN THE ANIMAL SLAUGHTER OPERATION

1) Animal arrival and temporary habitat
2) Stunning/Immobilising of Animal
3) Slaughtering/bleeding
4) Skinning
5) Evisceration and Splitting
6) Roasting and washing

### 1) Animal arrival and temporary storage

The animal arrival and temporary habitat area (see Fig 1)is the place where animals are kept when they are brought to the abattoir. Here the selection is carried out for the animal to be transferred to the slaughtering bay. The waste generated here includes dungs and feed that drops on the floor. The dungs are periodically evacuated to a dump area. Animals are also rested here to calm them from the transfer stress experienced during transportation. From the temporary habitat area, the animal for slaughter is selected and taken to stunning or immobilization point. This waste generated in this area is biologically degradable solids that can be composited into manure. This organic waste is usually disposed of by burying. It's worthy of note that the improper handling of this waste will result in potential environmental risk(Alonge, 2005;Bandawand Herago, 2017).

*Fig.1: Animal inthe arrival area.*

### 2) Stunning/Immobilising of Animal

The stunning of animals at the slaughter is to render the animal unconscious before bleeding and slaughtering. Stunning can be carried out using electric shock, mechanical or gas stunning to keep the animal unconscious until bleeding. Immobilization may not provide total unconsciousness but provide restraint. In almost all the facilities in Nigeria,the strain is used than stunning or immobilization.There is no waste produced at the stunning stage in the slaughtering process.

### 3) Slaughtering/bleeding

A part of the slaughtering process is the bleeding which involves letting out of the blood through the blood vessels when the blood vessel/artery at the neck is severed. The flow of blood out of the animal result in death. Complete or almost complete bleeding is recommended to avoid residual blood in the arteries that can result in contamination as bacteria growth occurs with the blood as a medium. The waste generated at the bleeding section of the abattoir is blood which needs proper handling as it initiates microbial growth within a short while. Blood is a medium for a blood culture test and when blood is not handled and disposed of properly this will lead to contamination and pollution at the abattoir.

### 4) Skinning

Skinning is the act of skin removal. The skinning of the animal is carried out after bleeding. Mechanical or manual skinning is used in the abattoir. The process is done with animals, mainly as a means to prepare the muscle tissues beneath for consumption or for use of the fur or tanning of the skin. Typically, large animals are open skinned and smaller animals are case skinned.

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*Fig.2: Animal Skinning*

**5) Evisceration and Splitting**

After the skinning operation, the carcasses are washed and positioned for evisceration and splitting. Opening and cutting are done using knife, axe and saw. The cutting starts with the aitch bone and then opening of the anus and the bowel and reproductive tract, the gut stomach is taken off. The contents are removed in these operations and abdomen are removed and washed.

Splitting is done on the carcass for the removal of the bones and then chopping operation is used to reduce size. The meat is now transferred to tables for packaging, evacuation to the market or for retail.

The waste generated includes solid (bone, undigested food, dung,etc) liquid (blood, wash water, semen, etc).

**6) Roasting and washing.**

In a typical Nigerian abattoir, the skin of the animal (for cow) is cut to sizes (see Fig 2) for roasting which fire from used car tyres, firewood or other fuels are used to roast the skin (see Fig 3)

*Fig.3: Animal skin roasting operation*

After the roasting, the roasted skin is taken to the washing pool, see fig 4.

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*Fig.4.1: Roasted animal skin wash operation*

*Fig.4.2: Roasted and washed animal skin*

## III. WASTE GENERATION AND HANDLING

The waste from abattoir ranges from fluid intestinal to solid bones and gases from the roasting of the skin.

**Handling**

The handling of wastes from Abattoir including management are based on these categories

**Liquid Abattoir waste handling**

The liquid waste inabattoirs in Rivers State, Nigeria are poorly managed. Researches recorded blood, wash water, intestinal fluid, which involves Chemical Oxygen demand (COD) and Biological Oxygen demand (BOD) of densities ranging from 180 to 218,000mg/l and 120 to 160,500mg/l respectively (Ezeoha&Ugwuishiwu, 2011; Oruonye, 2015; Bandaw and Herago, 2017).

The blood and the wash water are discharged into the public drain without treatment. Scavengers visit abattoir facilities some times to collect the blood, boil and dry it into blood meals for animal feed. At present, there is no concrete arrangement for the use or management of liquid water from 90% of the abattoir in Rivers State, Nigeria.

**Solid Abattoir waste handling**

The solid waste is mainly; bones, horns, animal dung/faeces/droppings, Paunch or Intestinal content. These are mainly heaped (see fig 5) in the abattoir for further processing. In the facility, they constitute a nuisance due to the odour and the flies and rodents it attracts (Ezeoha&Ugwuishiwu, 2011; Bello &Oyedemi, 2009).

The bone is crushed after burning to make animal feed mill. The faecal and intestinal content is composted into soil conditioning or plant manure (Oruonye, 2015).

**Gaseous emissions handling.**

The major gas emission point in the abattoir is the skin roasting operation (see figure 3). At this stage firewood, used car tyre or used plastics are deployed as fuel. This results in pollution of the environment and contamination of the skin are will a delicacy in parts of West Africa. Polychlorinated bisphenols (PCBs) are chief culprits in the contamination of food and meat during preparation or processing with some petroleum and other carbon-based fuel.

## IV. QUANTITY OF WASTE AND SUGGESTED USAGE

A number of applications can be found for the waste generated in abattoir facilities as the quantities of these wastes justify applicable and appreciable quantity (Table 1).

**Biogas from Abattoir water**

The quantity of solid waste and fluids obtained from abattoir can be rightly applied for the production of biogas. Further research can be done to produce material balance on the exact quantity of waste and economic viability as a feed for a biogas plant(Omole and Ogbiye, 2013).

The carbon-rich waste and its possibility of appropriate Carbon/Nitrogen (C/N value) can be harness as complements from other agro wastes such as sawdust may be considered.

**Biomethane filter**

The bone that is burnt and crushed can be a good source of filter for the purification of the biogas to obtain rich methane biogas for use.

These could produce biogas of appropriate calorific value for roasting of the skin which can substitute the car tyre and firewood which has environmental consequences. Also, the biogas will have little or no health effect compared with the fuel currently used for roasting of the skin. The quantity of waste material from various wastes is tabulated in table 1.

The proper and planned application of the waste from the abattoir will help in the design of proper deployment of the streams of waste to appropriate ways that will make its handling viable and create a conscious effort in its usage to

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reduce the pressure that can lead to misuse(Fearon et al., 2014; Rabah, 2010).

*Fig.1. A heap of Intestinal content and dung*

*Table 1: Abattoir waste and sources*

| S/N | Animal Type | Qty of Animal | Waste source | Quantity waste | Phase | County/Region | Reference |
|---|---|---|---|---|---|---|---|
| 1 | Cow | Per Cow | Blood | 12.6 (kg) | liquid | Nigeria | Aniebo et al, 2009 &Oruonye 2015 |
| 2 | Goat | Per Goat | Blood | 0.72(kg) | liquid | Nigeria | |
| 3 | Cow | Per Cow | Intestinal | 8.0(kg) | Solid | Nigeria | |
| 4 | Goat | Per Goat | Intestinal | 1.25(Kg) | Solid | Nigeria | |
| 5 | Cow | Per Cow | Waste tissues | 6.4(Kg) | Solid | Nigeria | |
| 6 | Goat | Per Goat | Waste tissues | 0.80(Kg) | Solid | Nigeria | |
| 7 | Cow | Per Cow | Bone | 11.8(kg) | Solid | Nigeria | |
| 8 | Goat | Per Goat | Bone | 2.06(kg) | Solid | Nigeria | |
| 9 | 55 Cattle, | Lot | Blood | 0.7 ton | liquid | Tamale, Ghana | Fearon et al, 2014 |
| 10 | | | Gut | 0.5 ton | Mix | | |
| 11 | 50 Sheep | | Waste tissues | 0.4 ton | Solid | | |
| 12 | 20Goat | | Bone | 0.7 ton | Solid | | |

## V. CONCLUSION AND RECOMMENDATION

The study reviewed the abattoir operations and waste management options with a view of looking at the operations that go on in abattoirs. The various waste and how they are handled and alternative or suggested ways of adequate adoption or deployment of the waste.

The abattoir operation starts from the arrival and temporary storage point where the animals are kept on arrival to the stunning and immobilizing point where the animal is restrained and incapacitated before slaughtering. The next point is the bleeding and slaughtering where the animal is killed. The hides and skin are removed at the next point in the abattoir operation and then the evisceration and splitting point where the animal is cut intoparts and ready for packing and transfer to the market or storage. The other operation is the roasting and washing where the skin is roasted and washed.

The waste generated in the abattoir that finds useful application is classified as liquid, comprising of the blood, wash waste and intestinal fluids which isthe most abattoir is discharged without treatment into open drainages of water body, and as solid which includes bones, horns, intestinal content that are majorly used as manure. The bone is burned and crushed for bone meal.

Adequate and planned application is suggested for the use of abattoir waste as feed-in biodigesters and the use of the bone for cleaning of the produced gas into purer biomethane that can serve as an environmentally friendly fuel for roasting of skin.

The outcome of this review is the suggestion of the production of biogas using abattoir wastes with the animal bone serving as a filter for purer biogas. The recommendation, therefore, is that with an appropriate and well-designed biogas plant, adopting this method of

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production and treatment will guarantee purified biomethane gas.

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# Economical analysis of a natural lighting system, through a prismatic domus, in a shed in the Manaus industrial district

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***Abstract*****—** *The prismatic Domus is a technology presented to show an economic analysis referring to the use of natural lighting, where the sun is an efficient and safe source of energy. Relate this technology to the environment, considering the impacts and use of natural resources and the thermal comfort of the employees working in the area of the shed, considering its length, width, right foot and total area, in addition, showing the need for preventive maintenance and corrective technology, as well as the investment values, with their respective investment returns. The objective of this study is to demonstrate an economic analysis based on the use of the Prismatic Domus, which is a source of natural energy capture, in an industrial center company in Manaus, AM, as a renewable energy source instead of fossil fuel. The object of this analysis was a shed in the industrial pole located in the city of Manaus, where the dimensions of the building's shed were measured, regarding width, length and height. Thus, it started by collecting measures from the shed, which obtained 45 x 53 x 11m, respectively. Based on NBR 5413, which deals with the interior´s illuminance and the data collection related to the shed, recorded in the dimensions of 45 x 53 x 11m respectively, a luminometrically study was carried out, where software, such as softlux in it is free version, are normally used, available to download free of charge, where you can record the information in each step of a total of 04 steps and choose from the pre-established options that meets the needs of each project. The data presented show that in the use of prismatic domus technology, the reduction with electricity consumption is 70.52% compared to the use of a lighting system that uses the utility energy. With the use of this system, using the prismatic domus, there is no concentration of light in a single point (hot spot effect), has ease of cleaning and low maintenance.*

***Keywords*****— Economy, Energy efficiency Urbanization.**

## I. INTRODUCTION

Artificial lighting has transformed the lives of human beings, especially with regard to human well-being related to their comfort, as well as the emergence of technologies that use fossil resources for electric energy as a generating source, introducing a new model to improve human life. Energy efficiency and resource use by these systems. However, the price that is paid for this scenario of comfort and technological development to be implemented results in environmental impacts and degradation [1].

Artificial light follows the human trajectory, where over time, new products have emerged linked to this process of energy generation, among them, the lamp, which in turn emits heat with other elements, contributing directly to the heating which has been causing climate change, posing risks to human life and the environment, and may limit habitat and its resources for future generations [1].

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The concern of using less and less fossil fuels as a source of energy and minimizing environmental impacts has become a challenge for scientists, where in times of awareness of the rational use of electricity and the cost of charging the local permit holder, including the appeal for sustainability, arises in Brazil as an alternative to traditional systems, from natural lighting using prismatic polycarbonate, being characterized as renewable energy source [2].

As long as there is no awareness, sustainability and the need to migrate to renewable energy sources, the planet and man will suffer the consequences given the scarcity of their natural resources [2].

Economic analysis focused on natural lighting using prismatic polycarbonate, therefore, seeks to demonstrate that we can obtain satisfactory results when compared with commonly implemented technologies [3].

Given the developed capitalist model, time has become synonymous with money, so technologies need to minimize the use of the technical workers required for preventive and/or corrective maintenance, in addition to the advantages considering the economic bias, such as the thermal comfort of employees in the workplace. Concerning the so-called "Sealed Building Syndrome", which are projects that do not interact with the external environment, where they are neglected for this reason, a single window receives a huge amount of energy during the day. An example that can be extended to the upper coverage area of this shed making it energy efficient and improving the quality of life of employees [4].

From this analysis, it is possible to opt for a more energy efficient technological innovation project that does not transmit heat to the environment, ensuring the return on investment in a minimum time, which can attract investors, or even in the construction of new buildings, which can already implement these renewable energy solutions [4].

Natural lighting system

There are rules for various activities, environments and standards, but when it comes to natural lighting, meeting the standards is not enough, because in addition to the rules, you need to meet other related factors that are visual discomfort, glare, tiredness, exposure to ultraviolet rays, inherent factors that for those who work daily in an environment given these changes becomes increasingly detrimental to humans and can cause headaches, nausea for lack of excess lighting, where a good distribution of light and color is essential [6].

The daylighting system can be a variant, depending on the type of material used for sunlight transmission, where the study focuses on polymers used in engineering applications, such as polycarbonate and its variations, seeking to disseminate their energy efficiency, flexibility, comfort, safety, durability, ultraviolet resistance and heat retention [6] (Figure 1 and 2).

*Fig.1: Installation of Prismatic Domus in the outside area.*
Source: [6]

*Fig.2 – Installation of prismatic domus in the inside area of the company.*
Source: [6]

Prismatic elements were developed for obstructed environments, such as basements, sheds in order to redirect sunlight towards the environmental background. Thus, the prismatic panels are positioned at the roof level to capture sunlight and direct it into the environment in all directions, managing to become a receiver of the sun's rays and fragment them into "micro rays" sending back to the atmosphere 75% of the heat transmitted by infrared rays, where the big heat transmitting villains, allow only the passing of visible light, with 100% Color Reproduction Index (IRC), by diffraction action, and the illumination scattered evenly in the environment [4].

Prismatic domus is a term used to refer to a group of transparent and amorphous plastics, considered a material resistant and lightweight with a high degree of transparency and high impact resistance. Because of these properties, as is the case of blocking ultraviolet light (UV), it is widely used in roofing protecting those in the

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environment from this radiation providing higher thermal quality, since ultraviolet radiation is a major responsible for the heat coming from solar light. It is also a good heat-resistant, electrical insulator, self-extinguishing not spreading flames, has dimensions of 1.3 x 1.3m; 1.3 x 2.5m; 1.6 x 1.9m, thermoformed sheet, with the highest concentration of micro prisms approximately 40,000 per m² [6].

The refraction is based on one of Newton's experiments with prisms, noting that when lightenters the prism, it undergoes refraction with the same effect on prism output. Underlining the Snell-Descartes Law, it´s stated that the deviation that light undergoes in this process of entering or leaving the prism depends on the refractive indices of the prism material and air. However, when light travels through the prism glass, it has the scattering effect, so each frequency of light feels a different refractive index and, when exiting the prism, suffers a different deviation [6].

For each frequency of the visible spectrum of light we associate a color, where because of this phenomenon it is observed the formation of this color gradient at the exit of the prism. In the phenomenon of refraction, there is a change in the speed of propagation of light through a deviation from the original direction, that is, the light undergoes an angular deviation from the normal line, so that it passes from one transparent medium to another transparent one [7].

Thus, if the incidence of light in the way is normal, that is, it has an incidence angle equal zero, the light will not deviate and, therefore, its refracted angle will be null [7]. On the other hand, when the incidence of light causes an oblique deviation, the light ray will come closer to the normal line, leading to the deviation in the light path, i.e., the phenomenon of refraction.

The objective of this study is to demonstrate an economic analysis based on the use of the Prismatic Domus, which is a source of natural energy capture, in an industrial center company in Manaus, AM, as a renewable energy source instead of fossil fuel.

## II. METHODOLOGY

The research methods of this analysis start from field research, considering its accomplishment from obtained data on the spot [8]; bibliographic, where it is necessary to consult articles, norms, books and manuals; and descriptive aiming to describe the characteristics of certain populations or phenomena [9].

The object of this analysis was a shed in the industrial pole located in the city of Manaus, where the dimensions of the building's shed were measured, regarding width, length and height. Thus, it started by collecting measures from the shed, which obtained 45 x 53 x 11m, respectively.

For the installation of the prismatic plate, one has to consider that one of its faces facing the inside of the shed contains thousands of microprisms, for the diffusion of natural light, generating a behavior of "scattering" of light throughout the environment, in a single point “hot spots” and light tracing as the sun's position varies [10].

For projects using prismatic domus as material, useful utilization percentages are required, taxed from 2 to 3.5% of the total coverage area, considering the Brazilian Standard 5413 [11] which deals with Interior Illuminance, indicating the amount of lux suitable for the shed (area of analysis) from 300 to 500 lux, following the same criteria of a lighting design [11].

## III. RESULTS AND DISCUSSION

Based on NBR 5413, which deals with the interior´s illuminance and the data collection related to the shed, recorded in the dimensions of 45 x 53 x 11m respectively, a luminometrically study was carried out, where software, such as softlux in it is free version, are normally used, available to download free of charge, where you can record the information in each step of a total of 04 steps and choose from the pre-established options that meets the needs of each project.

The breakdown is initially (step 1) from data such as: a. inserting the name of the environment; b. the dimensions the building imputing the width, the length, the right foot, choosing the colors/reflectance; c. the environmental conditions regarding the cleaning requirement and the type of activity in the shed.

In step 2 it is specific to the choice of luminaire, where one finds for each choice their respective characteristics, such as: a. technical specification; b. Photograph; c. drawing; d. photometry; e. illuminance; f. utilization factor and zonal flow.

In step 3, you will find a field to specify illuminance (lux) for the project area. Already in the last phase (step 4) based on the calculations of the last three steps, we obtain as a result: a. amount of average, minimum and maximum lux; b. the number of luminaires needed for the area; c. the distances between each other, beyond the row numbers. Still in this step, a layout can be obtained specifying the location of the luminaire and its lux, being in point-to-point formats, both color and black and white illuminance using the colors visually to identify the maximum, medium and minimum lux (Figures 3, 4, 5 and 6).

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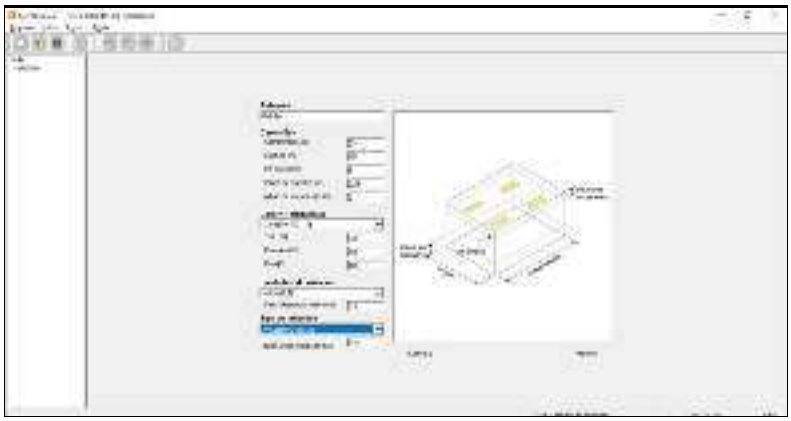

*Fig.3: Entering the environment data.*
Source: [12]

*Fig.4: Luminarie selection*
Source: [12]

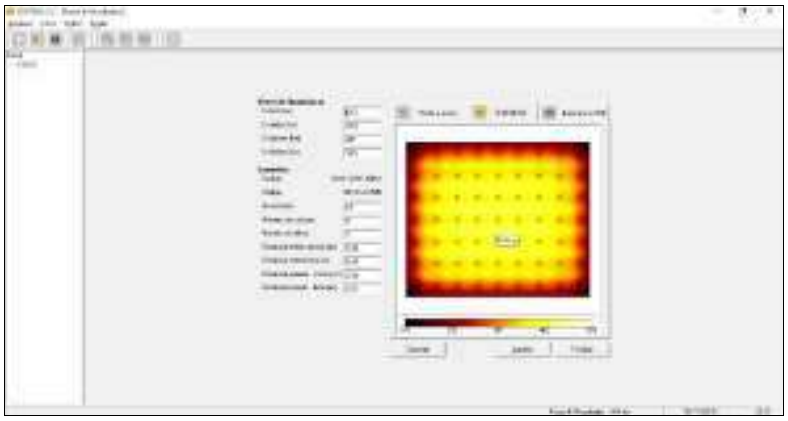

*Fig.5: Luminarie Distribution.*
Source: [12]

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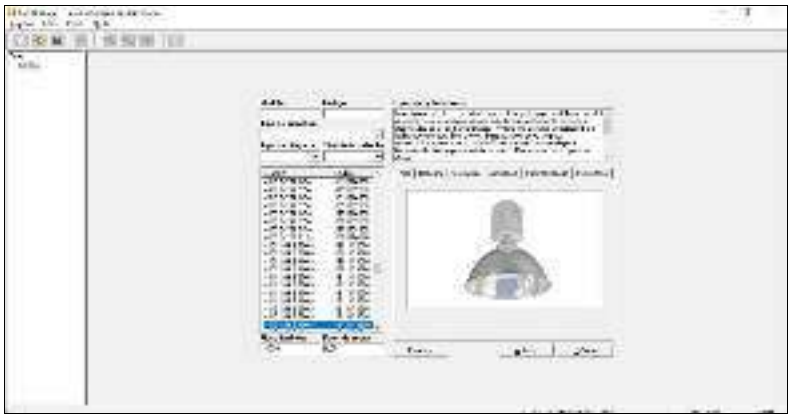

*Fig.6: Lux measurement at each luminarie location point*
*Source: [12]*

Through the obtained data, it is observed the quantity of 63 luminaires to be installed in this shed, with power of 400W each luminaire, which considers the working regime of the shed of 17h, on the days covering from Monday to Saturday. For this analysis, the average kWh value considereded to be R $ 0.52, obtained by the average monthly tariff between peak and off-peak consumption (Table 1).

*Table 1: Luminaries operation data*

| Description | Power | R$ Average media kWh | Operation (h) | Quantity |
|---|---|---|---|---|
| Overlap lamp | 400 | 0,52 | 17 | 63 |

Source: Own authorship, 2019.

This way, approximate values were obtained, having a daily expense of R $ 222.77, totaling monthly expenses of approximately R $ 5,791.97, where, if we consider the 26 days in the month, excluding Sundays only, one reaches an annual electricity use in the amount of R $ 69,503,62, in this area only.

Evaluating the installation of the prismatic Domus for this same area, the following specifications are used: a roof using galvanized trapezoid tiles, with thickness of 0.40mm, 7.0m in length, and 1.0m in width; In addition to the useful percentage of utilization taxed at 3%, it may reach a total area of 2,385m² at the end, in which only the use of approximately 72m² will be necessary for the installation of the prismatic domus. The choice of dimensions of the prismatic domus is 1.60 x 1.90m, bie in this area a quantity of approximately 24 plates should be installed.

From the working regime practiced in this shed, of 17 hours daily, Monday to Saturday and with the use of the natural lighting system of 12 hours daily, it can be concluded that the values will be reduced. (Table 2).

*Table 2: Prismatic domus application in reducing of electricity consumption.*

| Description | Power | R$ Average media kWh | Operation (h) | Quantity |
|---|---|---|---|---|
| Overlap lamp | 400 | 0,52 | 5 | 63 |

Source: Own authorship, 2019.

It is observed that the operating hours will reach 5h daily, resulting in a daily cost reduction of R$ 65.52, considering 26 days a subsidy of R$ 1,703.52 and a decrease of R $ 20,442 annually, 24 in the lighting system.

Therefore, Table 3 shows a reduction in the amount paid with electricity, considering the use of prismatic domus.

*Table 3: Reduction of electricity use*

| Operation (h) | R$ daily | R$ monthly | R$ Yearly |
|---|---|---|---|
| 17 | 222,77 | 5.791,97 | 69.503,62 |
| 5 | 65,52 | 1.703,52 | 20.442,24 |
| **Reduction de 70,52%** | | | |

Source: Own authorship, 2019.

Thus, it is observed that the prismatic domus can offer numerous advantages, such as energy reduction and consequent reduction in financial expense, high durability and mechanical resistance, lower thermal transmission, ultraviolet filtering, 100% color rendering index, excellent performance on cloudy days, zero eye glare, increased lamp life of the artificial lighting system, low amount of equipment to illuminate large environments,

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ease of cleaning and low maintenance making the system with the use of prismatic domus an excellent The choice of short, medium and long term, in addition to implementing sustainability, much more than economy, with this choice helps to protect the planet, turning off the lights illuminates a new possibility to preserve the environment.

## IV. CONCLUSIONS

The data presented show that in the use of prismatic domus technology, the reduction with electricity consumption is 70.52% compared to the use of a lighting system that uses the utility energy.

With the use of this system, using the prismatic domus, there is no concentration of light in a single point (hot spot effect), has ease of cleaning and low maintenance.

When the lamps are turned off, a new possibility is lit to preserve the environment, considering the natural use of lighting with sunlight, besides the reduction of costs, there is an interaction with the external environment, especially in terms of improvement of the environment. Work environment, performance, and productivity of its employees.

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# Applications of Fiber Bragg Grating Sensors in the Industry

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***Abstract*****—***Industrial Revolutions marked periods of exponential growth in the industrial sector. Among the technologies immersed in this area is fiber optics, which was initially used in the telecommunications industry, but is currently present in several industrial sectors. More specifically, this work addresses its applications in Instrumentation associated with the concept of Bragg grids. In this paper is published a brief introduction to fiber Bragg gratings (FBG), aiming to present an analysis of the most recent articles related to the use of fiber Bragg grating in industrial sensors. We selected 19 papers to show the results and the positive and negative data of this technology. Although it is a promising technology, it still needs standardization with the conventional industry environment.*

***Keywords*****— fiber Bragg gratings, fiber optic sensors, Instrumentation, sensors.***

## I. INTRODUCTION

The industry is based on a set of economic activities, sequential or not, to convert raw materials into manufactured products for subsequent marketing. Since its emergence in England, between the XVIII and XIX centuries, the industry has gone through three revolutions, where fundamental changes occurred. Even with these significant changes, production has not stopped evolving, and because of this, studies in new techniques, new instruments, and equipment relentlessly continue to satisfy the increasingly critical global market.

Among the main difficulties demanded by the Market is the quality of the final product, the high indices of productivity and availability of equipment, the safety of the collaborators, and the preservation of the environment. It is in this context that Instrumentation stands out, being the field of engineering which studies, develops and applies devices for measurement, indication, registration, transmission, and conversion for the control of the most diverse variables of industrial and non-industrial processes, with the purpose of guaranteeing greater safety, efficiency, reliability and environment preservation [1].

Before instrumentation, operators carried out the control of variables manually. Later, it started using the pneumatic signal, therefore already improving the processes. Following arose the electrical and electronic sensors, which are the most commonly, used sensors nowadays. The instrumentation system can be utilized in two sorts of control processes, being the first of these the open loop systems, when the process does not require an automatic or manual control of the controlled variable; i.e., it is only necessary to analyze how the process behaves without interference for corrections. The second type of system and the more employed one is the closed-loop system, which requires the manipulation of one or more variables to keep the output variable close the programmed parameters, in other words, when the output signal can be controlled according to the needs of the process [2].

Among the electronic sensors, there are fiber optic sensors (FOS), which emerged soon after the invention of the optical fiber in the 1970s. In this period, the optical devices such as the laser, photodetectors, and the optical fibers were too expensive; as a result, only telecommunication companies used this technology, using it to improve the telephone network. With the evolution of the optical fiber during the 1980s, the optoelectronic devices became more affordable, which favored their utilization as sensors. The FOS can be applied in many branches of the industry, measuring different variables such as temperature, deformation, pressure, vibration, gas concentrations, among others [3].

An optical fiber generally is made of glass or plastic, consisting of the core, a cladding, and a coating from inside to outside [4]. The Fiber Bragg Grating sensor is similar to a standard optical fiber, but with Bragg gratings inserted into the core of the thread with specific spacing between them. These gratings reflect light differently from the rest of the fiber. When the optical fiber is submitted to a positive or negative deformation, these spacing change,

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making it possible to analyze the measured values through this variation by use of an optical interrogator.

The objective of this present work is to present a review of the recent papers related to the application of fiber Bragg grating sensors in the industry. This kind of sensor is one of the FOS options most used to carry the measurements of variables mentioned in the previous paragraph, because of their pure fabrication and the reflective signal being relatively stable. Despite its great benefits, these sensors still find profound resistance to their implementation in industries, in consequence of the lack of reliance and standardization of the technology. However, it is relevant to the application of these sensors where the conventional sensors are not useful or do not have a claim, due to their limitations.

## II. METHODOLOGY

Due to this review, it was necessary to follow a sequence of research stages. Firstly, were defined the theme, the overall objective, and the specific objectives; further, it was described the following generic logical expression: ("Applications") AND ("FBG OR Fiber Bragg Grating") AND ("Industry"). This valid expression was suited to the advanced search syntax of each search mechanism of the following knowledge databases: Web of Science, ScienceDirect, MDPI and IEEE Xplore. Other filters were applied according to what each database allowed, refining the search, for example, year of publication of the paper, subject, journal, type of the article, among others. Using the MDPI base for example, by applying the logical expression solely, 380 articles were found. Proceeding with the filters available, the first was a year of publication, diminishing the number of articles to 264. Finally, by applying the filter for exclusively, the sensors journal resulted in the name of 187 articles.

On the carried search, only articles fitting the logical expression were included. It was necessary to analyze the title and abstract of the articles found in the selections, due to the significant amount of papers found, despite the filters applied. In the initial search, we found 373 articles, being 56 on Web of Science, 122 on ScienceDirect, 187 on MDPI and 8 on IEEE Xplore. After the initial search, the inclusion criteria were applied. These are:

- The articles must present applications of the fiber Bragg grating sensors;
- The forms must have applicability in the industrial environment;
- There should not be papers on the same application with the same type of Bragg gratings;
- The articles used in the results should not be older than six years of publication.

In the remaining articles were verified the field of application, the types of sensors of Bragg gratings, and the magnitudes of measurement, to have better control of the selection, avoiding similar or even identical papers. The application of these criteria reduced the number of articles from 373 to 60 articles matching the proposal of this paper. From these, 41 articles were selected for being utilized as a reference in the Introduction and Theoretical Foundation sections, while the other 19 were chosen to be exposed in the Results section respecting the inclusion criteria.

## III. THEORETICAL FOUNDATION

### 3.1. Fiber Optics Sensors

Despite many believing that fiber optic sensors are a novelty, they studied for around four decades. Several approaches have been utilized to measure various physical parameters, but only some types of FOS are commercially attractive. In fact, in many cases, the systems of these sensors are not available in complete form, which is, including electronic components for detection and signal processing [5].

The future of these sensors is promising since they present very know benefits, such as compaction, immunity to electromagnetic interference and ionizing radiation, high sensibility, high bandwidth, and minimum weight. These properties make FOS essential photonic devices in dangerous environments, as nuclear power plants, where the detection and evaluation of the radiation levels and changes in temperature are crucial, especially in case of accidental restrictions [6]. These sensors were developed to measure electrical current and voltage, mechanical tension, temperature, pressure, gas, chemical contaminants, rotation, vibration, acceleration, bending, torsion, movement, biomolecules among others [7].

### 3.2. Fiber Bragg Grating Sensors

#### 3.2.1. Working Principle

Periodic or aperiodic modulation of the effective refractive index (RI) in the core of an optical fiber possessing a diameter of around 4 to 9 micrometers formed the Bragg gratings in optical. Usually, the disturbance is between 5 mm to 10 mm, and the period is in the order of hundreds of nanometers, or longer, as in the case of long-period gratings. The development process of these gratings will be exposed further in the section named Manufacturing techniques. The RI disturbance leads to reflection of light in a narrow range of wavelengths, presenting an optical reflection spike at a specific wavelength, known as Bragg peak. This name was given due to the similarity to Bragg's

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law for X-ray diffraction [3]. In Fig. 1, presents the sensor structure and its working principle.

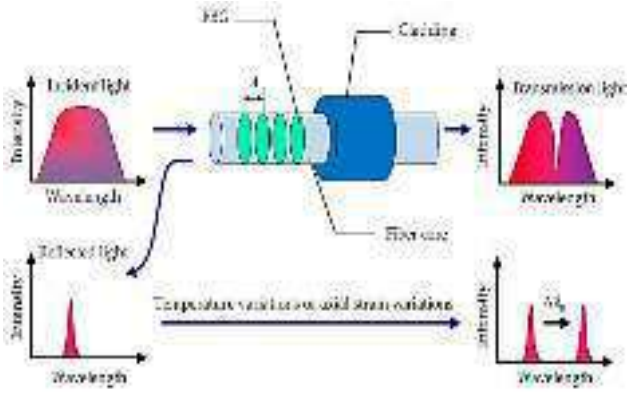

*Fig. 1: Diagram of the working principle of the Bragg gratings. Source: image from [4].*

Bragg's diffraction occurs to electromagnetic radiation whose wavelength is in the same order of magnitude of the atomic spacing when incident onto a crystalline material. In this case, the radiation is scattered in a specular manner by the atoms of the material and experiments constructive interference according to the Bragg's law. This law describes the condition for constructive interference of several crystallographic planes of the crystalline network separated by a distance d as shown in Equation (1).

$$2d \sin\theta = n\lambda \quad (1)$$

In which θ is the angle of incidence, n is an integer and λ is the wavelength. A pattern of diffraction is obtained measuring the intensity of radiation spread in function of the angle θ [8].

These results in an optical filter aligned with periodic regions of variable RI. The multiplicity of internal reflections of periodic interfaces results in a narrow Gauss waveform being reflected (the Bragg's peak). All other waveforms are transmitted through the sensor. Bragg's wavelength is determined by Equation (2) [3].

$$\lambda bragg = 2\ neff\ \Lambda \quad (2)$$

In which Λ is the grating period, λbragg is the Bragg's wavelength, and neff is the effective RI of the light in the fiber. Essentially, this condition means that the wavenumber of the grating corresponds to the difference of the (opposite) wave vectors of the incident and reflected waves. In this case, the complex amplitudes corresponding to the contributions of fields reflected from different parts of the grating are all in phase, so that they can be summed constructively; this is a type of phase correspondence [9].

In general, when the thermomechanical loads act on the Bragg gratings, the change in wavelength Δλbragg is given by Equation (3).

$$\Delta\lambda bragg = \lambda bragg\left(\frac{1}{neff}\frac{dneff}{dT} + \frac{1}{\Lambda}\frac{d\Lambda}{dT}\right)\Delta T + \lambda bragg\left(\frac{1}{neff}\frac{dneff}{d\varepsilon} + \frac{1}{\Lambda}\frac{d\Lambda}{d\varepsilon}\right)\Delta\varepsilon \quad (3)$$

The first term on the right-hand side of Equation (3) represents the effect of temperature on the shifting of the Bragg's wavelength.

With $\left(\frac{1}{neff}\frac{dneff}{dT}\right)$ being the thermo-optical coefficient and $\left(\frac{1}{\Lambda}\frac{d\Lambda}{dT}\right)$ the coefficient de thermal expansion coefficient. The second term on the right side of Equation (3) represents the contribution of tension to the shifting of the Bragg's wavelength. It corresponds to a change on the periodicity of the grating and the change induced by optical tension on the refractive index. Assuming isothermal conditions and deformation are acting solely in the longitudinal direction of the fiber, Equation (3) becomes Equation (4).

$$\Delta\lambda_{bragg} = \lambda_{bragg}(1 - p_{eff})\Delta\varepsilon \quad (4)$$

In which $p_{eff} = \frac{neff^2}{2}\left[p12 - \upsilon(p11 + p12)\right]$, $p_{11}$ and $p_{12}$ are the components of optical fiber tension and υ is the Poisson's ratio [10].

3.2.2. Temperature Compensation

Temperature has a powerful impact on the signals of the Bragg grating sensors. Naturally, the fiber, like any other material, expands when the temperature rises and contracts when temperature decreases, consequently the RI also suffers alteration. The deformation measurement, depending on the ambient temperature would be completely compromised if it were not by the temperature compensation. To carry out this compensation it is necessary to take some steps, the fundamental ones are:

- To install an extra sensor, close to the deformation sensor to measure temperature: consequently, it would be possible to make a mathematical compensation through comparison of data and subtraction of the effects of temperature;
- Position two sensors in a push-pull configuration so that when under deformation, one of them is compressed while the other suffers an opposite deformation;
- Encapsulate the fiber with protection, which expands in the opposite direction, in a manner that the tension applied on the sensor cancels the effect of temperature and it is not necessary to employ any mathematical compensation [11].

3.2.3. Key Types of Sensors

In the first years after its device, the attention was attracted to traditional methods of fabrication, such as the uniform FBG and long-period gratings (LPG). Recently other types of sensors-based Bragg gratings have appeared which will be presented concisely further. These new types of sensors are differentiated by the structures inscribed into the core

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of the optical fiber [12]. In Fig. 2 it is presented four of the main sorts of fiber Bragg grating sensors.

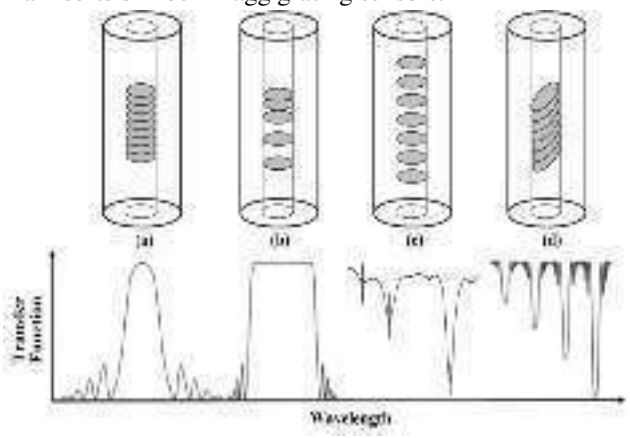


*Fig. 2: Differences of the types of Bragg grating sensors: (a) standard; (b) chirped (c) long-period and (d) tilted, with their correspondent transmission signals below. Source: Image adapted from [12].*

3.2.3.1. Long-period Bragg Grating Sensors

Long-period Bragg gratings are generally designed so that there is coupling between the propagating mode of the core and the first cladding. The system of coupled equations and corresponding boundary value conditions holds valid for the calculation of the transmittance function of a long-period network. However, on behalf of the interaction occurring between distinct environments, the coupling coefficient cannot be calculated in a simplified manner as it happens with traditional Bragg gratings [13].

These sensors are utilized primarily in systems, which analyze the refractive index, due to the high sensibility to the RI of the medium around the sensor. This sensibility has been being applied on the production of sensors, to monitor the concentration of the solution of a substance during a chemical process or to measure the level of a fluid inside a container [14]. Similarly, to what occurs on conventional Bragg grating sensors, these can be utilized to produce sensors for the detection of many physical parameters, including external reflective index, temperature, curvature, load, and liquid levels among others [15].

3.2.3.2 Chirped Bragg Grating Sensors

The chirped Bragg grating possesses a variable period between gratings which generally results in the reflected spectrum being significantly increased; consequently, these are frequently used as band-pass filters [16], [17].

3.2.3.3. Tilted Bragg Grating Sensors

On tilted Bragg gratings, the grating is in an angle concerning the optical axis resulting in the light being coupled outside of the fiber core, generating a change on the reflected wavelength and the bandwidth [18]. Generally, tilted Bragg gratings are used in optical interrogators as spectrometers [19].

3.2.4. Interrogators

The information from each sensor must be separated and understood. For this to take place, it is necessary for an interrogation system. For Bragg grating sensors, typically, the interrogation system monitors the signal reflected by the gratings. To that end, the system must be composed basically by a coherent light source which emits a broadband signal, an optical circulator with three optical ports to separate the message, one or more sensors in an optical fiber and an interrogator, which measures the value of the external parameter based on the wavelength of the spectrum reflected from the Bragg grating sensor [11]. In Fig. 3 it is shown, in a simplified manner, an interrogation system with the equipment and essential components.

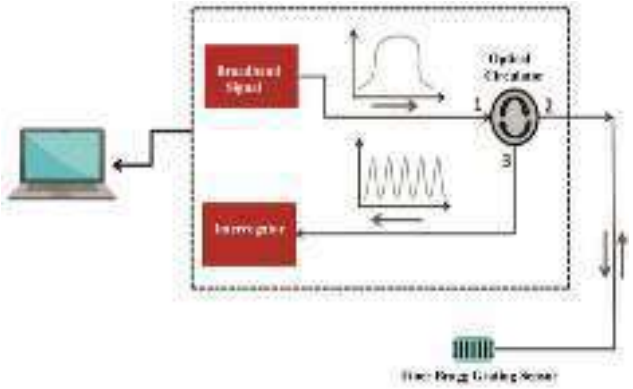


*Fig. 3: Schematic diagram of the interrogation system. Source: Image adapted from [20].*

Initially, the interrogators were enormous unities, complex and expensive; however, since the late 1990s, several groups of different researchers attempted to minimize and simplify them without losing functionality. When Bragg gratings suffer deformation, the wavelength of the reflection peak is altered. For the measurements, it is necessary to quantify these changes accurately. There are many different means to analyze these optical spectrums. For laboratory tasks, interferometers are the most commonly used [21]. The interferometric schemes convert changes in the wavelength to changes in phase but are not suitable for robust industrial applications. In industrial environments, other principles dominate. Two of these will be briefly explained below.

The edge filter principle utilizes special optical filters with transparency dependent of the wavelength, is considered the most straightforward technique and requires a narrow bandwidth sensor ($\Delta\lambda \approx$ 0.05 nm to 0.3 nm)

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whose wavelength deviations of the reflected signal are transformed in intensity changes by a linear variable filter. It is a band-pass filter with higher sensibility [22].

For the C band (1550 nm), the interrogators with tunable lasers represent first-class instruments. A tunable laser concentrates all of its energy in an extremely narrow band, and all the range of bandwidth sweeps the spectrum with high power and can provide an excellent signal to noise ratio [23].

Comparing the three techniques mentioned above, according to the characteristics of possible resolution, measurement speed, long-term stability, compatibility of signal multiplexing and the potential cost of application, it was observed that the tunable laser technique presents better results for industrial applications according to the Table 1.

*Table 1: Comparison of different interrogation techniques. Source: Adapted from [24].*

| Characteristics | Interferometry | Edge filter | Tunable laser |
|---|---|---|---|
| **Resolution Range** | $10^3$ - $10^4$ | $10^2$ - $10^3$ | $10^3$ - $10^5$ |
| **Measurement speed** | High | High | High |
| **Lon term stability** | Good | Good | Good |
| **Multiplexing capacity** | High | Low | High |
| **Potential cost** | Medium | Low | High |

3.2.5. Fabrication Techniques

The interest for Bragg gratings started with the possibility of writing the gratings laterally in the fibers, as seen on the work of [25]. The first technique used to inscribe Bragg gratings in fibers was the interferometer, which can be used in various configurations. A laser beam is divided in two by a prism. Each part is reflected in mirrors to meet again and form an interference pattern over the fiber to be inscribed. The cylindrical lenses concentrate the beams in the area of an inscription of the fiber, around 5 mm by 200 μm, to increase the density of the UV dose.

The most used technique at the moment is known as the phase mask, which is a diffractive optical element which spatially modulates the UV light beam with a specified period. Phase masks are formed on a fused silica substrate by a holographic technique. When a laser beam strikes the phase mask, the diffraction occurs, and the shaft is divided into several orders of diffraction. These two orders start at the same point on the other side of the phase mask but are divergent. The optical fiber is placed in contact or close to the phase mask, inside of the close range where the interference pattern is produced. The main advantage of this technique is its simple configuration since it is not necessary for the laser to present a good coherence and there are not mirrors to align [21].

Although this process is conceptually direct, there are many significant constraints to be overcome when producing these sensors. The first one is the cost of the equipment, specifically the excimer laser, as well the phase mask. Next, there is also the positioning of the components in such a way that gratings with precise characteristics of RI variation and correct spacings can be produced accurately along the fiber [26].

A contemporary example of equipment for manufacturing Bragg gratings is the automated system by Northlab Photonics, which was developed to fulfill the need for flexible fabrication of consistent Bragg grating sensors and high quality in a production basis. The phase masks are all kept in a spinning disk to allow switching between manufacturing of different types of these sensors, without handling by the operator. The Optical fiber is mounted onto a modular device and is positioned in a linear stage which allows the Bragg grating fibers to be inscribed along the fiber in a precise position in an automated fashion [26].

3.3 Bragg Grating Sensors Applications

The use of FBG has been growing continuously, and the applications of this technology have become more advanced [27]. Although initially restricted to communications purposes, currently associated with the Instrumentation area, this technology has been applied in the form of sensors in several industrial sectors.

3.3.1. Telecommunications

The investigation of telecommunication systems is of great significance to obtain greater spectral efficiency and a total capacity of information and reduce the performance degradation caused by transmission impairments. It is essential to calculate the transmission of the dense wavelength division multiplexing (WDM) for broadband access. The Bragg gratings technology undertakes a vital role on the systems of dense WDM, facilitating the filtering of specific wavelengths of the system. An optical add-drop multiplexer (OADM) is a device used in WDM systems for multiplexing and routing of different light channels inside or outside a single-mode fiber (SMF). It is a sort of optical node, generally utilized for the production of telecommunication networks [28].

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3.3.2. Electrical Industry

The Bragg grating sensors are excellent for use in the electrical energy industry due to their protection against electromagnetic interference. Also, these can be used in long-distance configurations, on account of the low transmission loss in the fiber. The temperature of electrical transformers, transmission lines, and high electrical currents have been calculated with these sensors [29].

One of the leading causes of fires in power systems is high temperatures, which in turn are usually caused by short-circuits and high leakage currents. Thus, defective or damaged equipment can be detected by continuously monitoring variations in temperature of the winding of electric machines, whose temperature can increase even with the operation of the cooling system of the machine. Jia et al. [30] present a sensor for an application in which the temperature of a transformer winding is measured with the optical fiber Bragg grating technology. The temperature monitoring system is divided into three parts: a man-machine interface developed with LabVIEW, an FBG wavelength demodulation system and fiber Bragg grating temperature sensor.

In the electrical energy sector, there are two factors, which may cause the breakdown of an electronic sensor: the presence of high voltages and high electromagnetic interference. Therefore, depending on where one wants to measure a parameter, it can be pretty difficult or even impossible to use a conventional sensor. The best option to deal with this is to make use of fiber Bragg grating sensors, due to their characteristic of immunity to electromagnetic interference; thus, it is possible to place them very close or even atop a high potential cable. Also, these do not necessarily require electrical energy on the location of the sensor [8]. Bragg sensors detect the most different electrical variables in several work ranges, as can be seen in Table 2.

3.3.3. Petrochemical industry

With the oil and gas industry rapidly growing, increasing the efficiency and profit demands improvements in the technology for cost-effective production in key areas of exploration of reservoirs an in the production management of oil wells. The Bragg grating sensors are used for seismic exploration and are required to be able to measure multiple physical parameters, as temperature, pressure and acoustic waves, in a harsh environment. This application requires high sensibility over the broad range of vibration frequency ranging from 5 Hz to 2.5 kHz, which contains essential geological information [31].

*Table 2: Different variables measured utilizing Bragg gratings. Source: Adapted from [8].*

| Variables | Units and ranges |
|---|---|
| Electric Current | A to kA |
| Leakage Current of Insulators | μA to mA |
| Voltage | mV to MV |
| Impedance | μΩ |
| Vibration of Structures and Equipment | m/s² |
| Temperature | °C |
| Gas Concentration | Ppm |
| Pressure | mBar to Bar |
| Distance Between Stationary and Rotating or Moving Parts | 1 or 0 |

In the oil and gas industry, there is the necessity of measuring the interface level between the fluids in wells, reservoirs, processing vessels and storage tanks for liquids of different densities, corrosivity, and viscosity. Moreover, the processes involve high ranges of pressure and temperature, which raises the requirements of complexity and robustness for the instrumentation [32].

3.3.4. Construction industry

Applications in civil construction structures [33], [34] as bridges, roadways, skyscrapers, and mines may have as target different stages of the construction: monitoring the stress during and after building. The measurements during construction include pre-stressing forces applied to precast concrete components; weight on critical locations; dissolved between the concrete and metallic beams; concrete shrinkage and chemistry (pH) during hardening. The post-construction measurements include continuous detection of incidents and impacts; evaluation of the aging and splits in concrete and asphalt; and weigh-in-motion. Both the static and dynamic analyses are taken from a surface mounted Bragg grating sensor [35].

3.3.5. Environmental industry

Chloroform is released into the environment through numerous anthropogenic sources, where industries utilize it on the production lines. Exposition to 50 ppm of chloroform may harm human health. The traditional methods of chloroform detection include spectrophotometer and metallic oxide. These methods are not suitable for on-line monitoring because they are easily affected by environmental factors, such as ambient temperature and air humidity. Ahad et al. [36] developed a new sensor with Bragg gratings coated with polyaniline

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film, which was used as an optical sensor to the detection of chloroform.

In this study, the effect of synthesis parameters, such as different proportions of dopants and different temperatures of polymerization for the efficiency of the sensor was being investigated. Polyaniline showed the highest conductivity ($1.627 \times 10^{-2}$ S/cm) and the best ability (sensibility = 0.0015) with a response time of seven seconds. The mechanism during the detection of chloroform was studied through the infrared analysis by Fourier transform (FTIR) and ultraviolet-visible (UV-Vis), and the results revealed the physical interaction of the partial negative charge of chloroform with the partial positive charge of the polyaniline chain. Moreover, the performance of the sensor, as recyclability, selectivity, detection limit (DL), quantification limit (QL) and analysis of the real sample were studied in this research.

3.3.6. Chemical industry

The IR constitutes a property inherent to each substance, and it is through it that, particularly in the domain of optical monitoring of substance concentrations, settles the communication between state alterations of the measurand and the response of the sensor system. Areas comprising biochemistry, chemical analysis, and in particular, the control of different parameters in natural or industrial settings constitute the primary targets for the monitoring of the refractive index value [8].

Bragg gratings can be used in sensors, which carry the real-time monitoring of material concentrations in aqueous solutions, or materials placed in inaccessible locations or potentially explosive environments, and for the quality control of industrial production. The levels of solutions as ones of sodium chloride and calcium chloride were measured with sensibility equal to or higher than measurements with conventional Abbe refractometer [37].

3.3.7. Medical industry

Besides the diverse applications on the industrial fields for monitoring several physical variables, Bragg gratings have a promising future in medical applications. Janting et al. [38] highlight spectral multiplexing capability, biocompatibility, and small size is favorable characteristics making an excellent potential for use in-vivo sensing.

The FBG sensors have been widely employed to monitor physiological and cardiac parameters, in microsurgeries, blood pressure on the feet of diabetic patients, in biomechanical studies, temperature monitoring during the thermal ablation of cancer, in systems of respiratory control and the tactile sensor, thanks to its biocompatibility characteristics, full bandwidth, flexibility, small size, non-toxicity among others. Additionally, they are suitable for application in environments with high electromagnetic noise, because of their immunity to electromagnetic interference and their intrinsic compatibility with magnetic resonance. This last characteristic makes the FBGS adequate for monitoring biological parameters (for example, respiratory and cardiac monitoring) during magnetic resonance procedures [39].

3.3.8. Aviation and aerospace industry

In the aviation and aerospace, a significant challenge is faced, which is service monitoring and perceiving in real time the integrity of the structures with an onboard sensor system. For this application, it is used as a distributed Bragg grating sensor system [40].

It is of great importance to calculate the temperature and stress simultaneously to correct thermal stress and the measurements of static deformation. Several approaches were proposed for simultaneous measurements of temperature and strain [41]. Another example was the deployment of a system with eight strain sensors and six temperature sensors on the Airbus A 340-600 fuselage, which was successfully tested in parallel with electrical strain gages to measure the load in real conditions [42].

## IV. RESULTS

Werneck et al. [8] observed the occurrence of problems concerning the internal temperature measurements in a hydroelectric generator, as sensibility, lack of linearity, accuracy, among other errors. Faced with this, they applied Bragg gratings for correction of these problems. After deployment, the researchers observed precision of 99%, even after 2.5 years after implementation the system continued to be effective. The system also provided immunity against electromagnetic interference when compared to conventional sensors, as well as reduced costs as a consequence of the substitution of kilometrages of cables by merely some optical fibers.

Basumallick et al. [43] modified an optical accelerometer based on cantilevers. The sensibility of the accelerometer was effectively enhanced nearly twice when changed with Bragg gratings in comparison to the conventional conception, due to the architecture requiring a simpler and more robust design.

Jiang et al. [44] compared several techniques based on Bragg gratings for varied applications, such as measurements of vibration and temperature applied to the aviation industry, monitoring of the water sublimation status, and parameters for improved safety in airplanes. The sensor was immersed in liquid nitrogen for 200 hours to explore the stability in cryogenic temperature, which

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revealed a result of 9 pm of reflected wavelength fluctuation and a standard deviation of 0.76 pm.

Rodriguez-Cobo et al. [45] modified a fiber Bragg grating sensor for application in monitoring pressure in the manufacturing of plastic molds, during the compression phase, efficiently monitoring the structural integrity of the manufactured parts as well monitoring deformation while the structure is in operation. The sensor is embedded in composite material and exhibits a linear response to both strain and temperature, rendering it suitable for structural integrity monitoring.

Zaynetdinov et al. [46] constructed Bragg grating sensors with a polyimide coating in order to give the sensors active sensibility in diverse temperature ranges due to the capacity of this compound to be resistant to low and high temperatures (-271 °C to 300 °C), what lead to better sensibility, stability and precision in the detection in the temperature range of -271 °C to 127 °C. The researchers demonstrated as well the possibility of multiplexing, that is, measurements in several points with a single fiber.

Sarkar et al. [47] applied Bragg gratings in sensors for electrical transformers, monitoring online and identifying partial overloads sustained by them, due to the fiber Bragg gratings being composed of a dielectric material dispensing the necessity of an isolation arrangement for insertion in the transformer. The conventional sensors require electrical connections near the measurement locations and amplifiers for transmission of the harvested signals, which is a difficult task for the installation of such sensors. The suggested sensor presented experimental results superior to the conventional ones, presenting higher sensibility and immunity to interferences from the high voltages of transformers.

Osuch et al. [48] investigate the application of tilted Bragg gratings for utilization in sensors of simultaneous measurement of temperature and liquid level. After the modifications with the gratings, the researchers observed that it was possible to identify values in wider coverage ranges, differently from when utilized without the Bragg gratings. The liquid level and temperature in this application can be measured independently, and due to the 3.5° angle of the gratings inserted in the core of the fiber, good sensitivity responses were achieved. The system featured is capable of being applied in the chemical, food and automotive industries; as well, because of its all-fiber structure, in potentially dangerous environments where immunity to electromagnetic fields and electrical insulation is necessary.

Marignetti et al. [49] studied the demonstration of the Bragg's law principle, of an optical fiber operating as an electric field sensor. The system is based in a semiconductor laser diode, emitting light around 1577.5 nm, which interrogates the fiber sensor around its point of maximum reflectivity. The application of an active electrical filed triggers a small variation of the light path length of the waveguide due to electrostriction and, thus, disturbs the wavelength of the reflectivity of the peak of the grating, being necessary a quadratic compensation of the field amplitude.

Sridevi et al. [50] utilized Bragg gratings coated with graphene oxide for detection of nitrogen dioxide (NO2) in low concentrations (0.5 ppm – 3.0 ppm) after the insertion of the Bragg gratings it was observed an improvement in the sensibility of the detector.

Luo et al. [51] developed a sensor for detection of dissolved hydrogen, a byproduct of oil decomposition in transformers, which reveals the necessity de changing the transformer. This sensor utilized Bragg gratings for detection of different ranges of wavelength, to determine the need or not of replacing the transformer.

Bremer et al. [52] unified in a Bragg grating sensor the measurement of 3 parameters: pressure, temperature and refractive index, all measured simultaneously for tabulation systems focused on physicochemical parameters. Moreover, these parameters are essential for the detection of concentrations of chemical products in liquids, which is of great interest in efficient operations.

Lyu et al. [53] proposed a differential pressure sensor with magnetic transference utilizing Bragg gratings where the measurements do not impose direct contact between the sensor and the fluid, the test reveals that the sensor is adequate for measuring pressure in the range of 0-10 kPa with sensibility of 0.0112 nm/kPa, which can be used in locations with high temperatures, strong corrosion and high measures of overload.

Jiang et al. [54] attempted to solve the problem of an explosion in measurements of thermal gas flow caused by conventional electronic sensors. In light of this, they developed a sensor using Bragg gratings for fluid temperature measurement through a heat dissipation unity, substituting conventional photoelectric transducers.

Light in the C band from the amplified spontaneous emission (ASE) light source is divided, with a part being used to heat the coating and the other being used in the signal processing unity. In heating unity, an absorbing layer is introduced to replace the traditional resistance-heating module for minimizing the risk of explosion. The results of measurement demonstrated proper consistency between the difference of flow and temperature in the simulation.

Zhao et al. [55] optimized a conventional flow meter with optical fibers for application in water flow

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measurement (0 m³/h a 22.5 m³/h), utilizing Bragg gratings, they reduced imprecision to almost zero, leaving only 3.6%, in accordance to the resolution of 0.81 m³ demanded by the study. As a result, the addition of the Bragg gratings to the gauge showed several benefits such as good sensibility despite the compact size, a wide range of measurement, simple manufacturing, and minimum pressure losses.

Liu et al. [56] studied and have made possible a new pressure sensor for application in the windings of transformers, this sensor was designed with Bragg gratings and the measurement is monitored in real time, even in different positions the data keeps consistent and with good repeatability, demonstrating the excellent efficiency of the sensor.

Chiu et al. [57] coated a relative air humidity sensor made with Bragg gratings in graphene. After coating, they verified enhanced sensibility and detection of the relative air humidity, evidencing the excellent potential of the Bragg cell for monitoring air moisture.

Bieler et al. [58] due to the constant breakage of motor rotors, developed a magnetic sensor based on Bragg gratings, composed of Terfenol-D particles immersed in epoxy resin to detect broken rods on rotors of induction motors. Regardless of the low cost of an induction motor, production losses caused by a functional failure on the engine can be higher than the price of the motor itself.

The conventional technique has failed to indicate the extent of the damage. In contrast, with the sensor proposed it is possible to distinguish with precision the evolution of the damage on the motor shaft, even in the initial stages of failure. Moreover, for being a fiber optic sensor, it has the capacity of being inert even in systems of a dangerous atmosphere.

Liu et al. [59] applied Bragg gratings in the measurement of cutting force, vital process in machining. In work was implemented a new carbon integrated rotating dynamometer with Bragg gratings, implemented and tested with a cutting effect of four components. Verifying a high sensibility in the four elements as possible.

Leal-júnior et al. [32] evaluated the application of sensors with Bragg gratings in the oil industry due to the production of petroleum also involving the production of water, gas and suspended solids, which are separated from the oil in triphasic separators. They present a description of the problem of the multiphasic level in the petroleum industry and a revision of the current technologies for evaluation of the multi-interface level.

The technique of the Bragg grating sensors presented good chemical stability, intrinsic safety, small size, and multiplexing. The results revealed that the proposed sensor system is capable of measuring the interface level with a relative error of only 2.38%. Furthermore, this sensor system is also capable of measuring the oil density with an error of 0.8 kg/m3.

For better comprehension of the results mentioned in this section, it is presented in Table 3, where are listed, in chronological order, technical data complementary to the articles analyzed. This table possesses data related to the application field, measured variable, type of sensor, sensibility, the range of work, if there is temperature compensation or not, maximum error and the interrogation sensor utilized.

## V. DISCUSSION

In the course of this search and verification of the articles selected for this revision, it was quickly noticed that most of the applications of these sensors are very specific and of experimental nature, evidencing that this technology needs adaptations in the conventional industrial processes. Nevertheless, the superiority of these sensors concerning the conventional ones can be effortlessly perceived, as it was observed in [54], in which the researchers developed an intrinsically safe flow sensor for thermal gas, in other words, explosion-proof, a characteristic that is of extreme importance in industrial processes.

In addition to being intrinsically safe, the Bragg grating sensors carry other significant advantage in relationship to traditional sensors, which is the immunity to electromagnetic interference [47], [49], [58] proved this with the application of these sensors in hydroelectric power plants, electrical generators windings, high voltage transformers, and induction motors respectively.

Another important feature of these sensors is their chemical stability, which favors their application in the measurement of interface level of fluids, especially in the chemical and oil industries. Leal-júnior et al. [32] achieved satisfactory results in measuring the multiphasic level in the oil industry. Whereas Lyu et al. [53], highlights the resistance of the sensor to high corrosion levels when measuring differential pressure in direct contact with the fluid to be probed.

Among all its benefits, the most remarkable one is its multiplexing capability, that is, the potential to measure different parameters as deformation, temperature, vibration, pressure, displacement, among others, with a single fiber or a unique setting, but in various points. This advantage is evidenced in [44], where it was compared with other optical sensors in the measurement of temperature and vibration in the aviation sector.

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*Table 3. Comparison of information from the selected works.*

| Author | Year | Field of Application | Variable Measured | Type of Sensor | Sensibility | Coverage | Temperature Compensation | Maximum Error | Interrogation System |
|---|---|---|---|---|---|---|---|---|---|
| Basumallick *et al.* | 2012 | Experimental | Acceleration | Standard | 450 pm/g | - | No | - | Micron Optics SM130 |
| Werneck *et al.* | 2013 | Electrical Industry | Temperature | Standard | 13 pm/°C | 20 to 85°C | No | 0.007 °C | Spectral Eye 400-FOS&S |
| Jiang *et al.* | 2013 | Aviation and Aerospace Industry | Pressure, Temperature and Vibration | Standard | - | 0 to 103.75 kPa -253 to 150 °C | Yes | 0.1 kPa 0.76 pm | Fabry-Perot Filter |
| Rodriguez- Cobo *et al.* | 2015 | Construction Industry | Pressure | Standard | - | 0 to 0.8 kgf/cm$^2$ | Yes | - | - |
| Zaynetdinov *et al.* | 2015 | Experimental | Temperature | Standard | 6.8 pm/°C | -271.15 to 126.85 °C | No | 8.25% | Micron Optics SM125 |
| Sarkar *et al.* | 2015 | Electrical Industry | Pressure and Temperature | Standard | 1 pm μ ε$^{-1}$ and 10 pm °C$^{-1}$ | > 50 μ ε-1 and 28 to 80 °C | Yes | - | BaySpec's WaveCapture F1360550 |
| Osuch *et al.* | 2016 | Experimental | Level and Temperature | Tilted | -0.456 ± 0.009 dB/mm and 11.4 ± 0.2 pm/° C | 0 to 9 mm and 30 to 60°C | Yes | - | - |
| Marignetti *et al.* | 2016 | Electrical Industry | Electrical Field | Standard | 10 pm/°C | 1 to 20 kV | - | - | Tunable Laser |
| Sridevi *et al.* | 2016 | Experimental | Gas Detection | Standard | 0.8 pm/min | 0.5 to 3 ppm | No | - | Micron Optics SM130 |
| Luo *et al.* | 2016 | Electrical Industry | Hydrogen Detection | Standard | 1.96 (μ/L)/pm | - | Yes | 12% | Micron Optics SM130 |
| Bremer *et al.* | 2017 | Experimental | Pressure, RI and Temperature | Standard | - | 20 to 80 °C | Yes | - | Ando AQ6330 |
| Lyu *et al.* | 2017 | Experimental | Differential Pressure | Standard | 0.0112 nm/kPa | 0 to 10 kPa | - | - | - |
| Jiang *et al.* | 2017 | Experimental | Flow | Standard | 13 pm/°C | - | Yes | - | Fabry-Perot Filter |
| Zhao *et al.* | 2017 | Experimental | Flow | Standard | - | 0 to 22.5 m3/h | No | 0.386% | - |
| Liu *et al.* | 2017 | Electrical Industry | Pressure | Standard | 0.133 pm/kPa | - | Yes | 2.70% | - |
| Chiu *et al.* | 2017 | Experimental | Humidity | Tilted | 0.002 to 0.01 nm/%RH | 20 to 80% RH | Yes | - | - |
| Bieler *et al.* | 2018 | Electrical Industry | Magnetic Detection | Standard | 2.2 με/mT | 50 to 250 mT | Yes | - | Fabry-Perot Filter |
| Liu *et al.* | 2018 | Machining | Force | Standard | 1.067 με/N, 1.080 με/N, 0.148 με/N and 7.861 με/N | - | Yes | 5.35% | - |
| Leal-junior *et al.* | 2018 | Oil Industry | Density Level | Standard | 2.89 pm/cm | - | Yes | Level = 2.38% Density = 0.8 kg/m3 | Micron Optics SM125 |

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Leal-júnior et al. [32] present the possibility of measuring level and density in oil tanks in oil rigs and Bremer et al. [52] who demonstrate a sensor capable of measuring pressure, temperature and refractive index of a fluid in a single point simultaneously.

Alternatively, these sensors, even with these advantages still are not being applied in large scale on the traditional industry, mainly on account of the initial cost of implementation. Although the Bragg grating sensors are not expensive themselves, the interrogation systems still hold high value, compared to the traditional sensors, which readily adapt to the already existent technologies.

Despite being emphasized among the studies mentioned, the problematic implementation of the technology due to the high cost involved, with respect to Bragg gratings for application in temperature measurements, Zaynetdinov et al. [46] and Werneck et al. [60] developed a sensor capable of proportioning parameters as high reliability, multiplexing capacity, fast response time and low cost, based in their existent necessities, both with need of improvements insensibility of acquisition of temperature results.

Another negative factor of the technology of FOS, in general, is the lack of awareness of the technology. As optical fibers are generally utilized in telecommunications [61], when they are mentioned industrial sensors, it comes to mind the image of a fragile fiber which would not have applicability in a hostile environment as industrial. Jiang et al. [44], Osuch et al. [48], Bremer et al. [52], and Werneck et al. [60] make it clear in their work the excellent relationship of Bragg grating sensors and the heavy industrial environment.

## VI. CONCLUSION

It can be concluded that the Bragg grating sensors, among the FOS, are one of the most popular options for measurement of different parameters due to their pure fabrication. In the last years, these sensors were applied in a vast diversity of industrial sensing applications, monitoring the most several variables such as deformation, temperature, pressure, vibration, flow, humidity, among others.

Sensors based on the Bragg technology present numerous advantages if compared to the conventional electrical sensors. As examples may be listed their immunity to electromagnetic interference, they were intrinsically safe, possessing high reliability, multiplexing capability, their fast response time, covering long transmission distances, among others.

In contrast, despite the studies involving Bragg gratings having started in the 1970s, the insertion of these sensors in the industry has been little explored. The main reasons for the slow diffusion of this technology in the market are the lack of awareness, low confidence in this equipment, as it is no standardization in its use, and simplification of measurement systems based on this technology. This consequently generates a considerable expense and limits these sensors to specific applications, as in petrochemical industries, monitoring of structures integrity, chemical analyses and in telecommunications.

So that the Bragg grating sensors can earn more confidence, these must possess the capacity to fit in with the existent control structures. These sensors hold a great potential to substitute the conventional sensors in specific applications where these do not function adequately, or even their installation is not possible, due to certain characteristics as the environment being explosive or with high electromagnetic interference.

The integration of a matrix of fiber sensors in a control system would be a logical first step. A fiber system can be connected to a programmable logic controller (PLC) through a simple interface module. This would eliminate the necessity of additional training, therefore, reducing the costs and the suspicion on this technology, allowing the use of fiber sensors to become a standard engineering practice on industrial processes. Furthermore, this would open the path for almost all types of optical control in the future.

For better integration of these sensors in the industry, qualified professionals are needed both from the area of industrial instrumentation as of telecommunications. The combined work of these two fields is necessary, since most of the concepts of the functionality of these sensors come from telecommunications, although the knowledge of the industry needs comes from industrial instrumentation.

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# Optimization of Tiger Nut Milk Microencapsulation Process: Evaluation of Solubility and Oxidative Stability

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***Abstract***— *The appropriate concentrations of inulin and modified tiger nut starch were evauated in a sequential experimental design to improve the microencapsulation process of tiger nut milk. The stability emulsification index was the response variable studied to evaluate the effectiveness of the microencapsulation process. The concentrations observed through the central composite design (CCD) that most improved the stability emulsification index corresponded to 9.40% inulin and 0.40% modified tiger nut starch. The preservation capacity of the microencapsulated tiger nut milk was evaluated by determining the solubility in water (76%) and oxidative stability (46 h) of the microspheres. The chemical composition indicated important concentrations of protein (5.40%), calcium (191.65 mg / 100 g), carbohydrate (65.10%) and vitamin C (3.17%).*

***Keywords***— ***Microencapsulation; Optimization; Tiger nut starch; Tiger nut milk; oxidative stability, solubility.***

## I. INTRODUCTION

The "tiger nut milk" or "horchata" is a non-alcoholic beverage widely consumed in Spain and some African countries. In recent years,it has been expanding around the world. It has low acidity (6.3-6.8) and high nutritional quality, which increases its marketing potential. This product is rich in starch, oleic acid, linoleic acid, proteins and amino acids, mainly arginine [1-4]. It can be used as flavoring agents for ice creams, bakery products, biscuits, instant soups, and as an alternative source of extract for fermented products such as yoghurt, jams, jelly, beer and liquor [2,5]. Despite being an attractive product for commercializationthe fresh natural tiger nut milk may not be heated above 72 °Cdue to starch jellification, which limits its shelf-life[6]. One way to overcome this problem would be microencapsulation.

Microencapsulation is a technology that allows sensitive ingredients to be physically enveloped in a coating to protect them from adverse reactions, volatile loss or nutritional deterioration[7]In addition, microencapsulation can simplify food manufacturing processes by converting liquids to solid powders and decreaseproduction costs[8].Microencapsulation presents numerous applications in several segments of industry, such as the incorporation of hydrophobic substances into aqueous systems [9]; the masking of unpleasant taste and odor; increase the stability and shelf life.[10,11] Various materials may be used as "wall material" or encapsulating material to produce microspheres. Among these materials are those of natural or semisynthetic origin, such as carbohydrates, proteins,natural gums, esters of cellulose and some lipids[7]

In this work, the optimization of tiger nut milk microencapsulationwith inulin and modified tiger nut starch as wall material was carried out taking into account the oxidative stability and solubility of the microspheresproduced.

## II. MATERIALS AND METHODS

### 2.1 Materials

All reagents and biopolymers used in this work were purchased by Sigma-Aldrich CO., MO, USA.

### 2.2 Tiger nut milk and tiger nut starch

Tiger nuts (*Cyperus esculentus*) with 0.5 to 1.0 cm diameter were obtained in the city of Morros, east of the State capital of Maranhão. The tuber was sanitized with 10% sodium hypochloritesolution (v/v) and then stored in a freezer (- 4° C). Tiger nut milk was obtained after a procedure optimized by COSTA NETO et al. [12]

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with 8 hours of soaking time, 22 °C soaking temperature, 0.20% sodium metabisulphite concentration and 1:1 water proportion. The extraction process was performed according to the procedure described by GURAYA et al.[13].

**2.3 Chemical modification of the tiger nut starch.**

The tiger nut starch was modified by the esterification of the hydroxyls of the starch with the octenyl succinic acid anhydrous (Sigma-Aldrich CO., MO, USA) in alkaline medium according to the procedure described by SONG et al. [14].

**2.4- Microencapsulation of tiger nut milk**

**2.4.1Microencapsulation process**

The microencapsulation process was carried out through lyophilization of tiger nut milkright after the preparation of this beverage and addition of the encapsulating materials in order to avoid any oxidation of its components and / or loss of its microbiological stability. The encapsulants were suspended in tiger nut milk (10 ml) and stirred for 10 min using a magnetic stirrer bar; then frozen in ultra-freezer at -40 °C for 24 h and lyophilized in L101 benchtop freeze-dryer for approximately 48 h. The sample outlet temperature was 25 °C at approximately 77 μmHg.

**2.4.2Evaluation of encapsulating material**

Thecombination of biopolymers tested for tiger nut milk microencapsulation was based in the study of SILVA et al. [15], as follows: 10% arabic gum / 8.5% maltodextrin (AG/MTD);0.6% xanthan gum / 1.0% maltodextrin (XG/MTD);10% inulin (IN) and 10% inulin / 0.5% modified tiger nut starch (IN/TNS). Emulsion index(E.I.) and pH of the reconstituted tiger nut milk(microencapsulated tiger nut milk solubilized in water) were used as parameters to chose the best combination. These parameters were also evaluated for the control, which was the tiger nutmilk lyophilized without any encapsulant.

**2.4.3Optimization of microencapsulation**

Central composite design (CCD) was used to study the individual and synergistic effect ofinulin concentration (Z1) and modified tiger nut starchconcentration (Z2) on microencapsulation process. The CCD was designed with two levels,fourfactorial points, fouraxial points and fivereplicates at the center (13 experiments), reported in Table 1. The response variable was the emusification index (E.I).

*Table 1- Factors and levels studied through a rotational central composite design to evaluate the emulsification index of the microencapsulated tiger nut milk reconstituted in water.*

| Factors * | Levels | | | Axial point (α = 1,41) | |
|---|---|---|---|---|---|
| | -1 | 0 | +1 | - α | + α |
| $Z_1$ (%) | 5.00 | 7.50 | 10.0 | 3.96 | 11.03 |
| $Z_2$ (%) | 0.50 | 0.75 | 1.00 | 0.39 | 1.100 |

* Inulin concentration of inulin (Z1); modified tiger nut starch concentration (Z2)

**2.5Analysis of the microencapsulated tiger nut milk**

**2.5.1 Analytical Methods**

The physicochemical analyses of microencapsulated tiger nut milk composition were performed using the methods described in Official Methods of Analysis of AOAC International [16]. The parameters analyzed included: protein, total carbohydrate, lipid, moisture, ash, calcium, iron content, ascorbic acid, total sugar, reducing sugar and starch.

**2.5.2Solubility**

Solubility of the microcapsules was determined according to the modified methodology described by CANO-CHAUCA et al. [17]. For thisanalysis, 25 ml of distilled water was added to 0.25 g of each sample.The resulting suspension was centrifuged at 900*g* for 5 min. Twenty milliliters of supernatant was placed in a dry, empty Petri dish and taken to an air circulation oven at 105 ºC for 5h, after which was weighed. Empty and dry Petri dishes were weighed before the experiment. The solubility was calculated by the mass difference between the Petri dish with the dryed supernatant and the empty Petri dish and the results are expressed as a percentage of solubility.

**2.5.3Emulsification index (E.I) and pH**

For these analyses, 2.5 g of microencapsulated tiger nutmilk were reconstituted with 10 ml of distilled water in 15 ml test tubes under agitation (magnetic stirrer) for 10 min.

To evaluate the emulsion stabilityof the reconstituted microcapsules in water, emulsification index was determinedwith amodified methodology of FONTES

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et al. [18]. For this analysis, the reconstituted microencapsulated tiger nut milk was left to stand still for 24 h. After this period, the emulsionsizewas measured vertically. The E.I is given as a percentage of emulsified layer height (cm) divided by total height of the liquid column (cm).

The pH of the reconstituted microcapsules in water was determined with a pH meter (Digmed DM-22).

**2.5.4Oxidative stabilitymilk**

Oxidative stability of the microencapsulated tiger nut milkwas analysed according to Rancimat method [19]using Metrohm 743 model Rancimat (Herisau, Switzerland) instrument. Samples of 3 g were analysed under heating block temperature of 110 °C and constant air flow rate of 10 l/h for 70 h. Curves (condutivity *versus* time) obtained by the Rancimat method were evaluated by a graphical tangential method to calculate the induction period (IP), expressed in hours. All determinations were performed in duplicate and the mean value is reported.

## III. RESULTS AND DISCUSSIONS

### 3.1 Evaluation of encapsulating material for microencapsulation

Preliminary tests were conductedto determine thebest encapsulating materials for tiger nut milk. The concentrations and encapsulants initially defined were based on the work of SILVA et al. [15] for oily samples. The encapsulants used were: 10% Arabic gum / 8.5% maltodextrin (AG/MTD); 0.6% xanthan gum / 1.0% maltodextrin (XG/MTD); 10% inulin (IN); and 10% inulin / 0.5% modified tiger nutstarch (IN/TNS).

After lyophilization the control sample (tiger nut milk without encapsulant) featured an oily aspect and a yellow coloration, probably due to oxidation of the lipidic fraction of tiger nut milk. Samples with encapsulant material were less oily and showed a reduced yellow intensity, evidencing that these materials are, in a way, protecting the core material. AG/MTD was the closer to the control sample in visual aspect, followed by XG/MTD and IN.

On the other hand, when inulin was used withmodifiedtiger nut milk (IN/TNS) a white color and absence of oily characteristicswere noted. Therefore, it seems that the encapsulant IN/TNSpresented better results when compared to the other encapsulants studied. However, other paremeters were measured to ensure this result.

The results obtained after the reconstitution of the microencapsulated tiger nut milkin water are displayed in Table 2.It is important to emphasize that the pH value in a range of 6.70 to 7.03 (95%) confirms the freshness of the tiger nutmilk[6]. It was possible to observe that arabic gum with maltodextrine fails in preservingthefreshness (pH < 6.70), oremulsion stability. Three well-defined phaseswere formed as well as a precipitate.

*Table 2 – Parameters obtained for the reconstituted microencapsulated tiger nut milk in water.*

| Encapsulating | pH | Precipitate ** | E.I *** |
|---|---|---|---|
| Control* | 6.23 | (+) | 0.131 |
| AG/MTD | 6.43 | (+) | 0.136 |
| XG/MTD | 7.03 | (+) | 0.991 |
| IN | 6.80 | (+) | 0.850 |
| IN/TNS | 6.80 | (-) | 0.995 |

*No encapsulant material; AG/MTD = 10% Maltodextrin and 8.5% gum arabic; XG/MTD = 0.6% xanthan gum and 1.0% matodextrin; IN = 10% Inulin; IN/TNS = 10% Inulin and 0.5% modified tiger nut starch. ** (+) = present; (-) = absent. *** E.I = emulsification index.

Despite preserving the freshness (pH = 7.03) and having a high stability emulsification index (0.991), the reconstituted tiger nut milk with xanthan gum and maltodextrinpresented high viscosity, possibly due to the presence of xanthan gum. Inulin and inulin with modified tiger nut starch were good encapsulants to preserv freshness ($6.70 \leq pH \leq 7.03$) [6] maintain emulsion stability in comparison to the control. However, a slight precipitation was observed for IN, whichled to choosing IN/TNS for the next step as no precipitate was noted with this sample. It is possible that the hydrophobic fractionof the modified starch favored the micelle formation, whichinteractedwith the oily portion of the milk and allowed a higher emulsification index.

With these result acentral composite design (CCD) was designedto evaluate the optimum concentrations of inulin and modified tiger nut starch regarding the emulsification index (E.I).

### 3.2 Central Composite Design (CCD) to optimize inulin and modified tigernut starch concentrations

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The concentration of inulin ($Z_1$) and modified tiger nut starch ($Z_2$) weredefined as independent variables in a rotational central composite design (CCD) to obtain the highestemulsion stability (dependent variable) for the reconstituted encapsulated tiger nut milk in water.

According to Table 3, the emsulsification index ranged from 0.121 ± 0.03% to 0.998 ± 0.03% with a variance of 8.11%. It is important to emphasizethat the closer to the absolute value 1.00, the greater the emulsion stability. The variance for the response variable was 0.168% at the central point, indicating a significant repeatability of the experiments since it hada value lower than 10%, as described by BOX et al. [20].

*Table 3– Response variables studied by central composite design to evaluate the emulsification index of the microencapsulated reconstituted tiger nut milk.*

| Run | $Z_1$* | $Z_2$ * | E.I (%) ** |
|---|---|---|---|
| 1 | -1(5.000) | -1(0.500) | 0.322 |
| 2 | +1(10.00) | -1(0.500) | 0.720 |
| 3 | -1(5.000) | +1(1.000) | 0.121 |
| 4 | +1(10.00) | +1(1.000) | 0.875 |
| 5 | -1.41(3.964) | 0(0.7500) | 0.122 |
| 6 | +1.41(11.03) | 0(0.7500) | 0.891 |
| 7 | 0(7.500) | -1.41(3.964) | 0.998 |
| 8 | 0(7.500) | +1.41(11.03) | 0.861 |
| 9 | 0(7.500) | 0(0.7500) | 0.676 |
| 10 | 0(7.500) | 0(0.7500) | 0.750 |
| 11 | 0(7.500) | 0(0.7500) | 0.710 |
| 12 | 0(7.500) | 0(0.7500) | 0.750 |
| 13 | 0(7.500) | 0(0.7500) | 0.710 |

* concentration of inulin ($Z_1$); concentration of modified tiger nut starch ($Z_2$); emsulsification index (E.I)

The pareto chart analysis(Figure 1) showed that the independent variables ($Z_1$ and $Z_2$) and itslinear interaction were statistically significant at a significance level of 5% ($p < 0.05$). Only the linear term of the variable $Z_2$ was not statistically significant ($p > 0.05$).

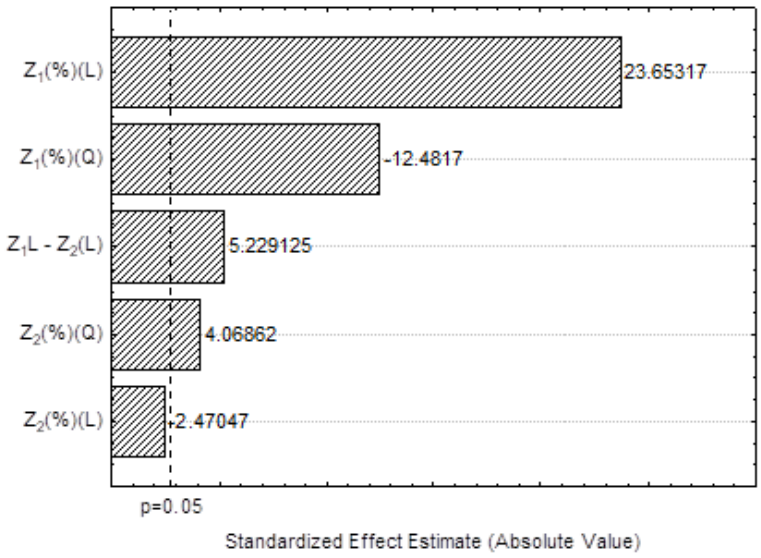


*Fig.1 - Central composite design Pareto chart for the emulsification index of the reconstituted microencapsulated tiger nut milk. Concentration of inulin ($Z_1$) and concentration of modified tiger nut starch ($Z_2$).*

The independent variable that most influenced the response was the linear term of the concentration of inulin ($Z_1$) (L) with a positive effect. The increase in inulin concentration increases the emulsion stability of the reconstituted beverage. The same behavior was observed for the linear interaction between both independent variables ($Z_1$ and $Z_2$) (L-L), emphasizing the synergistic effect of this interaction on the stability of the

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reconstituted milk. However, it is important to emphasizethat concentrations greater than 10% of inulin ($Z_1$) and 1.0% of modified tiger nut starch ($Z_2$) led tothe formation of a biphasic emulsion due to the appearance of a precipitate, which is undesirable for the commercialization of the product. Therefore, it was not possible to evaluate the emulsification index behavior regardinginulin and modified tiger nut starch concentrations at the values indicated in this CCD.

Table 4 summarizes the analysis of variance (ANOVA) performed in order to optimize the best concentrations of inulin and modified tigernut starch in relation to the emulsification index. With those results, an adjusted predictive model ($p < 0.05$) was determined.

*Table 4- Analysis of variance (ANOVA) from the CCD of the model adjusted for the emulsification index of the reconstituted microencapsulated tiger nut milk ($R^2 = 0.900$).*

| Factor* | SS[a] | DF[b] | M.S[c] | F-value[d] | P-value |
|---|---|---|---|---|---|
| $1 - Z_1$ (L) | 0.626609 | 1 | 0.626609 | 559.4723 | **0.000019** |
| $Z_1$ (Q) | 0.174488 | 1 | 0.174488 | 155.7928 | **0.000237** |
| $2 - Z_2$ (L) | 0.006836 | 1 | 0.006836 | 6.1032 | 0.068912 |
| $Z_2$(Q) | 0.018540 | 1 | 0.018540 | 16.5537 | **0.015240** |
| $Z_1L - Z_2L$ | 0.030625 | 1 | 0.030625 | 27.3438 | **0.006388** |
| Lack of fit | 0.088818 | 3 | 0.029606 | 26.4339 | **0.004253** |
| Pure error | 0.004480 | 4 | 0.001120 | | |
| Total SS | 0.968831 | 12 | | | |

*

Concentration of inulin ($Z_1$), Concentration of modified tiger nut starch ($Z_2$); [a]SS: quadratic sum; [b]DF: degrees of freedom; [c]M.S: mean square; [d]Test to compare the model variance with the residual variance (error).

Table 4 results demonstrated a goodcoefficient of determination for the emulsification index ($R^2$ = 90.0%). This value demonstrates a possible significance of the model since itwas unable to explain only 10.0% of the total variations (100%).However, it can be observed that the lack of fit was significant ($p < 0.05$). According to Rodrigues and Iemma [21], the lack of fit is not important in the development of a predictive model when the central point of the associated pure error has alow variability. In order toprove this, Rodrigues and Iemma [21] calculated the error of fit and relative error presented in Equations 1 and 2 regarding the interactionbetween the experimental response and the predicted response ofthe model. These terms are numerical representations of the plotpredicted values versus experimental values.

$$Erroroffit = Y - \hat{Y} \quad (1)$$

$$Relativeerror = \left(\frac{Y - \hat{Y}}{Y}\right) \times 100 \quad (2)$$

Where: Y = experimental response;
$\hat{Y}$ = model response.

Analysingthe results obtained in Table 4 for the emulsification index (E.I, response variable), it can beobserved that the pure error of the model (0.001) was very low, tending to zero. It satisfies the prediction and optimization condition of a significant lack of fit, described by Rodrigues and Iemma [21]. Therefore, it was possible to obtain the model (Equation 3) from real variables based on the ANOVA and the Regression coefficient (0.90).

$$E.I = -0.214 + 0.391Z_1 - 0.026Z_1^2 - 2.41Z_2 + 0.142Z_1.Z_2 \quad (3)$$

After the development of the mathematical model for the emulsification index of the reconstituted tiger nut milk encapsulated by the inulin and modified tiger nut starch, the possibility of prediction and optimization of this model was confirmed bythe results obtained from the error of fit (Equation 1) and relative error (Equation 2). The results are summarized in Table 5.

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*Table 5- Emulsification index values of the reconstituted microencapsulated tiger nut milk predicted by the model and deviations of the CCD.*

| Run | $Z_1$* | $Z_2$* | E.I (%) | E.I pred. | Error of fit | Relative error (%) |
|---|---|---|---|---|---|---|
| 1 | -1(5.000) | -1(0.500) | 0.322 | 0.452 | -0.131 | **-40.543** |
| 2 | +1(10.00) | -1(0.500) | 0.720 | 0.835 | -0.114 | -15.860 |
| 3 | -1(5.000) | +1(1.000) | 0.121 | 0.215 | -0.094 | **-77.300** |
| 4 | +1(10.00) | +1(1.000) | 0.875 | 0.872 | 0.126 | 12.577 |
| 5 | -1.41(3.964) | 0(0.750) | 0.122 | 0.005 | 0.117 | **95.989** |
| 6 | +1.41(11.03) | 0(0.750) | 0.891 | 0.799 | 0.092 | 10.351 |
| 7 | 0(7.500) | -1.41(3.964) | 0.998 | 0.872 | 0.126 | 12.577 |
| 8 | 0(7.500) | +1.41(11.03) | 0.861 | 0.782 | 0.080 | 9.255 |
| 9 | 0(7.500) | 0(0.750) | 0.676 | 0.782 | 0.080 | 9.255 |
| 10 | 0(7.500) | 0(0.750) | 0.711 | 0.723 | 0.034 | 4.539 |
| 11 | 0(7.500) | 0(0.750) | 0.758 | 0.723 | -0.012 | -1.755 |
| 12 | 0(7.500) | 0(0.750) | 0.758 | 0.723 | 0.034 | 4.539 |
| 13 | 0(7.500) | 0(0.750) | 0.715 | 0.723 | -0.012 | -1.755 |

* Concentration of inulin ($Z_1$); Concentration of modified tiger nut starch ($Z_2$); emulsification index (E.I); Experimental emulsification index (E.I); Predicted emulsification index (E.I pred.)

Table 5 demonstrates that the relative errors were low in the desired region where the emulsification index is maximized.Relative errors inferior to 20% are considered satisfactory, according to Rodrigues and Iemma [21]. This result corroborates with the very low value of the pure error (0.001), confirming the possibility of developing a predictive model to optimize the emulsification index even if it presented a significant lack of fit ($p < 0.05$). However, runs 1, 3 and 5 had higher relative errors, respectively -40.543%, -77.300% and 95.989%, which presented lower emulsification index values: 0.322, 0.121 and 0.122 respectively. This proves that the model did not adjust to concentrations equal to or lower than 5.0% of inulin but the prediction and optimization capacity of the model was not affected[21]. In addition, the experimental conditionof 3.964% ($\alpha = -1.41$) of inulin (run 5) was the most critical, confirming that the microencapsulated tiger nut milk did not show an emulsion stability in low concentrations of inulin. Moreover, it is possible to confirm that the response variable inulin concentration was the main factor in the CCD due to its greatest effect already observed in the Figure 1.

Therefore, the mathematical model was used to optimize the concentrations of inulin and modified starch and to obtain the response surface,represented in Figure 2.

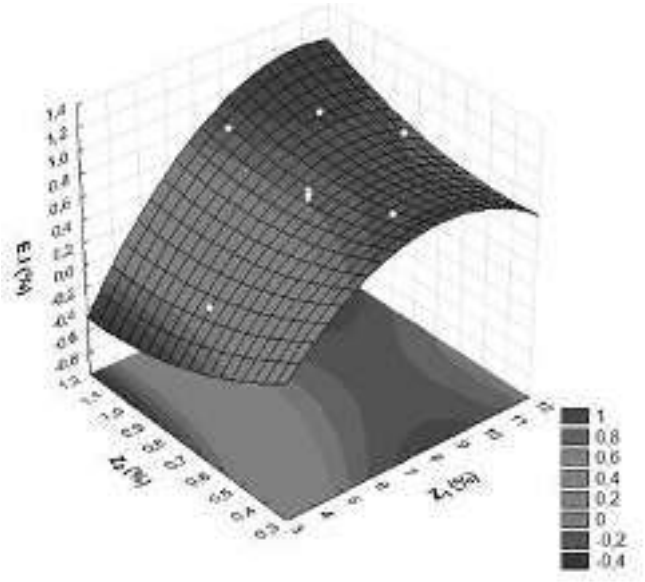


*Fig.2 - Response surface for the emulsification index (E.I) of the reconstituted microencapsulated tiger nut milk with inulin ($Z_1$) and modified tiger nut starch ($Z_2$).*

It can be observed that the stability of tiger nut milk increase with low concentrations of modified tiger nut starch ($Z_2$) and higher concentrations of inulin ($Z_1$). The optimum concentrations of inulin ($Z_1$) and modified tiger nut starch ($Z_2$) were 9.40% and 0.40%, respectively.

**3.3 Chemical composition of microencapsulated tiger nut milk**

After the microencapsulation process with the blend of inulin (9.40%) and modified tiger nut starch

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(0.40%), the microencapsulated tiger nut milk showed a tendency towards a white color with a sandy aspectand high solubility in water. The reconstituted microencapsulated milk also presenteda tendency for white coloration, as the fresh tiger nut milk.The chemical composition of the microencapsulated tiger nut milkis displayed in Table 6.

*Table 6 - Chemical composition of the microencapsulated tiger nut milk with 9.4% of inulin and 0.4% of modified tiger nut starch.*

| Compounds | Microencapsulated tiger nut milk (%) |
|---|---|
| Starch | 30.20±0.06 |
| Reducing sugar | 16.80±0.04 |
| Total sugar | 33.60±0.03 |
| Moisture | 4.70±0.03 |
| Ash | 1.10±0.05 |
| Lipid | 23.70±0.02 |
| Protein | 5.40±0.01 |
| Total carbohydrate | 65.10±0.04 |
| Iron * | 1.84±0.02 |
| calcium * | 191.65±0.03 |
| Vitamin C * | 3.17±0.05 |

* Values expressed in mg/100g

The microencapsulated tiger nut milkwas composed mainly of starch, total sugar, lipid, calcium and carbohydrate. This is associated with the biological origin of the tiger nut (tuber) [5,22,23]and the possible influence of the encapsulants used in the microencapsulation process of this milk.The moisture content is in agreement with products of this nature.

The presence of inulin as microencapsulationmaterial favoredthe beverage food functionality, increasing its potential in the food industry mainly for sports and therapeutic purposes[5,6]

**3.4 Solubility of the microencapsulated tiger nut milk**

Figure 3 shows no significant variation (p = 0.073) (t test) in the solubility of thetiger nut milk microspheresover 60 days. The solubility during this period ranged between73.0±0.15% and76.3±0.10%. This demonstrated an evident stability of tiger nutmilk microsphere solubility over the studied period. In addition, it is important to note that the freeze-drying process (-50 °C) (lyophilization) did not affect the solubility of these microspheres. This result suggests that the microencapsulation process using the blend of inulin andmodified tigernut starch occurred satisfactorily.

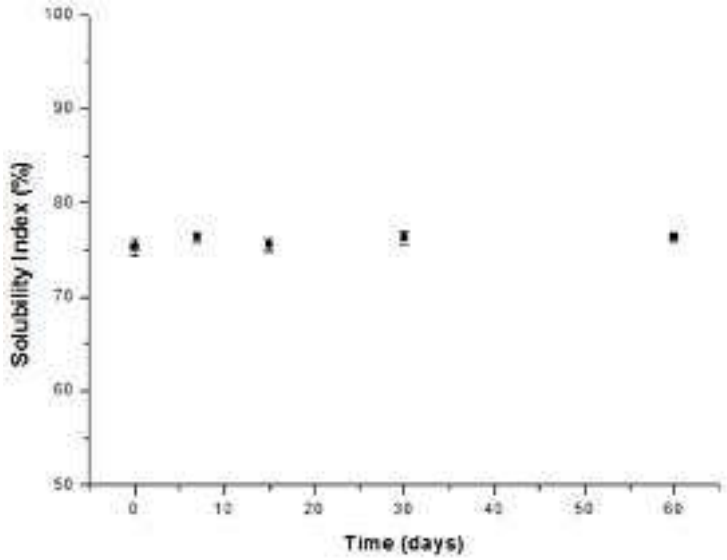


*Fig.3 - Solubility of the tiger nut milk microencapsulated with 9.4% of inulin and 0.4% of modified tiger nut starch over 60 days.*

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Moreover, it is important to note that the solubility value obtainedfor these microspheresobtainedwithinulin (9.40%) and modified tiger nutstarch (0.40%) was similar to the results obtained by LACERDAet al.[24]. The researchers found solubilitiesof 76.8 to 85.0% for jussara pulp microsphere using inulin and matodextrin as encapsulants via spray drying.

Other similar results were obtained by FAZAELI et al. [25] using arabic gum and matodextrin (77-85% of solubility) as encapsulants; bySANTOS et al. [26] using arabic gum and porous granules of rice starch and gelatin (77.01-78.33% of solubility); byCASTRO et al. [27] using cashew gum and arabic gum (76.22%). Furthermore, microencapsulation processes using arabic gum presented higher values of solubilities due to their branched structure, which causes their structural folding and allow rapid reconstitution of the microencapsulated in water [27].

### 3.5 Oxidative stability (volatile acids) of the microencapsulated tiger nut milk

For the determination of the oxidative stability of the tiger nut milkmicrospheres obtained with 9.4% of inulin and 0.4% of modified tiger nut starch, the conductometry technique was used, which is based on the record of the conductivity variations of the distilled water from the collection of low molecular weight acids obtained after forced oxidation of the sample [28].

The oxidative stability presentedin Figures 4(a) and 4(b), shows that the microsphere undergoes oxidation from the induction time of 46 hours at 15 $\mu S.cm^{-1}$.

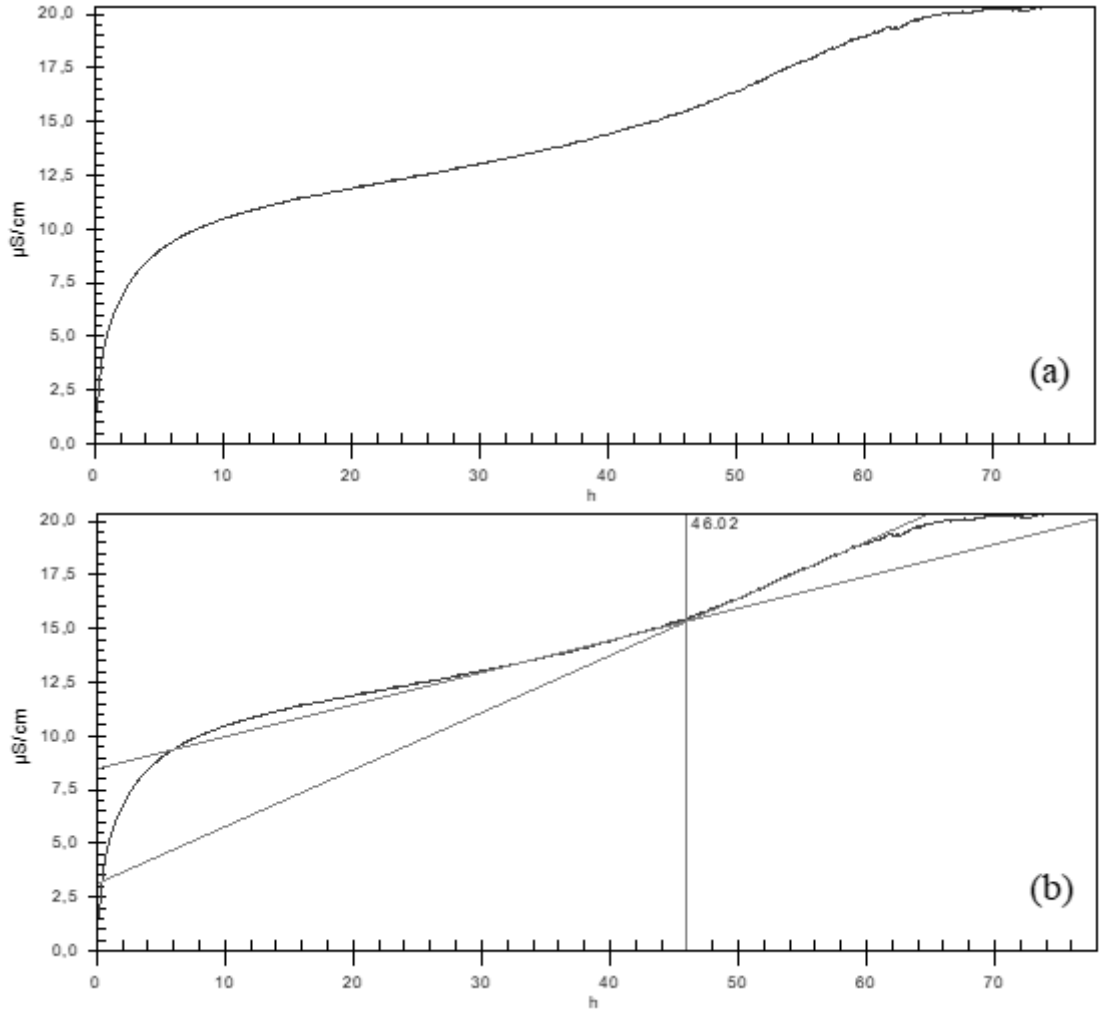


*Fig.4 - Oxidative stability of microencapsulated tiger nut milk with 9.4% of inulin and 0.4% of modified tiger nut starch: (a) evolution of the oxidation process; (b) determination of the time in which the microspheres underwent the oxidation process.*
* The Curve refers to the oxidation process; ** Cross-sectional diagonal lines refer to the point of intersection which comprises oxidation of the microspheres; *** Vertical line refers to the induction time for lipid oxidation of the microspheres

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The induction time of 46 hours for lipid oxidation of the microsphere indicated that the encapsulation using inulin (9.40%) and modified tiger nut starch(0.40%) was able to protect the active material from oxidation for 46 hours. After this time, the microspheres were completely oxidized.

It should be emphasized that oleic acid is the most abundant oil in tiger nut[29].Soybean milk, which is also rich in oleic acid, has an induction time of 5.2 hours to undergo the oxidation process [30].Therefore, it shows that the encapsulation process was of greatimportance to maintainthe nutritional quality of the tiger nut milk.

## IV. CONCLUSION

The blend of inulin and modified tiger nut starch was more suitable for the microencapsulation process of tiger nut milk. The best concentrations of inulin and modified tiger nut starch to microencapsulate tiger nut milk via lyophilization were: 9.40 and 0.40 % respectively.

The microencapsulated tiger nut milkpresented prebiotic characteristics as a function of the insertion of inulin as an encapsulant. This was important sinceit amplified the intrinsic nutritional potential of this milk. Microencapsulation was paramount for the oxidative processes to occur slowly and to maintain an excellentsolubility during a 60–daystorage.

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# Comparison of Three Gravimetric-Geometric Geoid Models for Best Local Geoid Model of Benin City, Nigeria

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***Abstract***— *The conversion of geometric as well as ellipsoidal heights from GNSS observations to practical heights for engineering constructions has necessitated the determination of the local geoid model of areas. Benin City is a developing area which requires a local geoid model for conversion of geometric heights to orthometric heights for physical developments in the area. This paper is on the best local geoid model of Benin City, Nigeria by comparing three gravimetric-geometric geoid models of the study area. GNSS and gravimetric observations were carried out on 49 points to respectively obtain their coordinates and absolute gravity values. The theoretical gravity values of the points were computed on the Clarke 1880 ellipsoid, subtracted from the absolute gravity values and corrected for the air (free air) to obtain the free air gravity anomalies of the points. The computed free air gravity anomalies were applied to compute the geoid heights of the points using the integration of the modified Stokes integral. Three geometric geoid surfaces (plane, second degree and third degree surfaces) were fitted to the computed gravimetric geoid heights using the least squares technique to obtain the gravimetric-geometric geoid models of the study area. The RMSE of the three gravimetric-geometric geoid models were computed to determine their (the models) accuracy. The three gravimetric-geometric geoid models were compared using their accuracy to obtain the most suitable geoid model of the study area. The results of the comparison showed that the third degree gravimetric-geometric geoid model is most suitable for application in the study area. It is recommended that ellipsoidal heights obtained from GNSS observation within Benin City, Nigeria should be converted to orthometric heights using the third degree geoid model.*

***Keywords***—***gravimetric, geometric, local, geoid, model.***

## I. INTRODUCTION

The Geoid is one of the Earth's shapes. Geoid surface is used to approximate the physical shape of the Earth. It is the equipotential surface of the Earth's gravity field which more or less coincides with mean sea level (Borge, 2013). Ubajekwe (2011) also defined the geoid as the equipotential surface of the earth's attraction and rotation which coincides on average with the mean sea level in the open Ocean. It is the surface which coincides with the mean sea level assuming that the sea was free to flow under the land in small frictionless channels. Ubajekwe (2011) explained further that the mean sea level is not quite an equipotential surface owing to non-gravitational forces (such as ocean currents, winds and barometric pressure variation). In geodetic surveying, the computation of the geodetic coordinates of points is commonly performed on a reference ellipsoid closely approximating the size and shape of the earth in the area of the survey. The actual measurements made on the surface of the earth with certain instruments are however referred to the geoid. Moritz and Hofmann (2005) stated that the geoid coincides with that surface to which the oceans would conform over the entire earth if free to adjust to the combined effect of the earth mass attraction (gravitation) and the centrifugal force of the earth's rotation. They also explained that the geoid is a surface along which the gravity potential is everywhere equal and to which the direction of gravity is always perpendicular when optical instruments containing gravity reference levelling devices are properly adjusted during observation coincides with the direction of gravity and are therefore perpendicular to the geoid. The angle between the plumb line which is perpendicular to the geoid (the vertical) and the perpendicular to the ellipsoid (the ellipsoidal normal) is defined as the deflection of the vertical. Civil engineers use the geoid as the reference surface for elevations while oceanographers use it for studies of ocean circulation, currents and tides. It is also valuable to geophysicists for displacement studies, geophysical interpretation of the Earth's crust, and prospecting (Borge, 2013).

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The GNSS ellipsoidal height is a geometric height which is obtained with reference to the ellipsoid. The ellipsoidal height is not suitable for engineering work as it is not a practical height determined with respect to the geoid. Nowadays, most geodetic observations are carried out with GNSS receivers. The spirit levelling, on the other hand, is time-consuming and applying it over long distances may reduce the reliability of the measurements. But there is a relation, as well as a link between the ellipsoidal height and the orthometric height. The link between the ellipsoidal and the orthometric heights is the geoid height. In other words, if the geoid and the ellipsoidal heights of a point are known, the orthometric height of the point is computed using the relation given by Eteje *et al.* (2018) and Oluyori *et al.* (2018) as:

$$h = H + N \quad (1)$$

Where,

h = Ellipsoidal height; H = Orthometric height; N = Geoid height

The relationship between the heights is further explained using the three reference surfaces (the ellipsoid, the geoid and the earth surface). The ellipsoidal height is determined with respect to the reference ellipsoid; the orthometric height is obtained with respect to the geoid while the observations are carried out on the earth surface. The ellipsoidal height is the vertical distance measured from the surface of the ellipsoid along the normal to the observation point on the earth surface while the orthometric height is the vertical distance measured from the geoid along the vertical, as well as the plumbline direction to the observation point on the earth surface. Figure 1 shows the relationship between the three reference surfaces, as well as the ellipsoidal, orthometric and the geoid heights (Eteje *et al.,* 2018)

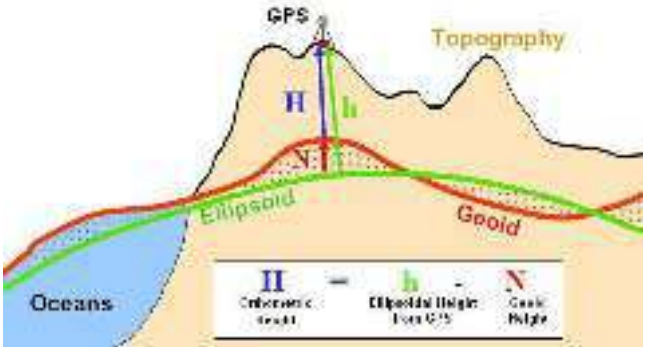


*Fig. 1: Relationship between Orthometric, Geoid and Ellipsoidal Heights*

Source: Eteje *et al.* (2018)

The geoid can be determined using various methods such as the gravimetric, geometric, Astro-geodetic, transformation and gravimetric-geometric methods amongst others.

The gravimetric method can be carried out by the well-known Stokes-integral, equation (2) and the use of accurately determined absolute gravity data (Heiskanen and Moritz, 1967, Eteje, 2015 and Eteje *et al.,* 2018).

$$N = \frac{R}{4\pi\gamma}\iint_{\sigma}\Delta g S(\psi)d\sigma \quad (2)$$

Where $N$ is geoid undulation, $\Delta g$ is gravity anomaly, $S(\psi)$ is stokes function, $\gamma$ is normal gravity on the reference ellipsoid and $R$ is mean radius of the earth. The geometric method is to use the known "geoid heights" at some points, which are derived from co-located GNSS-determined heights and levelled heights to interpolate the geoid heights at other points (Chen, and Luo, 2004). The interpolation of the geoid heights at any other point involves the use of interpolation models such as bicubic model and other models like multiquadratic model, etc. In Astro-geodetic method of geoid determination, the geoid heights of points are determined with reference to a geodetic (reference) station whose geoid height is known. The geoid heights differences between points are determined using the components of deflection of the gravity vector which can be obtained by carrying out astronomical and geodetic observations. The astronomical observation is carried out to determine the astronomical coordinates (astronomical latitude, $\Phi$ and astronomical longitude, $\Lambda$ ) by observing stars. The geodetic observation is used to determine the geodetic latitude, $\varphi$, geodetic longitude, $\lambda$ and ellipsoidal heights, $h$ as well as the azimuths, $\alpha$ and geodetic distances, $\ell$ between network points. Using the astronomical and geodetic coordinates, the components of deflection of the gravity vector can be computed. The transformation method involves the use of the well-known Euclidean similarity transformation model which is used to convert Cartesian coordinates between two geodetic reference frames that generally differ in terms of three translation parameters (tx, ty, tz), three orientation parameters (εx, εy, εz) and a factor of uniform spatial scale change (δs) (Eteje *et al*., 2018).

The gravimetric-geometric method has to do with the use of gravimetrically and geometrically obtained data. That is the combination of the gravimetric and the geometric methods. Here, the geoid heights of selected points are determined with the gravimetric method and a geometric surface is fitted to the gravimetric geoid heights to enable the interpolation of geoid heights of points of interest. Usually, two or more geometric surfaces are fitted to the geoid heights of the points and the Root Mean Square Error (RMSE), as well as the standard error of each of the models, is computed and compared to obtain the

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most suitable model for application in the study area. The fitting of the geometric surfaces to the gravimetric geoid heights requires the computation of the model parameters, as well as coefficients using the least squares technique. The computed model parameters and the coordinates of the points are used to develop a program for the implementation of the model in the study area. The RMSE and as well as the reliabilities of the models are obtained by comparing the results from physical measurements carried out on some selected points with their corresponding results from the determined geoid models.

Benin City, Nigeria is the capital of Edo State. It is a developing area where massive roads constructions are presently ongoing. As stated earlier, most observations are being carried out using GNSS receivers. Some of the preliminary surveys used for the design of the roads were carried out using Real-Time Kinematic GNSS observation technique. The heights obtained from the observations were ellipsoidal heights and they were used without converting them to orthometric heights. This is because there has not been a local geoid model of Benin City, Nigeria. Orthometric heights are required in engineering constructions to decide on suitable gradients to direct the flow of water at various levels of proposed constructions. With orthometric height water can flow from one point to another while with ellipsoidal height, it is not possible. Today, the Benin City, Nigeria is facing a serious flood problem. Several attempts have been made to solve this problem but there has not been headway as the height differences between points relative to the geoid as the mean sea level has not been properly established. This study determines and compares three gravimetric-geometric geoid models to decide on the best local geoid model of Benin City, Nigeria.

### 1.1 The Study Area

Benin City, Nigeria is a City approximately 40 kilometres north of the Benin River. The City is also linked by roads to Asaba, Sapele, Siluko, Okene, and Ubiaja and is served by air and the Niger River delta ports of Koko and Sapele. The City is made up of three Local Government Areas, Oredo LGA, Ikpoba Okha LGA and Egor LGA. It has a total population of 1,749,316 according to 2019 NPC projection. It covers a total area of about 1,204 km². Benin City is bounded by UTM zone 31 coordinates 660000mN and 712500mN, and 770000mE and 815000mE. Figures 2a and b show the maps of the study area.


*Fig. 2a: Map of Edo State*


*Fig. 2b: Map of Benin City*

Source: Ministry of Lands and Surveys, Benin City

### 1.2 Normal Gravity Computation

The normal, as well as the latitude gravity, is computed on a specified ellipsoid. Eteje *et al*. (2018) gave the model for the computation of the theoretical gravity on
the Clarke 1880 ellipsoid as

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$$g_{T\,Clarke1880\,(B)} = 9.78051938\begin{pmatrix}1+0.005247463\sin^2\varphi\\-0.000008795\sin^2 2\varphi\end{pmatrix}\text{ms}^{-2} \quad (3)$$

Where,

$g_{T\,Clarke1880}$ = Theoretical gravity on the Clarke 1880 ellipsoid

$\varphi$ = Station latitude

### 1.3 Gravity Anomaly

The gravity anomaly, $\Delta g$, is the difference between the observed gravity value ($g$) reduced to the geoid, and a normal, or theoretical, computed gravity value ($\gamma_o$) at the mean earth ellipsoid, where, the actual gravity potential on the geoid equal the normal gravity potential at the ellipsoid, at the projection of the same terrain point on the geoid and the ellipsoid respectively, that is (Dawod, 1998 and Eteje *et al.*, 2019)

$$\Delta g = g - \gamma_o \quad (4)$$

Considering the nature of the topography of the earth surface, which is irregular in shape, there are two basic types of gravity anomalies (free air and Bouguer anomalies). In this study, it was only the free air correction that was applied. That is free air gravity anomalies that were used.

### 1.4 Free Air Correction

This is the first step for reducing topography effects. It simply corrects for the change in the elevation of the gravity meter, considering only air (hence a free-air) being between the meter and selected datum. According to Aziz *et al.* (2010), this correction is added to the observed gravity because the increased radial distance of the station from the centre of the Earth results in a lower observed gravity value than if the station were at the local datum. The formula to calculate the magnitude of the reduction in practice is given by Eteje *et al.* (2019) as

$$g_{FA} = -\frac{2g}{r}H_s = -308.6H\mu Gal = -0.3086HmGal \quad (5)$$

Where,

$H$ = Station orthometric height in metres

$g$ = Mean value of gravity (980500 mGal)

$r$ = Mean radius of the Earth

### 1.5 Integration of Stokes's Formula

According to Eteje *et al.* (2018), using the modified Stokes integral given in equation (2), the geoid heights of points are computed if their gravity anomalies and geographic coordinates are known. Featherstone and Olliver (1997) gave the integration of equation (2) as

$$N = \frac{r\Delta g}{8\gamma}\begin{pmatrix}-6\sin^2\psi_o\ln\left\{\sin\left(\frac{\psi_o}{2}\right)+\sin^2\left(\frac{\psi_o}{2}\right)\right\}+16\sin\left(\frac{\psi_o}{2}\right)+12\sin^2\left(\frac{\psi_o}{2}\right)\\-24\sin^3\left(\frac{\psi_o}{2}\right)-12\sin^4\left(\frac{\psi_o}{2}\right)-4\cos\psi_o+5\cos 2\psi_o-1\end{pmatrix} \quad (6)$$

Where $N$ is the geoidal height of individual point, $\psi_o$ is the surface spherical radius, $\gamma$ is the theoretical as well as normal gravity, $\Delta g$ is the gravity anomaly and $r = R$ is the mean radius of the earth.

### 1.6 Computation of Surface Spherical Radius, $\psi_o$

The surface spherical radius, $\psi_o$ is computed as (Shrivastava *et al.*, 2015)

$$\cos\psi = \sin\varphi\sin\varphi^1 + \cos\varphi\cos\varphi^1\cos(\lambda^1 - \lambda) \quad (7)$$

Where,

$\varphi$ = Mean latitude of the points

$\varphi^1$ = Latitude of individual point

$\lambda$ = Mean longitude of the points

$\lambda^1$ = Longitude of individual point

### 1.7 Computation of Combined Topographic Effect

To obtain a precise geoid height of a point, the combined topographic effect is calculated and applied to the computed geoid height of the point. The formula for the computation of the combined topographic effect, $\delta N_{Comb}^{Topo}$ is given as (Sjöberg, 2000 and Kuczynska-Siehien *et al.*, 2016):

$$\delta N_{Comb}^{Topo} = -\frac{2\pi G\rho}{\gamma}\left[H^2 + \frac{2}{3R}H^2\right] \quad (8)$$

where $G$ is the earth gravitational constant, $\rho$ is density, $R$ is the mean radius of the earth and $H$ is the orthometric height of observation point which can be obtained from the DTM of the area.

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### 1.8 Geometric Geoid Surfaces

According to Eteje *et al.* (2018), geometric geoid surfaces are mathematical interpolation surfaces fitted to geoid heights to enable geoid heights of new points to be determined using variable such as geographic or rectangular coordinates of the points. These surfaces include plane surface, bi-linear surface, second degree surface, third degree polynomial and fifth degree polynomial. Eteje *et al.* (2018) further explained that the surface to be adopted as well as the degree and order of the polynomial depends on the size of the study area and the variation of the geoid heights. For a small area, the plane surface is used, for a relatively large area, the second and third order polynomial surfaces are used.

### 1.9 Plane Surface

The plane surface as given by Odumosu *et al* (2016) is

$$N = (h - H) = N_o + N_1 e + N_2 n + \delta_N \quad (9)$$

The least squares solution to equation (9) can be further mathematically expressed as (Odumosu *et al*, 2016):

$$(h - H) = N_o + N_1 e + N_2 n \quad (10)$$

$$(H) = h - N_o - N_1 e - N_2 n \quad (11)$$

$$(h - H) = (1 \;\; e \;\; n)\begin{pmatrix} N_O \\ N_1 \\ N_2 \end{pmatrix} \quad (12)$$

Where X is the required parameters $= \begin{pmatrix} N_O \\ N_1 \\ N_2 \end{pmatrix}$, $e$ and $n$ are respectively easting and northing coordinates of the selected points.

### 1.10 Polynomial Surface

The polynomial surface for local geoid heights interpolation given by Kirici and Sisman (2017) and Oluyori *et al.* (2018) is

$$N_{(x,y)} = \sum_{i=0}^{m} \sum_{\substack{j=k-i \\ i=0}}^{k} a_{ij} x^i y^j \quad (13)$$

Where,

$a_{ij}$ = Polynomial coefficients

$m$ = Degree of polynomial

$x, y$ = Plan coordinates of points

In applying the polynomial, the degree should be chosen and the polynomial should be formed for the chosen degree. Kirici and Sisman (2017) gave the third degree polynomial as

$$N = a_{00} + a_{10}X + a_{01}Y + a_{20}X^2 + a_{11}XY + a_{02}Y^2 + a_{30}X^3 + a_{21}X^2Y + a_{12}XY^2 + a_{03}Y^3 \quad (14)$$

Also, Sanlioglu *et al.* (2009) gave the second degree polynomial, Multi-quadratic model as:

$$N = a_0 + a_1X + a_2Y + a_3X^2 + a_4Y^2 + a_5XY + a_6X^2Y + a_7XY^2 + a_8X^2Y^2 \quad 15)$$

Where,

$Y = ABS(y - y_o)$

$X = ABS(x - x_o)$

$y$ = Northing coordinate of observed station

$x$ = Easting coordinate of observed station

$y_o$ = Northing coordinate of the origin (average of the northing coordinates)

$x_o$ = Easting coordinate of the origin (average of the easting coordinates)

### 1.11 Observation Equation Method of Least Squares Adjustment

The fitting of the polynomial interpolation surface to a set of geoid heights requires the model parameters (variable coefficients) to be computed. The computation of these coefficients is done by observation equation method of least squares adjustment technique. The functional relationship between adjusted observations and the adjusted parameters as given by Eteje and Oduyebo (2018) is:

$$L_a = F(X_a) \quad (16)$$

Where $L_a$ = adjusted observations and $X_a$ = adjusted parameters. Equation (16) is a linear function and the general observation equation model was obtained. The system of observation equations is presented by matrix notation as (Ono *et al.,* 2018):

$$V = AX - L \quad (17)$$

Where,

$A$ = Design Matrix,

$X$ = Vector of Unknowns

$L$ = Observation Matrix.

$V$ = Residual Matrix

The residual, $V$ which is the difference between the estimate and the observed is usually useful when applying least squares adjustment technique for the determination of geoid heights interpolation model parameters since it is

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equal to the difference between the model geoid heights and the computed geoid heights from GNSS observations and spirit levelling of the points. So, it can be used as a check. The unknown/model parameter is computed as (Oluyori *et al.,* 2019)

$$X = (A^T A)^{-1} A^T L \quad (18)$$

Where,

$(A^T A)^{-1}$ = Inverse of the normal matrix

The step by step procedures for the computation of the polynomial interpolation model Coefficients ( $a_{mn}$ ) of the variables (*x, y*) are detailed in Eteje and Oduyebo (2018).

**1.12 Accuracy of the Model**

The accuracy of the gravimetric-geometric geoid models is obtained using the Root Mean Square Error, RMSE index. To compute the accuracy of the model, the geoid heights of the selected points from the geoid model are compared with their corresponding gravimetric geoid heights to obtain the geoid height residuals. The geoid height residuals and the total number of the selected points are used for the computation of the RMSE, as well as the accuracy of the model. The Root Mean Square Error, RMSE index for the computation of the gravimetric-geometric geoid model accuracy as given by Yilmaz and Kozlu (2018) is

$$RMSE = \pm\sqrt{\frac{1}{n}\sum_{i=1}^{n}(\delta N_{\text{Residual}})^2} \quad (19)$$

Where,

$\delta N_{\text{Residual}} = N_{\text{Computed}} - N_{\text{Model}})$

$N_{\text{Computed}}$ = Gravimetric Geoid Height

$N_{\text{Model}}$ = Gravimetric-Geometric Geoid Height

n = Number of Points

## II. METHODOLOGY

The methodology was divided into data acquisition, data processing and results presentation and analysis. Figure 3 shows the flow chart of the adopted methodology.

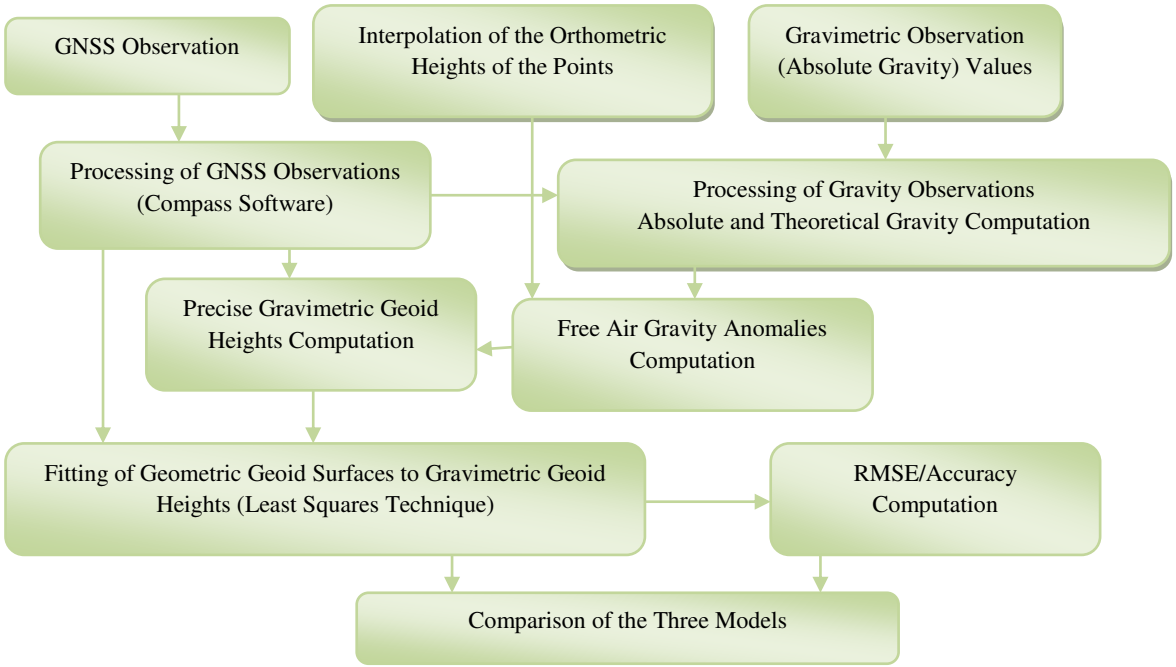


*Fig 3: Flow Chart of the Adopted Methodology*

**2.1 Data Acquisition**

A total of 49 points were used in the study. The points included two primary control stations (XSU 92 and XSU 100 were respectively located in Edo College and School of Nursing premises). The points were selected along the major roads of the City (See Figure 4). GNSS observation was carried out using CHC 900 dual-frequency GNSS receivers to obtain the coordinates and ellipsoidal heights of the points. The observations were carried out relative to control station XSU 92 using the static method of GNSS observation (See Figures 5 and 6).

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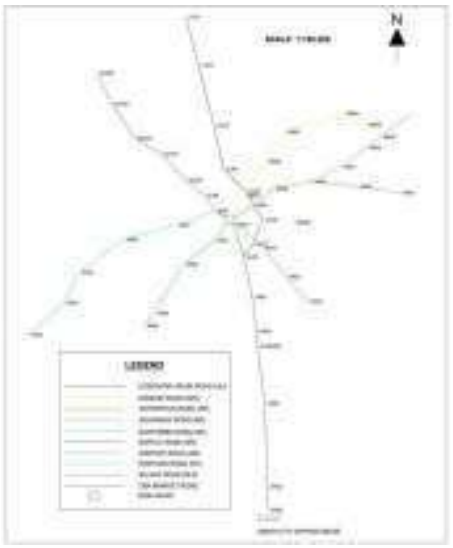

*Fig 4: Selected GPS and Gravity Points*


*Fig. 5: Base Receiver at Control Station XSU92*


*Fig. 6: Rover Receiver at One of the Points (RR01) at Ring Road*

The selected points were observed with a gravimeter (SCINTREX CG-5 Autograv Gravimeter) to obtain their absolute gravity values. The observation was carried out by an expert, a Geophysicist from Mountain Top University, Ibafo, Ogun State. The gravity observation of the points was carried out in seven different loops relative to a point whose absolute gravity value was known which was located within the Benin City Airport premises (See Figures 7 and 8).


*Fig. 7: Gravimeter Set over Reference Station at Benin City Airport*


*Fig. 8: Gravimeter at Control Station XSU92*

### 2.2 Data Processing

The GNSS observations were respectively downloaded and processed with HcLoader and Compass Post-processing software to obtain the positions and the ellipsoidal heights of the points. The geographic and rectangular coordinates, as well as the ellipsoidal heights of the points, were processed in Minna datum. The gravity observations of the points were processed by the expert who carried out the observations to obtain their absolute gravity values. All the necessary corrections such as drift correction, etc were applied during the processing. The theoretical gravity values of the points were computed on the local (Minna) datum ellipsoid (Clarke 1880 ellipsoid) using the latitude coordinates of the points, as well as equation (3). The gravity anomalies of the points were computed by finding the differences between the absolute gravity values of the points and their corresponding theoretical gravity values, as well as using equation (4). The computation of the free air correction requires the application of the orthometric heights of the points. And these were obtained by interpolation using the orthometric heights and the absolute gravity values of the two primary

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control stations (XSU 100 and XSU 96). The orthometric heights of the points were interpolated as there was no Digital Terrain Model (DTM) of the study area. The free air correction was applied to the computed gravity anomalies of the points using equation (5). The free air and the Bouguer gravity anomalies of the points were computed but the free air gravity anomalies were used in the study. This is because the geoid heights of the two primary control stations obtained from their known orthometric and ellipsoidal heights approximated the geoid heights of the stations computed using the free-air gravity anomalies, as well as equation (6). The gravimetric geoid heights of the points were computed with the geographic coordinates, free air gravity anomalies and the theoretical gravity values of the points using equation (6). The computation of the gravimetric geoid heights of the points required the application of the spherical radius and it was computed using equation (7). The computed gravimetric geoid heights of the points using equation (6) were co-geoid heights. To obtain precise gravimetric geoid heights of the points, the combined topographic effect has to be computed and applied to the co-geoid heights. The combined topographic effect was computed using equation (8). To obtain the best gravimetric-geometric geoid model of Benin City, three geometric geoid surfaces (plane surface, equation (9), second degree surface, equation (10) and third degree surface, equation (11)) were fitted to the gravimetric geoid heights of the points. The fitting of the geometric geoid surfaces to gravimetric geoid heights of the points requires the computation of the model parameters using the least squares adjustment technique. The models' parameters were computed using equation (18). Microsoft Excel programs were developed with the computed models' parameters. The RMSE, as well as the accuracy of the models, were respectively computed with equations (19).

## III. RESULTS PRESENTATION AND ANALYSIS

### 3.1 Analysis of the GNSS Observation Results

The DGPS observation was carried out to obtain the coordinates and the ellipsoidal heights of the selected points. The DGPS observations were processed using Compass post-processing software. From the processing of the DGPS observations results, it was seen that the processed observations passed both the Network Adjustment Test and the $\chi$-Square (Chi-square) Test. This implies that the normal matrix generated was a regular one and inverted accordingly for the calculation of residuals.

### 3.2 Analysis of the Gravimetric-Geometric Geoid Models

Table 1 presents the gravimetric geoid heights; the three gravimetric-geometric geoid models (plane, second degree and third degree surfaces/models) heights and their respective RMSE while Figure10 shows the plot of the RMSE of the three gravimetric-geometric geoid models. This was done to determine which of the three gravimetric-geometric geoid models is most suitable for application in the study area. The smaller the RMSE, the better the gravimetric-geometric geoid model. It is seen from Table 1 and Figure 10 that the RMSE of the plane surface, second degree surface, and the third degree surface models are respectively 0.9839m, 0.7126m and 0.6746m which shows that the third degree gravimetric-geometric geoid model is most suitable for application in the study area. It can also be seen from Table 1 that the minimum and the maximum geoid heights from the third degree surface gravimetric-geometric geoid model are respectively 1.002m and 3.760m. This shows that geoid heights can be interpolated with the chosen (third degree surface gravimetric-geometric) geoid model within the range of 1.002m to 3.760m in Benin City, Nigeria.

*Table 1: Gravimetric Geoid Heights, the Three Gravimetric-geometric Geoid Models heights and their Absolute Differences between the Gravimetric Geoid heights*

| POINT | GRAVIMETRIC GEOID HEIGHT (m) (A) | MODEL GEOID HEIGHT | | | DIFF. B/W (A) & (B) (m) SQUARED | DIFF. B/W (A) & (C) (m) SQUARED | DIFF. B/W (A) & (D) (m) SQUARED |
|---|---|---|---|---|---|---|---|
| | | PLANE SURFACE (m) (B) | SECOND DEGREE (m) (C) | THIRD DEGREE (m) (D) | | | |
| XSU92 | 2.086 | 2.386 | 0.749 | 1.072 | 0.0900 | 1.7876 | 1.0282 |
| RR01 | 2.420 | 2.069 | 1.456 | 2.257 | 0.1232 | 0.9293 | 0.0266 |
| SR01 | 1.588 | 1.989 | 1.607 | 2.275 | 0.1608 | 0.0004 | 0.4720 |
| SR02 | 1.978 | 1.927 | 1.791 | 2.209 | 0.0026 | 0.0350 | 0.0534 |
| SR04 | 2.520 | 1.799 | 2.504 | 3.260 | 0.5198 | 0.0003 | 0.5476 |
| SR05 | 2.802 | 1.614 | 3.266 | 3.445 | 1.4113 | 0.2153 | 0.4134 |
| SR06 | 3.266 | 1.560 | 3.442 | 2.961 | 2.9104 | 0.0310 | 0.0930 |
| XSU100 | 2.098 | 1.897 | 1.872 | 2.214 | 0.0404 | 0.0511 | 0.0135 |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AR01 | 0.685 | 1.922 | 1.239 | 1.240 | 1.5302 | 0.3069 | 0.3080 |
| AR02 | 0.720 | 1.698 | 1.343 | 1.082 | 0.9565 | 0.3881 | 0.1310 |
| AR03 | 1.436 | 1.425 | 2.452 | 2.233 | 0.0001 | 1.0323 | 0.6352 |
| AR04 | 1.439 | 1.342 | 2.827 | 2.658 | 0.0094 | 1.9265 | 1.4860 |
| UU01 | 4.658 | 2.307 | 3.880 | 3.667 | 5.5272 | 0.6053 | 0.9821 |
| UU02 | 3.498 | 2.259 | 2.527 | 2.905 | 1.5351 | 0.9428 | 0.3516 |
| UU03 | 1.981 | 2.197 | 1.680 | 1.761 | 0.0467 | 0.0906 | 0.0484 |
| UU04 | 1.276 | 2.142 | 1.538 | 1.407 | 0.7500 | 0.0686 | 0.0172 |
| UU05 | 1.346 | 2.208 | 1.429 | 1.330 | 0.7430 | 0.0069 | 0.0003 |
| UU06 | 1.489 | 2.228 | 0.940 | 1.175 | 0.5461 | 0.3014 | 0.0986 |
| UU07 | 1.329 | 2.122 | 1.253 | 1.197 | 0.6288 | 0.0058 | 0.0174 |
| UU08 | 1.263 | 2.039 | 1.469 | 1.374 | 0.6022 | 0.0424 | 0.0123 |
| AD01 | 2.986 | 2.777 | 2.171 | 2.299 | 0.0437 | 0.6642 | 0.4720 |
| AD02 | 4.019 | 2.956 | 2.839 | 3.041 | 1.1300 | 1.3924 | 0.9565 |
| AD03 | 4.420 | 3.059 | 3.103 | 3.321 | 1.8523 | 1.7345 | 1.2078 |
| AK01 | 1.376 | 2.217 | 1.211 | 1.211 | 0.7073 | 0.0272 | 0.0272 |
| AK02 | 1.473 | 2.360 | 1.242 | 1.002 | 0.7868 | 0.0534 | 0.2218 |
| AK03 | 2.252 | 2.583 | 1.503 | 1.463 | 0.1096 | 0.5610 | 0.6225 |
| AK04 | 3.101 | 2.816 | 2.240 | 2.485 | 0.0812 | 0.7413 | 0.3795 |
| AK05 | 3.954 | 3.026 | 3.615 | 3.283 | 0.8612 | 0.1149 | 0.4502 |
| MR01 | 1.300 | 2.191 | 1.415 | 1.372 | 0.7939 | 0.0132 | 0.0052 |
| MR02 | 1.488 | 2.386 | 1.560 | 1.220 | 0.8064 | 0.0052 | 0.0718 |
| MR03 | 1.614 | 2.561 | 2.115 | 1.786 | 0.8968 | 0.2510 | 0.0296 |
| MR04 | 4.037 | 2.919 | 3.119 | 3.146 | 1.2499 | 0.8427 | 0.7939 |
| MR05 | 4.313 | 3.010 | 3.069 | 3.302 | 1.6978 | 1.5475 | 1.0221 |
| SK01 | 1.500 | 2.163 | 1.193 | 1.043 | 0.4396 | 0.0942 | 0.2088 |
| SK02 | 2.035 | 2.219 | 1.542 | 1.233 | 0.0339 | 0.2430 | 0.6432 |
| SK03 | 2.379 | 2.275 | 2.161 | 1.931 | 0.0108 | 0.0475 | 0.2007 |
| EKS | 0.665 | 2.001 | 1.204 | 1.325 | 1.7849 | 0.2905 | 0.4356 |
| SLK0 | 0.668 | 1.978 | 1.222 | 1.051 | 1.7161 | 0.3069 | 0.1467 |
| SLK01 | 0.781 | 1.915 | 1.345 | 1.067 | 1.2860 | 0.3181 | 0.0818 |
| SLK02 | 1.326 | 1.846 | 1.942 | 1.716 | 0.2704 | 0.3795 | 0.1521 |
| SLK03 | 1.736 | 1.745 | 2.537 | 2.506 | 0.0001 | 0.6416 | 0.5929 |
| SLK04 | 2.688 | 1.702 | 3.314 | 3.431 | 0.9722 | 0.3919 | 0.5520 |
| SLK05 | 3.357 | 1.699 | 3.555 | 3.760 | 2.7490 | 0.0392 | 0.1624 |
| EK01 | 0.078 | 1.757 | 0.776 | 1.043 | 2.8190 | 0.4872 | 0.9312 |
| EK02 | 0.983 | 1.439 | 1.643 | 2.010 | 0.2079 | 0.4356 | 1.0547 |
| EK03 | 1.729 | 1.124 | 3.160 | 3.156 | 0.3660 | 2.0478 | 2.0363 |
| EK04 | 2.001 | 0.969 | 3.389 | 3.344 | 1.0650 | 1.9265 | 1.8036 |
| EK05 | 2.516 | 0.701 | 2.480 | 2.247 | 3.2942 | 0.0013 | 0.0724 |
| AIRPORT | 0.578 | 1.705 | 1.298 | 1.058 | 1.2701 | 0.5184 | 0.2304 |
| | | | | **RMSE =** | **0.9839** | **0.7126** | **0.6746** |

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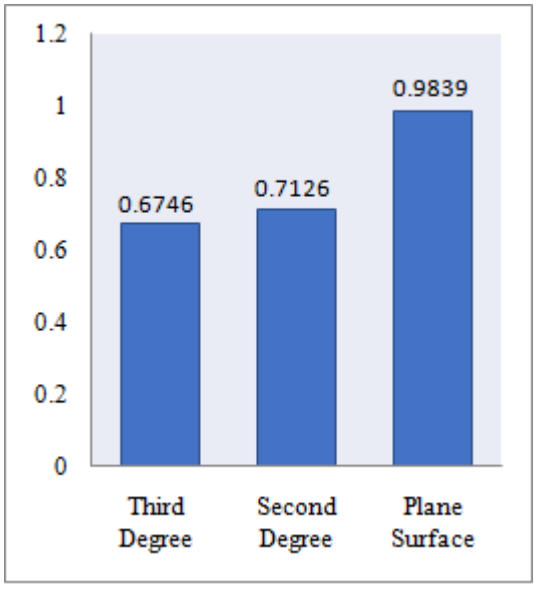


*Fig 10: Plot of RMSE of the three Gravimetric-Geometric Geoid Models*

Figures 11a to 11d respectively show the surface plots of the gravimetric, third degree surface gravimetric-geometric, second degree surface gravimetric-geometric and the plane surface gravimetric-geometric geoid heights of the selected points. This was done to present graphically the shape of the gravimetric geoid heights and those of the three gravimetric-geometric geoid models to determine which of the three gravimetric-geometric geoid models shape is most identical with the gravimetric geoid heights shape by comparing the three gravimetric-geometric geoid models shapes with that of the gravimetric heights. Comparing the three gravimetric-geometric geoid models shapes with that of the gravimetric geoid heights also enables the determination of which of the three gravimetric-geometric geoid models is most suitable for application in the study area. It can be seen from Figures 11a to 11d that the shape of the third degree surface gravimetric-geometric geoid model is most identical with that of the gravimetric geoid heights. This also implies that the third degree surface gravimetric-geometric geoid model is most suitable for application in the study area.

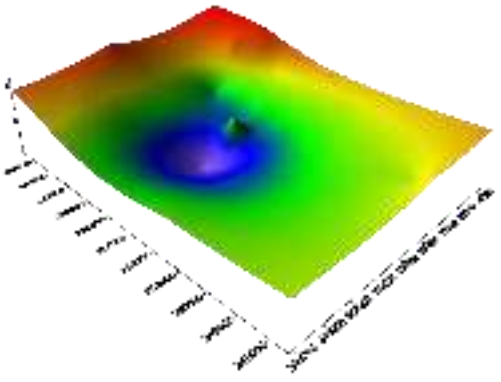

Fig 11a: Surface Plot of Gravimetric Geoid Heights

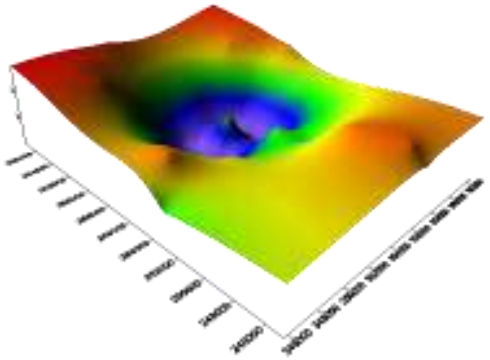

Fig 11b: Surface Plot of Third Degree Gravimetric-Geometric Model Geoid Heights

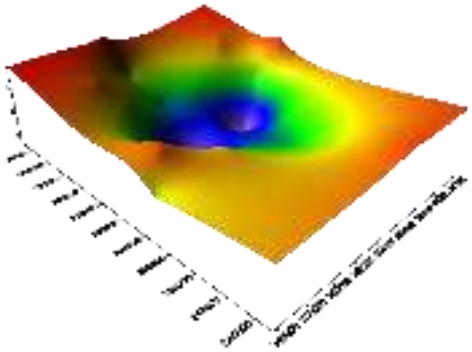

Fig 11c: Surface Plot of Second Degree Gravimetric-Geometric Model Geoid Heights

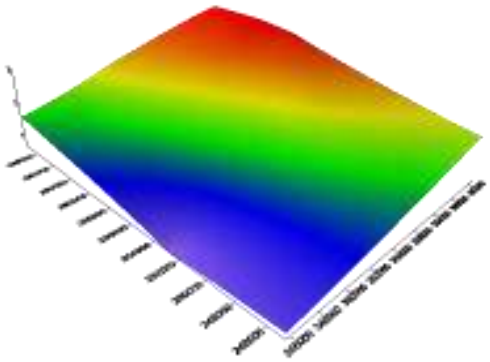

Fig 11d: Plot of Plane Surface Gravimetric-Geometric Model Geoid Heights

## IV. CONCLUSIONS AND RECOMMENDATIONS

1. The study has established the local geoid model of Benin City, Nigeria from the combination of gravimetric and geometric methods of geoid determination.
2. The determined geoid model was termed local geoid model as the absolute gravity values used were obtained from gravimetric observations carried out physically in the study area and as their respective theoretical gravity values were computed on the

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local ellipsoid adopted for geodetic computation in the study area.

3. The gravimetric-geometric geoid models were obtained by fitting three geometric geoid surfaces to the computed gravimetric geoid heights using the least squares technique.
4. The accuracy of the three gravimetric-geometric geoid models was obtained by computing their respective RMSE.
5. The third degree surface gravimetric-geometric geoid model is recommended for application in Benin City, Nigeria as it has the highest accuracy among the three gravimetric-geometric geoid models.
6. A Microsoft Excel program was developed for full implementation of the determined geoid model in the study area.
7. It is recommended that whenever ellipsoidal heights obtained from GNSS observations within Benin City, Nigeria are to be converted to practical, as well as orthometric heights, the determined geoid model should be applied.
8. It is also recommended that the use of assumed, as well as handheld GPS receiver heights for engineering works should be totally abolished as this study has established the local geoid model of Benin City.

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# Analysis of the hydraulic characteristics of bamboo tubes, using the brazilian bamboo - species Bambusa vulgaris var. vittata

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***Abstract*****—** *With the growing repercussion of the impact of the use of plastic, there was the need for replacement of this material in several sectors of the economy. Among these is the civil construction industry, which has been innovating the types of materials used in conventional construction methods. Aiming at these adaptations, this study proposes to analyze the feasibility of using bamboo as a hydraulic conductor, justifying its application, especially in the communities of the interior of the state of Amazonas, where the arrival of inputs is hindered by long distances and deficient means of transportation. Bamboo samples were extracted and submitted to laboratory tests where a hydraulic system was assembled in order to determine the flow and pressure loss of the bamboo. The system relied on the use of PVC pipes and connections. To read the pressure drop and the flow rate, hoses and a hydrometer were used, respectively, where at one end there was a pump responsible for the functioning of the system and at the other end, a water tank was closed, both belonging to the hydraulic laboratory of the Federal Institute of Amazonas. The data collected in the test were analyzed and used in the Hazen-Williams equation that resulted in the coefficient of roughness C which, for the bamboo, the value obtained was 103.15. Through the study developed, it is possible to design and apply bamboo pipes according to the ABNT NBR-5626 criteria.*

***Keywords*****—** ***Bamboo, Bambusa vulgaris var. vittata, hydraulic, hydrosanitary installations, pressure drop.***

## I. INTRODUCTION

It has long been observed that the issue of sustainability is discussed in Brazil and, in this context, the need arose to study alternative methods and materials that would cause less impact on the environment. In this context, we highlight civil construction as a technical area concerned with the development of the study of natural resources and renewable sources, using unconventional and recyclable raw materials, enabling economy and modernizing the constructive processes already known.

A good alternative is the use of vegetal origin materials such as bamboo - light, resistant, rigid and versatile vegetal [14]. Thanks to its easy adaptation in most of the Brazilian territory, its rapid growth and the possibility of cultivating it in areas unfit for agriculture, protecting the soil from erosion, bamboo would be an alternative for its use, either in irrigation and drainage water supply or in wastewater supply [8]. Because it presents advantages such as accelerated growth, ease of planting and handling, and accessible acquisition value, bamboo can be used to replace PVC pipes used in hydrosanitary installations.

In Brazil, the most common exotic species are Bambusa vulgaris, Bambusa vulgaris var. vittata, Bambusa tuldoides and Dendrocalamus giganteus, all Asian origin brought by Portuguese colonizers and, later, the genus Phyllostachys [11]. We highlight the species found in abundance in the state of Amazonas is *Bambusa vulgaris var. vittata* known as bamboo-imperial or bamboo-Brazilian, which has the hardness and resistance as physical characteristics.

The study of the hydraulic behavior of bamboo in the Amazon region is lacking in information, therefore the objective of this study is to analyze the pressure loss, flow and roughness coefficient of bamboo-imperial pipes - *Bambusa vulgaris var. vittata* - using the Hazen-Williams equation and obtaining the data through laboratory tests in order to verify its hydraulic performance in comparison to PVC pipes.

## II. METHODOLOGY

The research was of the experimental field type and quantitative approach in order to obtain the results and answers about the problematization presented in this work.

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The study was divided into three stages. The first is based on the definition of bibliographic research through primary sources, as well as technical reports, dissertations and published articles. The second is to select bamboo samples for the study, defining a pattern of choice and determining, through laboratory tests, the pressure drop and roughness established by the Hazen-Williams equation. After data analysis, the last step was to compare the data obtained from bamboo with the pertinent data to the PVC pipes, represented by graphs and tables.

**2.1 Place of research and laboratory tests**

The laboratory tests were carried out at the Hydraulics Laboratory of the Federal Institute of Education, Science and Technology of Amazonas - IFAM, where the assembly of the system and the tests to determine the pressure loss and flow of bamboo pipes were performed.

**2.2 Bamboo Extraction Site**

The sample of bamboos was taken from a predominantly residential region of the eastern zone of the city of Manaus.

**2.3 Sample extraction and cleaning of nodes**

The extraction of bamboo was performed with the aid of an axe, in which four samples of bamboo were cut above the first thatched, as shown in figure 1. Due to the objective of this study to propose the use of bamboo as a conductor for building systems, it was then decided to use diameters approximately 40 mm, a diameter widely used in water-sanitary installations.

As the body of the bamboo is born with a larger diameter and as it grows it becomes thinner, when extracting the bamboo it was opted to use the upper stalks because they are close to the diameter planned for the system. This decision affected the length that became 1.5 m, diverging from the desired length of 3.0 m.

After the extraction, the removal of the nodes was performed manually with the aid of an iron bar with sharp edges. Then, the excess of internal diaphragm of the bamboo was removed, presenting a treatment like what would be done in the interior of the Amazon, as shown in Fig. 2.

*Fig.1: Bamboo extraction. Figure 2: Bamboo interior after cleaning the knots Bamboo interior after cleaning the knots. Source: Author.*

**2.4 Diameter Determination**

With the samples present in the laboratory, the second stage of the research to determine the diameter was initiated. The chosen method was to fill the bamboo with water and pour it into a beaker. Through the liquid level it was possible to read the volume (mL). After collecting the volumes for all samples, the values obtained in the equation presented below were applied, allowing to know the mean internal diameter of each one;

$$(1)\mathrm{Dm} = \frac{\sqrt{(4 \times \mathrm{VOL})}}{\sqrt{(\pi \times \mathrm{L})}}$$

Dm = average inner diameter of bamboo tube [m];
Vol = Inner Volume of Bamboo Tube [m3];
L = Bamboo Tube Length [m].

**2.5 Determination of pressure drop**

2.5.1 Materials Used

In order to determine the flow rate and the pressure drop, a system was created which had the following materials available:

Water meter ¾";
Water tank 410 L and pump belonging to Hidro Didactic machine;
Threadable plastic hose adapter ½";
Hose ½" 10 m;
4 bamboo samples 1.5 m with external Ø ≈ 40 mm;
PVC tube Ø 40 mm;
2 Flexive Hose 10 cm Ø = 2";
2 Clamp Ø = 2";
Register;
4 Tee with reduction 40x25 mm;
4 Bushing of 25x20 mm;
4 Threadable gloves of 20x ½";
2 Threadable gloves of 25x ¾";

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2 bushings of 40x25 mm;
5 knees Ø 40 mm;
Thread sealing tape;
Preparing solution;
Plastic adhesive for PVC.

2.5.2 System assembly

The process of assembling the system began with the welding of PVC pipes and fittings. At first the section of the tube to be welded was sanded, then the prepared solution was passed, and the plastic adhesive was applied finishing the welding, according to Fig. 3, 4 and 5.

*Fig.3: Plastic preparation and adhesive solution for PVC. Source: author.*

*Fig.4: Application of the solution. Source: author.*

*Fig.5: Adhesive application. Source: author.*

After assembly of the assembly frame, the bamboo sample was fitted with a flexible sleeve and clamps for attachment. With the sample inserted, the tests were started after connecting the system to the pump. The compound worked as follows: the pump threw water into the system, which rose through the first hose (ha) determining the first water column and so on. Through the difference between the water columns, it was determined the pressure loss of the bamboo (ha-hb) and the pvc (hc-hd) for the presented conditions. Then, the water flow followed in the direction of the hydrometer, promoting the reading of the flow and, later, led to the water tank that closed the system. The same process was repeated for all samples. For each sample, the AB and BA directions were analyzed for better visualization of the bamboo behavior, as shown in the following results.

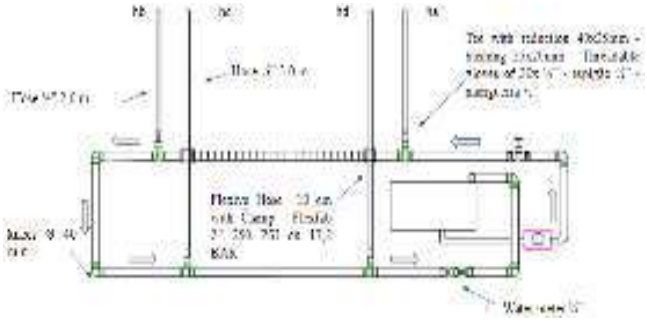

*Fig.6: Scheme of the system detailing the connections used (the arrows indicate the flow of water). Source: author.*

*Fig.7: Real image of the test system, showing the machine used in the IFAM laboratory.*

**2.6 Bamboo roughness**

With the values obtained - diameter, pressure loss and flow - it was possible to calculate the roughness coefficient of the bamboo using the Hazen-Williams equation;

$$(2)\ hf_{bamboo} = \frac{10{,}646 \times L \times Q^{1{,}85}}{C^{1{,}85} \times Dm^{4{,}87}}$$

hf bamboo = Pressure drop in bamboo tube [m];
L = Tube length [m];
Q = Flow rate [m3/s];
Dm = Average bamboo tube inside diameter [m];

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C = Coefficient of roughness.

## III. RESULTS AND DISCUSSIONS

At the end of the trial, the data were collected and subsequently treated. As previously mentioned, the samples were tested in AB and BA directions for better visualization of the bamboo behavior. The following tables show the results obtained in the field. The value for the coefficient (C) was obtained in calculation using the Hazen-Williams equation.

*Table 1. Field data for direction AB. C value obtained through equation (2).*

| Sample | Dm(mm) | Q (m³/s) | Hf (m) | C |
|---|---|---|---|---|
| 01 | 32 | 0,00052 | 0,09 | 73,6 |
| 02 | 29 | 0,00052 | 0,12 | 81,6 |
| 03 | 34 | 0,00052 | 0,047 | 89,1 |
| 04 | 32 | 0,00040 | 0,021 | 124,3 |

*Table 2. Field data for direction BA. C value obtained through equation (2).*

| Sample | Dm(mm) | Q (m³/s) | Hf (m) | C |
|---|---|---|---|---|
| 01 | 32 | 0,00052 | 0,05 | 101,1 |
| 02 | 29 | 0,00052 | 0,103 | 89,1 |
| 03 | 34 | 0,00052 | 0,015 | 165,2 |
| 04 | 32 | 0,00040 | 0,03 | 102,5 |

From the co-effectors, a mean coefficient Cm was extracted in order to compare the performance of the bamboo and the PVC tube for the conditions analyzed.

*Table 3. Mean coefficient of bamboo samples for AB and BA directions.*

| CmAB | CmBA | C PVC |
|---|---|---|
| 92,15 | 114,48 | 140 |

With the values of Cm it was possible to relate the pressure loss to different flow values as presented in the tables and graphs below.

*Table 4. Comparison of pressure drop between PVC and bamboo - AB.*

| Q (m³/s) | JPVC (m/m) | JBamboo (m/m) |
|---|---|---|
| 0,00015 | 0,0025 | 0,0059 |
| 0,00021 | 0,0047 | 0,0111 |
| 0,00029 | 0,0086 | 0,0201 |
| 0,00033 | 0,0109 | 0,0256 |
| 0,00038 | 0,0142 | 0,0332 |
| 0,00042 | 0,0171 | 0,0400 |
| 0,00045 | 0,0194 | 0,0454 |
| 0,00050 | 0,0236 | 0,0552 |
| 0,00052 | 0,0254 | 0,0593 |

*Table 5. Comparison of pressure drop between PVC and bamboo – BA.*

| Q (m³/s) | JPVC (m/m) | JBamboo (m/m) |
|---|---|---|
| 0,00015 | 0,0025 | 0,0040 |
| 0,00021 | 0,0047 | 0,0074 |
| 0,00029 | 0,0086 | 0,0135 |
| 0,00033 | 0,0109 | 0,0171 |
| 0,00038 | 0,0142 | 0,0222 |
| 0,00042 | 0,0171 | 0,0267 |
| 0,00045 | 0,0194 | 0,0304 |
| 0,00050 | 0,0236 | 0,0369 |
| 0,00052 | 0,0254 | 0,0397 |

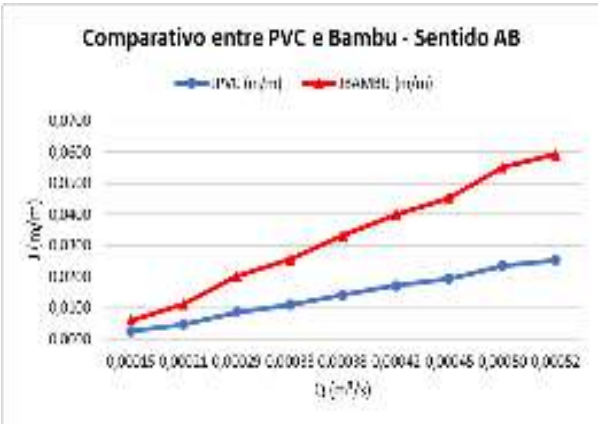


*Fig.8. Comparison of pressure drop in direction* AB.

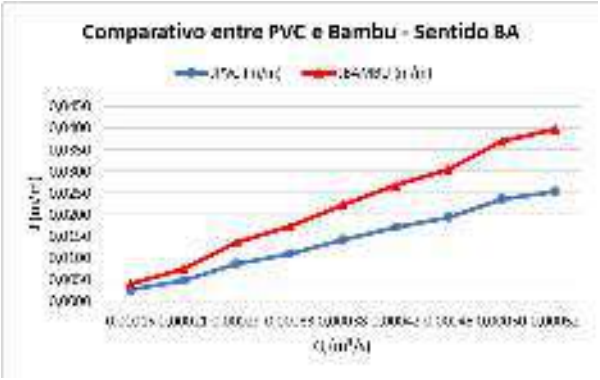


*Fig.9. Comparison of pressure drop in direction BA.*

## IV. CONCLUSION

By means of the results presented, it is possible to conclude that the mean of the coefficient C, considering the value found for CmAB and CmBA, is equivalent to 103.315 which represents 73.80% of the PVC coefficient. This result, when compared to the C of the PVC tube, proved to be lower and can be justified by the initial treatment performed in the cleaning of the nodes, which was done manually and rustically, simulating the procedure to be performed in riverside communities of the Amazon. With the determination of the coefficient of roughness C for the bamboo, it is possible to verify the

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design of pipes using this material by the criteria of NBR-5626, with respect to the loss of load.

From this scenario, the study serves as a reference for future studies both in the application of bamboo as a hydraulic conductor in a real situation and in the analysis of the hydraulic characteristics for another bamboo species, in comparison with the bamboo species 'vulgaris' vittata.

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# Association between Income and Self-Perception of Health with Life Satisfaction of life of seniors in Corresidence

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***Abstract*** *— Due to the aging process, new family arrangements have emerged, one of which is that of co-residence, which may be related to several factors for the elderly, such as their health and financial conditions. Thus, the aim of this study is to analyze the relationship between income, self-perception of health and life satisfaction in elderly co-residents. The study design will be cross-sectional, population-based and quantitative approach. The study participants were 239 elderly in co-residence situation. For data collection, we used the adapted Brazil old age Schedule questionnaire and the Health Status questionnaire. The analysis used Pearson's chi-square test, with significance set at 5%. The results of the crossover of data between self-perceived health and life satisfaction of the sample,, revealed that positive cases of self-rated health are correlated with higher frequencies of life satisfaction (p = 0.02). From the study, it was concluded that the elderly living in co-residence are satisfied with the family arrangement in which they live, thus directly influencing their own perception of their health.*

***Keyword*** *— **Self image. Old man. Relationship between generations. Income. Personal satisfaction.***

## I. INTRODUCTION

Population aging has been growing progressive and steadily all over the world, a fact that initially occurred in developed countries and more recently gained great space in developing countries [1]. According to the Brazilian Institute of Geography and Statistics - IBGE (2019), the Brazilian population is made up of 209,635,403 million people, and the number of elderly people ( ≥ 60 years old) has been gradually increasing over the years. In 2012, the population aged 60 and over was 25.4 million, while in 2017 it was 30.2 million, otherwise there was an 18% growth in this age group in this short period of time. Of this total, women represent 16.9 million (56% of the elderly ), while men are 13.3 million (44% of the elderly) (IBGE, 2018).

This constant growth of the elderly population can be mainly explained by the reduction in fertility, the increase in the number of families that chose not to have children, and also by the improvement of life expectancy and quality of life. As a result of the aging process, changes occur in perceptible aspects of the organism in relation to the physical, psychological and emotional, as well as changes in social, economic and cultural factors, such as the organization of families, since they are also aging, having the presence of at least one elderly person within the family, resulting in various forms of family arrangements, one of which is that of co-residence, which refers to the cohabitation between elderly with children and / or grandchildren in the same home space [2].

The family is seen as a supportive host, being the main source of care, support and protection [3]. Thus, co-residence between the elderly and their families may be related to several factors for the elderly, such as health and financial conditions, in which they receive the necessary

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care that may be offered by their families. For younger people, co-residence may be the result of difficulties in entering the labor market, which may lead to dependence on the income of the elderly [4].

In this context, intergenerational living can bring with it several benefits of improving the living conditions of the elderly and their families, as it represents a means of sharing care, affection, assistance, protection, besides allowing the division of expenses, playing a role important in income variations of parents and children, bringing greater savings and reduced spending [5]. However, this conviviality may not be beneficial when it presents conflicts, due to divergences of ideas and worldviews because they are individuals from different times. Moreover, it may also occur that co-residence does not guarantee the necessary support in times of difficulties for the elderly, thus becoming an unwanted family arrangement [6].

It is important to highlight that the World Health Organization (WHO) (2005) [7] emphasizes the importance of intergenerational coexistence for the health and well-being of the elderly, because, at this stage, these individuals present many pathologies associated with physiological changes that the process of senescence. teases naturally. Being close to their family members, the elderly have more careful care with their health and greater care, which directly interferes with their satisfaction and quality of life.

Understanding the importance of how the elderly are inserted in the family arrangement of co-residence and how this interaction and its characteristics may or may not impact their health is fundamental. This will facilitate the improvement of care for this public, as well as the elaboration of public policies and actions for health promotion and prevention by professionals in the area, in order to reach this whole population within this family dynamics. Nevertheless, it will enable a greater knowledge on the subject, favoring the improvement of the quality of life and conditions of the elderly. Thus, this study aims to analyze the association between income, self-perception of health and satisfaction in elderly co-residents.

## II. MATERIALS AND METHODS

The study design is a cross-sectional, population-based and quantitative approach. This is a subproject of the project entitled “Family Arrangement of Elderly Residents in Northeast and Southeast Municipalities of Brazil”, which was developed in two Family Health Units (FHU) in the city of Vitória da Conquista - BA, which were selected through a simple draw.

We included in the study population all the elderly in co-residence registered in the USF, totaling 239 elderly. As a selection criterion, individuals aged 60 years or older living in the urban area of Vitória da Conquista - BA, in a state of co-residence, participated in the research, and presented cognitive conditions that allowed answering the questions according to the application of the study. Mini Mental State Examination (MMSE). And those who refused to participate and those who after three attempts on alternate days and times were not found at home were excluded.

The MMSE consists of 11 items, which require verbal answers to questions of temporal and spatial orientation, attention, reading, memory, calculation, naming, verbal commands and copying a drawing (polygons). To evaluate the results obtained through MMSE, the following cutoff points will be adopted: 19 points for illiterate elderly; 23 points for seniors with 1 to 3 years of schooling; 24 points for seniors with 4 to 7 years of schooling and 28 points for seniors with schooling above 7 years (BRASIL, 2007). Scores below these scores indicate a risk of *deficit* cognitive.

The collection of the main project took place in two stages. In the first moment, the number of elderly registered in the USF was identified through the consultation of the family registration forms, called Form A, and a survey of the elderly who live alone and those who correspond with family members.

Then, the following instruments were applied to the selected elderly: the interview, through a semi-structured questionnaire containing participants' identification data, such as age, gender and family arrangement composition, the *Brazil Old Age Schedule* (BOAS) questionnaire adapted to evaluate the financial income and life satisfaction of the elderly, and the Health Status questionnaire.

The *Brazil Old Age Schedule* Questionnaire - BOAS is a research tool that investigates multidimensional factors of aging, based on other instruments with acceptable standards of validity and reliability. The BOAS was conceived from 8 major categories (general information, physical health, use of medical and dental services, activities of daily living, social resources, economic resources, mental health, needs and problems that affect the interviewee) [8]. The Health Status questionnaire was prepared by the study itself, containing information related to the health status of individuals. The empirically collected data were tabulated and received descriptive (frequency, mean and dispersion measurement) and analytical treatment (Pearson's chi-square test, with significance set at 5%) with the aid of the SPSS

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software. The tables were plotted by Microsoft Excel software.

The main study of which this research is part was approved by the Research Ethics Committee of the State University of Southwest Bahia (CEP-UESB), whose opinion nº 102.641, was issued observing the Resolution of the National Health Council (CNS) 196 / 96, in force at the time. Therefore, a request was made to CEP-UESB to include this study in the main project in accordance with Resolution No. 466 of December 12, 2012.

The data production was performed after the assent of CEP-UESB of the inclusion of this field of study, and the authorization of the SMS ofVitória da Conquista - BA for conducting the research in the USF. The participation of the elderly was voluntary, and the acceptance was formalized by signing the Informed Consent Form (FICF), signed in two copies, one of the informant's domain and the other of the researcher's guardian responsible for the study.

It is also noteworthy that this study is linked to the Center for Research and Studies in Health of the Elderly of the Independent College of the Northeast - FAINOR.

## III. RESULTS AND DISCUSSION

The sample of 239 elderly co-residents had a mean age of 72.20 ± 8.08 years, 184 female (77.0%), 143 who can read (61.1%), 101 in the current married state or in a stable union (42.3), as outlined in Table 1. Still on the results shown in this table, it was observed that the majority of the elderly are retired, being 156 (65.3%), and with monthly income centered on one minimum wage, 153 (64.0%).

*Table 1. Sociodemographic characteristics of the participants. Victory of the Conquest-BA, 2019.*

| Variables | Mean (± sd) | % Give me an answer | no | % |
|---|---|---|---|---|
| Age, *years* | 72.20 (± 8.08) | 100 | 239 | - |
| **Sex** | | 100 | | |
| Male | | | 55 | 23.0 |
| Feminine | | | 184 | 77.0 |
| **Read** | | 97.9 | | |
| Yes | | | 143 | 61.1 |
| Not | | | 91 | 38.9 |
| **Schooling** | | 97.5 | | |
| None | | | 81 | 34.8 |
| Incomplete Primary | | | 108 | 46.4 |
| Complete primary | | | 28 | 12.0 |
| Complete Elementary | | | 5th | 2.1 |
| Medium Complete | | | 10 | 4.3 |
| Graduated | | | 1 | 0.4 |
| **Marital Status** | 99.2 | | | |
| Never married | | | 4 | 1.7 |
| Married / living together | | | 101 | 42.3 |
| Widower | | | 99 | 41.4 |
| Divorced / Separated | | | 33 | 13.8 |
| **Retirement** | 96.2 | | | |
| Yes | | | 156 | 65.3 |
| Not | | | 74 | 31.0 |
| **Monthly income** | 95 | | | |
| One minimum wage | | | 153 | 64.0 |
| Between one and three minimum wages | | | 65 | 27.2 |
| Greater than four minimum wages | | | 4 | 1.7 |
| No income | | | 5th | 2.1 |

Sample standard deviation; Source: Research Data.

The family arrangement of the sample is predominantly composed of grandchildren 137 (57.3%), sons 132 (55.2%), daughters 129 (54.0%) and husband / partner in 97 (40.6%). In general, elderly co-residents are satisfied with their family relationship in 219 (97.8%) cases, as shown in table 2.

*Table 2. Composition of family arrangement of the interviewed elderly. Victory of Conquest - BA, 2019.*

| Variables | % Give me an answer | N | % |
|---|---|---|---|
| **Husband / mate** | 100 | | |
| Yes | | 97 | 40.6 |
| Not | | 142 | 59.4 |
| **Parents** | 100 | | |
| Yes | | 5th | 2.1 |
| Not | | 234 | 97.9 |
| **Children** | 100 | | |
| Yes | | 132 | 55.2 |
| Not | | 107 | 44.8 |
| **Daughters** | 100 | | |
| Yes | | 129 | 54.0 |
| Not | | 110 | 46.0 |
| **Brothers Sisters** | 100 | | |
| Yes | | 6th | 2.5 |
| Not | | 233 | 97.5 |
| **Grandchildren** | 100 | | |

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| | | | |
|---|---|---|---|
| Yes | | 137 | 57.3 |
| Not | | 102 | 42.7 |
| **Other relatives** | 100 | | |
| Yes | | 16 | 6.7 |
| Not | | 223 | 93.3 |
| **Other people (not relatives)** | 100 | | |
| Yes | | 13 | 5.4 |
| Not | | 226 | 94.6 |
| **Satisfied with the relationship** | 93.7 | | |
| Yes | | 219 | 97.8 |
| Not | | 5th | 2.2 |

Source: Research data.

According to the condensed data in Table 3, the elderly co-residents say they are satisfied with life, 227 (95.05%).

*Table 3. Life satisfaction of the elderly co-residents. Victory of Conquest - BA, 2019.*

| Variables | % Give me an answer | no | % |
|---|---|---|---|
| **Life satisfaction** | 98.3 | | |
| Pleased | | 227 | 95.0 |
| Dissatisfied | | 8th | 3.3 |
| They did not answer | | 4 | 1.7 |

Source: Research data.

Of the survey participants, 127 had self-rated health (53.8%), followed by 65 for good (27.5%). Of the elderly, 117 (58.2%) felt better in health than other elderly of the same age. The most self-reported diseases or accidents in the sample were systemic arterial hypertension, 190 (80.5%), falls in the last 12 months, 88 (38.4%), and 81 (35.1%) arthritis, rheumatism and arthritis. cases, as outlined in Table 4.

*Table 4. Composition of self-perceived health of respondents. Victory of Conquest - BA, 2019.*

| Variables | % Give me an answer | no | % |
|---|---|---|---|
| **Health self-perception** | 98.7 | | |
| Great | | 3 | 1, 3 |
| Very good | | 10 | 4.2 |
| Good | | 65 | 27.5 |
| Regular | | 127 | 53.8 |
| Bad | | 31 | 13.1 |
| **Health compared to other seniors of the same age** | 84.1 | | |
| Best | | 117 | 58.2 |
| Igual | | 52 | 25.9 |
| Worse | | 32 | 15.9 |
| **Self-reported illnesses / accidents** | — | | |
| Systemic arterial hypertension | | 190 | 80.5 |
| Fall in the last 12 months | | 88 | 38.4 |
| Arthritis, Rheumatism, Arthrosis | | 81 | 35.1 |
| Diabetes Mellitus | | 63 | 26.8 |
| Urinary incontinence | | 58 | 25.0 |
| Problem nervous or psychiatric | | 28 | 12.0 |

Source: Research data.

The results of the crossover of data between self-perceived health and life satisfaction of the sample, expressed in Table 5, revealed that positive cases of self-perception of health are correlated with higher frequencies of life satisfaction (p = 0.02).

*Table 5. Association of self-rated health and income with life satisfaction of the sample. Victory of Conquest - BA, 2019.*

| Variables | Life satisfaction | | $p^1$ |
|---|---|---|---|
| | **Pleased** | **In satisfied** | |
| **Health self-perception** | | | |
| Great | 3 (100.0) | — | |
| Very good | 10 (100.0) | — | |
| Good | 62 (98.4) | 1 (1.6) | 0.02 |
| Regular | 124 (98.4) | 2 (1.6) | |
| Bad | 26 (83.9) | 5 (16.1) | |
| **Monthly income** | | | |
| One minimum wage | 148 (96.7) | 5 (3.3) | |
| Between one and three minimum wages | 60 (95.2) | 3 (4.8) | 0.685 |
| Greater than four minimum wages | 4 (100.0) | — | |
| No income | 5 (100.0) | — | |

Pear Pearson's chi-square test; Source: Research Data

In the present study, as described in the results, it was possible to show that the co-residence of the elderly

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analyzed had a greater share in living with grandchildren (57.3%), sons (55.2%) and daughters (54%). According to the study by Silva, Júnior and Vilela (2014) [9], it was observed that in most elderly homes lived three or more residents (63.9%). Camarano et al. (2004) [10] define co-residence as coexistence among elderly people with children and / or grandchildren in the same home space, and this coexistence in family may be the result of several factors, which may be related since the lack of financial resources by both the elderly and their families, as the elderly's need to be cared for by a family member due to the impairment of their autonomy and independence [6].

The co-residence strategy benefits both younger and older generations with the presence of affection, caring, stability, cultural transmission, and love relationships. However, this interaction with different generations can also be marked by the occurrence of conflicts, resulting in negative points for the parties involved. Such conflicts may be geared to the divergences between ideas and opinions, which are influenced by different worldviews, each marked by its time, which may result in possible mishandling and neglect [11]. Regarding the level of satisfaction of these elderly with family relationships, the study obtained a positive result, in which 97.8% say they are satisfied. Studies by Meira et al. (2015) [12] show an equally high estimate when it comes to satisfaction with family arrangements, where 83.1% of the elderly are satisfied with co-residents. This shows that, despite the conflicts generated within the household, which is shared with children and / or grandchildren, the family plays an important role in this aging context, as it is seen as the basis for promoting support, support and protection of its members, predominating the feeling of love and affection among the members [4].

Regarding income, the study found that 65.3% of the elderly are retired, and 64% of this population live with only one minimum wage. The main determinants of the home arrangement of the elderly are demographic, socioeconomic and health. Income is pointed as one of the main factors that lead to co-residence. Thus, retirement can be considered attractive, both for relatives seeking to enjoy their resources, especially those living in situations of low purchasing power, as well as for elderly people who suffer financial needs [13].

It is also noteworthy that, in many cases, the elderly become the sole financial provider of the house, because even with spending on medicines and other health treatments, they have a higher income than young people, since many of them are unemployed [14]. In addition, as a result of high unemployment, divorce, or even difficulty in establishing their families, adult children have been staying longer in their parents 'home or even returning to their parents' home because of separation from their spouse, or return with wife and children for financial reasons. This makes the elderly remain the head of the family [6].

Thus, all this reality could suggest that the elderly were led to negative thoughts about co-residence and, consequently, have worse perception about life satisfaction, however the present study showed that 95.0% are satisfied with life, which It may be a reflection of the satisfaction they have in matching their family members. According to Reis et al. (2013) [15], elderly co-residents are more satisfied with their lives, because aging close to their families minimizes the occurrence of negative conditions regarding the perception of life and health. The benefit of this family arrangement is related to the company, the protection and support offered by family members, resulting in a satisfactory aging.

Despite the presence of high prevalence of chronic degenerative diseases and other diseases present in the study, self-perception of health of the elderly was referred to as "fair" in most cases (53.8%) or "good" (27.5 %). Compared to other seniors of the same age, 58.2% say they have a “better” state of health, even if it has not been rated “excellent” or “very good”, but they still consider themselves healthier than other individuals in same age group. This can be justified by the World Health Organization (WHO) definition of health, where health is “a state of complete physical, mental and social well-being and not just the absence of illness and disease”. Thus, self-perception of health involves aspects of physical, cognitive and emotional health. How people perceive their own aging and health can be an essential indicator of their adaptation and successful old age, bringing benefits to both their physical and emotional health. The relationship with family and friends, social and cultural factors positively influence the perception about their health and also about aging [16].

Observing the results of this study that there is an association between life satisfaction and self-perception of health, it is emphasized that this result may further help in understanding the discussion about the repercussions of co-residence, as well as understanding the health-care process. disease from the individual's own perspective and the possible impacts that living with the family can influence on their self-image and, consequently, on life satisfaction [17]. Thus, it is noted that the various aspects of emotional, psychological and social impact on the perception of health and life, and that these two variables influence each other. Thus, the important role that co-residence plays in the lives of the elderly stands out.

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## IV. CONCLUSION

From the study, it is concluded that the elderly living in co-residence are satisfied with the family arrangement, and that this variable is influenced by the perception about their health. Regarding income, this variable was not associated with life satisfaction, and it is possible to observe that some elderly, even with a considerably low income, said they were satisfied with life.

Given this, it is necessary to know better the family arrangement in which the elderly are inserted, so that they receive a deeper look about their needs, especially for health professionals who deal directly with these individuals, so that they can offer them a more humane care and assistance focused on prevention and health promotion.

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# Prevalence of bovine cysticercosis of slaughtered animals in south and southeast at state of Goiás, Brazil

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***Abstract*** *— Bovine cysticercosis is a zoonotic disease globally distributed that causes serious problems of public health and economic consequences. This parasitic disease is caused by species Taenia saginata, and the cattle as intermediate hosts, causing bovine cysticercosis, and human definitive host, causing taeniasis. The main symptoms of taeniasis are: malnutrition, intestinal obstruction, abdominal pain, anal itching, among others. In this sense, this study aimed determine prevalence of bovine cysticercosis in animals from southern and southeastern Goiás slaughtered at different slaughterhouses from 2004 to 2008, inspected by State Inspection Service (SIE) and Federal Inspection Service (SIF). For SIE, were surveyed 18 cities in south and southeast of Goiás, in the period 2005 to 2008, which 4927 animals were slaughtered, these 411 were positive for cysticercosis, revealing a prevalence of 8.3%, demonstrating endemicity of region. The inspection was carried out by SIF in the period 2004 to 2007 in 20 towns in south and southeast. From 300,825 slaughtered animals, 1731 were positive, establishing a prevalence of 0.5% for cysticercosis. Despite did not identify prevalence of endemic, some cities, when analyzed, proved to be endemic, such as Santa Cruz (8.5%), Cumari (6.5%) and Orizona (6.2%). According to the findings, appears that south and southeast of Goiás requires implementation of health education programs so that cycle is interrupted.*
***Keywords*** *— **Taenia saginata, Bovine cysticercosis, Slaughtered animals, Zoonotic disease.***

## I. INTRODUCTION

Taeniasis-cysticercosis complex has global distribution, demonstrating significative impact in public health, and registering serious economic losses in some countries, considered as a matter of food security [1].

*T. saginata* occurs in small intestine of humans who are the definitive host of this tapeworm. Humans get infected by eating raw or undercooked meat containing viable cysticerci. The tapeworm develops in small intestine and becomes sexually mature in about 3 months, producing gravid proglottids, which are mobile and either migrate from the host's anus spontaneously or are shed in faeces [2, 3] .The presence of tapeworm in intestine can cause some abdominal discomfort, mild diarrhoea, weight loss and pruritus caused by migrating proglottids [4].

Prevalences in humans are highly variables within a country and between countries. This variability in prevalence is due to hygienic habits, quality of meat inspection and culinary habits. However, human taeniosis is not a notifiable disease and reported prevalences are only indicative [5].

*T. saginata* is a tapeworm of humans with a global distribution and causing low morbidity [6]. Bovine cysticercosis is an important public health and economic problems caused by its consequence on public health nutrition and economy of some countries [7, 8].

Currently diagnosis of bovine cysticercosis is performed in slaughterhouses, during the post-mortem examination of housing, based on observation of metacestode tissue. Currently, records of cattle raised by the inspection of meat, still common in many locations worldwide [9 – 13]. It should be noted that the inspection of meat in slaughter establishments in Brazil is still performed under different conditions, being made in the municipal, state and refrigerated slaughterhouses with Federal Inspection Service

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for export and domestic trade. These differences are directly related to the requirements of the consumer market and the technical-financial and staffing of each unit. It is known that only inspection of carcasses carried out by technical inspection are not fully effective, because for reasons of aesthetic and commercial, are not usually shredded all the organs, viscera and carcass muscle [14].

In Brazil were reported prevalence of bovine cysticercosis in the following locations: California-2, 79% [15], Guarulhos, SP-10, 7% [16], Mato Grosso do Sul-1, 04% [17], Rio de Janeiro-5, 81% [18]. In Rio Grande do Sul bovine cysticercosis is the main cause of retention of carcasses in slaughterhouse under federal inspection [19].

The main town of Triangulo Mineiro, Uberlândia, located about 70 km from the border with southeastern Goiás, was found in a study on last bovine cysticercosis was carried out between the years 1979 to 1993 a rate of 1.87% [20].

Midwest and Southeast account for nearly 58.5% of the slaughter of cattle in Brazil. Mato Grosso is central Brazilian state in volume of slaughter, 13.6% of all domestic production made by establishments inspected. Then there are productions made in Sao Paulo (13.3%), Mato Grosso do Sul (12.2%) and Goiás (9.2%) [21].

There is a lack of current data to determine epidemiological profile of cattle raised in Brazil. In the specific region of south and southeast Goiás no exist data on prevalence of this zoonosis. The importance of understanding the complex Taeniasis-cysticercosis because it is a zoonosis and the establishment of infection is heightened by poor health, creating a public health problem, justify the need for a study to determine the prevalence of bovine cysticercosis in region.

The objectives of this study was to determine prevalence of cysticercosis in cattle slaughtered in different slaughterhouses in southern and southeastern Goiás monitored by the State Inspection Service (SIE) from 2005 to 2008 and analyze the frequency of infections viable and calcified in metacestode *T. saginata.*

## II. MATERIAL AND METHODS

**Study Area**

In order to inspect and review, the Defense Agency of Goiás Corporation (AGRODEFESA) divides state into 12 regions: Chapada dos Veadeiros⁄Alto Paraíso, Entorno⁄Formosa, Vale do São Patrício⁄Goianésia, Metropolitana⁄Goiânia, Estrada de Ferro⁄Catalão, Caiápo⁄Iporá, Alto Araguaia⁄Jataí, Rio Vermelho⁄Mozarlândia, Sul⁄Itumbiara, Norte⁄Poranguatu, Nordeste⁄Posse e Sudoeste⁄Rio Verde [21].

This study was conducted at Regional Estrada de Ferro⁄Catalão, composed of 22 municipalities in the south and southeast of the state of Goias at southeast region consists of 26 municipalities spread over an area of 25,122.039 km 2, corresponding to 7, 39% compared to state, its population density is 15.22% inhabitants/km2 (SEPLAN-GO, 2006). This study analyzed data from three municipalities of southern region (Caldas Novas, Marzagão and Rio Quente). In this study we considered data from 19 municipalities in the Southeast., The main city region is Catalão, located at 18 ° 10 '05 "S and 47 ° 57 '19" W, and 300 km from Brasília. The city's population is estimated at 75,623 inhabitants. The Gross Domestic Product (GDP) of more than 2.5 billion reais, the city ranks as the sixth largest economy in Midwest of Brazil and the third of Goiás About 80% of its population live in urban area and 20% live in the countryside. In 70's the rural area had 44% of the population of the municipality and due to the strong process of urbanization, rural population decreased to 10.48% [22].

**Population Study**

The study was conducted in 4927 cattle slaughtered on farms in south and southeast of Goiás, supervised by the State Inspection Service (SIE). Municipalities cedes are: Anhanguera, Caldas Novas, Campo Alegre, Catalão, Corumbaíba, Cristianópolis, Cumari, Davinópolis, Goiandiara, Ipameri, Marzagão, Nova Aurora, Orizona, Ombudsman, Palmelo, Pires do Rio, Rio Quente, Santa Cruz, São Miguel do Passa Quatro, Três Ranchos, Urutaí and Vianópolis.

**Collected Data**

In order to perform an epidemiologic history of cattle raised in south and southeast at state of Goiás, slaughter data were provided by AGRODEFESA in accordance with routine inspections conducted by the organ of State Inspection Service (SIE) for the period 2005 to 2008.

Inspection of post-mortem carried out by the SIE is visual, preceded by several incisions 0.5 cm in each organ (heart, diaphragm, shoulder, tongue, liver, kidneys, lungs and muscles) to examine positivity or negativity of metacestodeos *T. saginata* in animals. Monthly and annual reports are filled by the attending veterinarian and his team, from records collected daily, providing various information relating to the slaughter. These data are sent to the Ministry of Agriculture, Livestock and Supply-MAP. The procedures used in routine inspections are conducted in accordance with

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the stipulations of Article 176 of the Rules of Industrial and Sanitary Inspection of Animal Products-RIISPOA.

**Data analysis**

The positivity of cattle raised in the period analyzed, the city of origin and viability of infection was calculated using Graphpad Prism version 5.0 using the Chi-square.

All results were considered statistically significant at a significance level of 5% ($p < 0.05$).

## III. RESULTS

In period of 2005 to 2008, were inspected by the SIE, 18 of the 22 cities in the region. During this period, 4927 animals were slaughtered, these 411 were infected with metacestodes of *T. saginata*. In 2005 there was the most positive 11.5%. This difference was statistically significant when compared to years 2006 and 2007 (Figure 1).

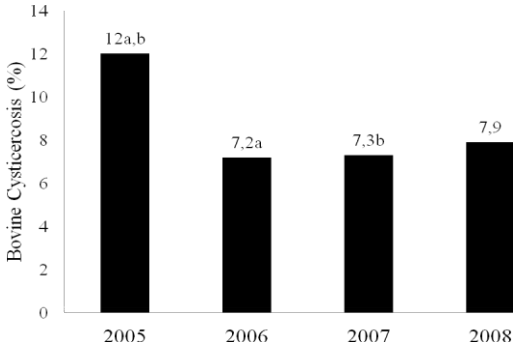


*Fig.1 - Incidence of cysticercosis Bovine reviewed by the SIE in the period 2005 to 2008. a (p = 0.0058) b (p = 0.0063).*

Can be seen in Table 1, the prevalence of cysticercosis in municipalities of origin of animals slaughtered per year. In 2005, no area showed a significant difference in distribution of bovine cysticercosis.

In 2006, Cristianópolis showed lowest prevalence, statistically significant when compared to other locations. The highest estimated prevalence in that year was 23.1% in São Miguel do Passa Quatro. This prevalence was statistically significant when compared to Catalão city ($p = 0.0261$), Cristinópolis ($p < 0.0001$) and Cumari ($p = 0.0359$).

In 2007 was recorded prevalence of 25% in São Miguel do Passa Quatro. This prevalence was statistically higher when compared to Catalão city ($p = 0.0002$), Goiandira ($p = 0.0065$) and Urutaí ($p = 0.0302$).

The higher prevalence in 2008 was recorded in municipality of Ipameri (17.9%). This difference was statistically significant in comparison to Catalão ($p = 0.0004$), Davinópolis ($p = 0.0140$), Santa Cruz ($p = 0.0082$) and Vianópolis ($p = 0.0013$).

Analysis of cattle raised during the four years showed that the city of São Miguel do Passa Quatro obtained highest prevalence (28.8%) compared to cities in Catalão ($p < 0.0001$), Cristianópolis ($p < 0.0001$) , Davinópolis ($p = 0.0063$), Goiandira ($p = 0.0013$), Ipameri ($p = 0.0350$), Nova Aurora ($p = 0.0193$), Orizona ($p = 0.0322$), Ombudsman ($p = 0.0018$), Santa Cruz ($p = 0.0252$), Urutaí ($p = 0.0059$) and Vianópolis ($p = 0.0046$).

Routine inspection of SIE analyzes type of infection of metacestodes of *T. saginata*, classifying it into viable infection or calcified. Analyzing data provided there was no statistical difference in relation to infection (Figure 2).

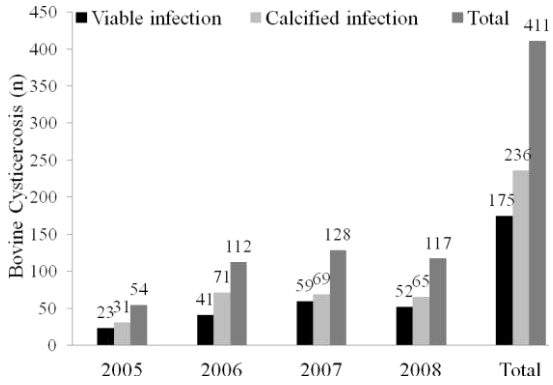


*Fig.2 - Distribution of infections, classified into viable and calcified, with respect to municipalities in south and southeast of Goiás, in the period 2005 to 2008, according to the SIE.*

Despite the year 2007 had highest infection rate feasible, there were no statistical differences regarding distribution of annual and local infections.

## IV. DISCUSSION

Complex Taeniasis-cysticercosis is a serious public health problem in many parts of the world, including Brazil. In places where infection is endemic, the transmission is related to poor hygiene and poor sanitation, especially in rural areas [25]. For Pan American Health Organization and World Health Organization, a region is considered endemic for taeniasis when its prevalence is greater than 1% to 0.1% human cysticercosis and cysticercosis animal 5% [26, 27].

The classification of a region as endemic for bovine cysticercosis is a serious public health issue, because as to be defiled, these animals had contact with human feces contaminated. An endemic area for cattle raised as it is for human taeniasis [28]. The filing of this complex in a region

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indicates that sanitation and health education are disabled, proving the need for programs of intervention by public health authorities.

*T. saginata* taeniasis is not subject of great concern as the taeniasis by *T. solium*, since the latter can cause human cysticercosis accidental. However, the taeniasis, independent of the ethological causes the host abdominal discomfort, diarrhea, weight loss and itching due to migration of gravid [4]. In areas where malnutrition is a factor of concern in public health, the presence of taeniasis aggravates the situation because of the spoliation of the host by the parasite [12, 13, 28, 29]. Transmission by *T. saginata*, between humans and cattle, generally are related to the primitives practices of animal creation, inadequate meat inspection, poor sanitation, and the deficiency in control polices or management [30] prove need of programs of intervention by public health authorities.

Mandatory reporting helps to identify and thus control of various diseases. In Brazil, for the complex Taeniasis-cysticercosis, mandatory reporting is done only some states and not for human cysticercosis [31]. Notification shall extend to entire national territory, covering all the infections present in the cycle. This procedure maps, reliably, the complex parasitic in the country, thus enabling their control and preventing its spread to non-endemic regions and other countries.

Specifically regarding bovine cysticercosis, the biggest concern for refrigerators and producers are economic consequences generated by condemnation of carcasses contaminated by restricting its marketing in foreign market [32].

Disease most commonly diagnosed during slaughter of cattle is cysticercosis, this problem intensifies in Brazil which has second largest cattle herd and slaughter in the world with about 200 million head . Cysticercosis is a disease most commonly diagnosed during slaughter of cattle and is a major cause of condemnation of the Federal Inspection Service oversees 49% of slaughtered animals [33].

Since complex Taeniasis-Cysticercosis causes economic problems, social and public health data on its actual occurrence is of paramount importance. However, in Brazil, despite record of inspection bodies, there are few studies that evaluate and compare the actual distribution of this disease. In the State of Goiás, in particular, there are no records of studies prevalence of bovine cysticercosis, thus preventing comparison of results in this study with similar studies.

Meat inspection at state of Goiás is performed by different institutions. The authors analyzed data for review by the SIE. Meat inspection at state of Goiás is performed by different institutions. Authors analyzed data for review by the SIE. Results regarding prevalence of total and specific each municipalities, qualified as a region endemic for cysticercosis.

Years 2006 and 2007 demonstrated decreased prevalence of bovine cysticercosis, which may indeed be associated with improvements in farming conditions and conscience health. However observed was an increase in the year 2008 and to be carefully examined by the public health.

Another aspect to be considered is classification held by SIE, the viability of infection, since this is related to continuity of parasitic cycle. Analysis of results shows no difference between viable and calcified infections, but further action in relation to this analysis must be taken. It is suggested, the inspection services, the quantification of metacestodes found and determining its feasibility. This will allow analysis of parasite load of infection, which implies virulence of parasite and host immunity. It will also make sure that infection is only by viable or calcified metacestodes.

Sanitary inspection of meat held in refrigerated slaughterhouses is an important preventive method, preventing carcasses unfit for human consumption are marketed [35]. Despite limitations related to inspection, it is an important and specific diagnosis of bovine cysticercosis, it identifies carcasses with massive infections and lightweight, and serves as an indicator of the degree of infection in a region [36].

Thus, inspection services work not only as supervisory body, but also as keepers of data centers for disease of great public health importance. Your contribution is vital epidemiological, but the lack of proper analysis, these data may be lost unexplored, as might be used in epidemiological mapping local, state and national diseases frequently, helping to develop programs of prevention and control of zoonoses more frequently in the country.

In this scenario, is essential to exchange of information between oversight bodies and institutions of education and research. Thus allowing the creation of alternatives for data collection and analysis more specific seasonal results, limiting the actual profile of the cattle raised in region, aiming at developing health measures to stop the disease cycle.

Only service of meat inspection is not sufficient and calls for the installation of preventive measures in farms where the animals are raised, involving the handling of animals and education of health professionals related to creation.

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## V. CONCLUSIONS

Owing to difficulty of diagnosing cysticercosis before slaughter and inspection of animals is also needed, creation of public policies, as eradication is virtually impossible to consider a country like Brazil where there are many social differences divided into an immense territorial extension.

The prevalence of 8.3%, found in cattle monitored by the SIE in the period 2005 to 2007, characterized south and southeast of Goiás as endemic for bovine cysticercosis. No statistical difference was found between frequencies of infection by viable and calcified metacestodes of *T. saginata*. It is necessary partnership between educational institutions and research with inspection services (municipal, state and federal) to determine the actual prevalence of bovine cysticercosis in country and develop strategies to interrupt cycle of this disease.

## CONTRIBUTORS

NA developed study idea and design, performed study and manuscript design.

LR and TSO contributed with script and preparation of manuscript.

HB conceived study, assisted in experimental design, and helped draft the manuscript. All authors read and approved the final manuscript.

## CONFLITS OF INTERESTS

Authors do not have any conflicts of interests based on the presenting information and data. In addition, authors do not have any financial competing interests.

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*Table 1 - Distribution of bovine cysticercosis in the region south and southeast Goiás state, according to the SIE, between the years 2005 to 2008.*

| Municipalities | 2005 | | 2006 | | 2007 | | 2008 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Slaughter | Positive % (n) | Slaughter | Positive % (n) | Slaughter | Positive % (n) | Slaughter | Positive % (n) | Slaughter | Positive % (n) |
| Caldas Novas | | | | | | | 20 | 10 (2) | 20 | 10 (2) |
| Campo Alegre de Goiás | | | | | | | 18 | 5,5 (1) | 18 | 5,5 (1) |
| Catalão | 5 | 20 (1) | 190 | 5,2 (10)[a] | 1 | 3,5 (9)[a] | 240 | 5 (12)[a,e] | 436 | 4,6 (32)[a] |
| Corumbaíba | | | | | 20 | 5 (1) | 20 | 15 (3)[f] | 40 | 10 (4) |
| Cristianópolis | | | 200 | 1 (2)* | | | | | 200 | 1 (2)[a] |
| Cumari | | | 100 | 5 (5)[b] | 20 | 5 (1) | | | 120 | 5 (6)[a] |
| Davinópolis | | | | | | | 60 | 3,3 (2)[a] | 60 | 3,3 (2) |
| Goiandira | | | 189 | 0,6 (13) | 180 | 5,5 (10)[c] | | | 369 | 6,2 (23)[a] |
| Ipameri | 23 | 13 (3) | 160 | 0,9 (15) | 282 | 7,8 (21) | 117 | 17,9 (21)[a] | 582 | 10,3 (60)[a] |
| Nova Aurora | | | 60 | 6,6 (4) | 20 | 25 (2) | 20 | 5 (1) | 100 | 7 (7)[a] |
| Orizona | 132 | 10,6(14) | 132 | 10,6 (14) | 104 | 6,4 (9) | 81 | 9,8 (8) | 449 | 10 (45)[a] |
| Ouvidor | | | | | 115 | 4,3 (5) | | | 115 | 4,3 (5)[a] |
| Pires do Rio | 219 | 12,7 (28) | 218 | 11,4 (25)[a] | 419 | 10,2 (43)[a] | 403 | 12,4 (50)[e] | 1259 | 11,6 (146) |
| Santa Cruz de Goiás | 40 | 10 (4) | 48 | 14,5 (7)[a] | 35 | 11,4 (4)[a] | 90 | 4,4 (4)[a] | 213 | 8,9 (19)[a] |
| São Miguel do Passo Quatro | | | 13 | 23,1 (3)[a,b] | 20 | 25 (5)[a,b,c] | | | 33 | 24,2 (8)[a] |
| Vianópolis | | | 22 | 13,6 (3) | 25 | 12 (3) | 103 | 2,9 (3)[a,e,f] | 150 | 6 (9) |
| Total | 449 | 12 (54)[g] | 1501 | 9,1 (112)[g] | 1435 | 7,5 (128)[g] | 1286 | 9,09 (117) | 4671 | 8,3 (411) |

* Lower prevalence of bovine cysticercosis (p<0,05) a , e, f, g (p<0,05); b (p= 0,0359); c (p= 0,0065); d (p= 0,0302).
* Lower prevalence of bovine cysticercosis (p<0,05) a , e, f, g (p<0,05); b (p= 0,0359); c (p= 0,0065); d (p= 0,0302)

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# Prevalence of sickle cell trait and sickle cell anemia in two Brazilian quilombola communities from Southwest Bahia State

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***Abstract*—** Sickle cell disease (SCD) is the most common hereditary hematologic disease in the world and prevalent among people of African descent. Large part of this prevalence is found in remaining quilombola populations, which still face difficulties related to health because of eventual discrimination and/or marginalization for ethnic, cultural and social reasons. Thus, the objective of the present study was to evaluate the prevalence of SCD - sickle cell trait and sickle cell anemia - in the population aged 10 years or older of the Lagoa de Maria Clemência and Oiteiro communities, Vitória da Conquista, Bahia, Brazil. To this end, a cross-sectional study was carried out with 149 individuals. Blood samples were collected by venipuncture and put in tubes containing EDTA. Initially, part of the blood was incubated with sodium metabisulphite to observe the occurrence of sickling under optical microscope. Samples with sickled erythrocytes were referred for hemoglobin electrophoresis with High Performance Liquid Chromatography. Data analysis showed that 4.1% of the population has SCD; of these, 3.5% have sickle cell trait and 0.7% have homozygous hemoglobin S, and 66.7% were female and 33.3 % male. The prevalence of SCD in the quilombola communities studied was similar to those found in other communities of northeastern Brazil. Because these individuals have greater hereditary susceptibility to SCD, and also because of their low socioeconomic conditions, constant monitoring of these populations is necessary to identify individuals with SCD and inform them of the possible risk of birth of children with sickle cell anemia resulting from the marriage between individuals with sickle cell trait.

***Keywords*— *sickle cell disease, sickle cell anemia; sickle cell trait; quilombola communities; black population.***

## I. INTRODUCTION

Sickle cell disease (SCD) is the most common hereditary hemoglobinopathy in the world. The worldwide prevalence of hemoglobin disorders is 7%, largely represented by thalassemia and sickle cell disease (WANG, 1999; WEATHERALL, 2001). This disease involves a range of different genetic modifications, ranging from mild, sometimes asymptomatic, to severe forms with a high mortality rate. The mutation occurs on chromosome 11 and results in the replacement of glutamic acid by valine at position 6 of the N-terminal end in the β-chain of globin, generating hemoglobin S and thus causing a structural and functional alteration in the protein. Individuals with homozygous hemoglobin S (HbSS) have a more severe condition; in turn, those with heterozygous hemoglobin S (HbAS) tend not to present clinical manifestations (DI NUZZO, 2004).

Red blood cell sickling occurs in conditions of low blood oxygen tension, such as those present in physical and mental stress, infection, dehydration, and changes in body temperature. When erythrocytes are sickle-shaped, they lose their elasticity and tend to cause vaso-occlusion

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in the microcirculation and, consequently, induce ischemia and/or tissue necrosis (OLIVEIRA *et al.*, 2013). Clinical presentations resulting from this process can be mild to severe pain, lower limb ulcers, acute chest syndrome, priapism, retinopathies, stroke, renal failure, among others (FÉLIX, SOUZA and RIBEIRO, 2010).

Historically, SCD originated in the African continent and was brought to America by the time of colonization, through about 3-4 million African slaves (OLIVEIRA *et al.*, 2013). Despite miscegenation throughout Brazil, there is a higher prevalence of SCD in the Northeast due to the increased number of black ancestors. Large part of this prevalence is found in remaining quilombola populations, which still today face difficulties related to health because of eventual discrimination and/or marginalization for ethnic, cultural and social reasons ZAGO *et al.*, 2002). Furthermore, epidemiological information specifically pertaining to quilombola people in health information systems is scarce, demonstrating the importance of conducting epidemiological studies with this population group (GOMES *et al.*, 2013).

In this context, the objective of the present study was to investigate the prevalence of sickle cell trait (SCT) and sickle cell anemia (SCA) in two quilombola communities in Vitória da Conquista (Bahia, Brazil), called Lagoa de Maria Clemência and Oiteiro.

## II. MATERIAL AND METHODS

This is an experimental cross-sectional study conducted with the residents of the Lagoa de Maria Clemência and Oiteiro Quilombo Remnants, Vitória da Conquista, Bahia, Brazil. This article is part of a larger project entitled: Genetic counseling for patients with sickle cell trait and identification of chronic diseases as well as their risk factors in quilombola residents of southwest Bahia, whose activities were submitted and approved by the Research Ethics Committee of the State University of Southwest Bahia, under CAAE number 73479917.6.0000.0055.

All residents were invited and spontaneously decided to participate in the project. All the people who wished to participate were included in the study of SCT and SCA, except those under 10 years of age. These individuals signed the Informed Consent Form (Appendix 1) or the Consent Form in the case of underage (Appendix 2) (in the case of those who could not write, fingerprints were collected). Volunteers were also interviewed about their socioeconomic status and risk factors for SCT and SCA (Appendix 3).

Blood samples (about 5 mL) were collected from patients after 10 - 12 hour fast by venipuncture, through a vacuum collection system using a needle (venipuncture) in 1 tube containing EDTA. After collection, the material was stored in refrigerated coolers at 4 °C until analysis at the Medical Biochemistry Laboratory of the Southwest Bahia State University. An aliquot of 50 µl of blood was diluted in 100 µl of physiological solution, followed by the addition of 100 µl of sodium metabisulphite (2%). This mixture was placed on a microscopy slide and spread within 4cm$^2$. The slides were prepared with a cover glass, sealed from contact with air, and examined under a 40x objective lens in a microscope after 1 and 24 hours (NAOUM, 1987). The analysis was performed by two independent examiners. When sickling was observed, the blood sample was sent to an outsourced clinical laboratory and analyzed by hemoglobin electrophoresis to identify HbS homozygosis or heterozygosis (CHINELATO-FERNANDES and DOMINGOS, 2006; WOITOWICZ1 *et al.*, 2010).

## III. RESULTS AND DISCUSSION

The total population of this study was 149 individuals, distributed in 80 (53.7%) women and 66 (46.3%) men. The average age was 42.2 years. The frequency of SCD was higher in females (66.7%) than in males (33.3%) (Table 1).

Regarding ethnicity, 49, 44.3, 4.7 and 2% declared to be black, brown, white and indigenous, respectively. All individuals with SCD were black or brown. None of the white or indigenous participants had SCD (Table 2).

*Table 1. Frequency and percentage of DF in individuals from Quilombos.*

| | Sickle cell trait | Sickle cell anemia | No Sickle cell anemia | Total |
|---|---|---|---|---|
| Women | 4 (80%) | 0 (0%) | 76 (53.1%) | 80 (53.7%) |
| Man | 1 (20%) | 1 (100%) | 67 (46.9%) | 66 (46.3%) |
| Total | 5 (3.4%) | 1 (0.7%) | 143 (96%) | 149 (100%) |

The numbers outside and inside the parentheses indicate the number of people for a given analysis and the percentage of the number of people relative to the total for that analysis, respectively.

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*Table 2 .Frequency and percentage of self-reported ethnicity by individuals from Quilombos.*

| | Sickle cell trait | Sickle cell anemia | No Sickle cell anemia | Total |
|---|---|---|---|---|
| Black | 3 (60%) | 0 (0%) | 70 (49%) | 73 (49%) |
| Brown | 2 (40%) | 1 (100%) | 63 (44,1%) | 66 (44.3%) |
| Indigenous | 0 (0%) | 0 (0%) | 3 (2%) | 3 (2%) |
| White | 0 (0%) | 0 (0%) | 7 (4.9%) | 7 (4.7%) |
| Total | 5 (3.4%) | 1 (0.7%) | 143 (96%) | 149 (100%) |

The numbers outside and inside the parentheses indicate the number of people for a given analysis and the percentage of the number of people relative to the total for that analysis, respectively.

When asked whether they were aware of their condition, that is, SCT or SCA, 64.4% of the individuals did not know whether they had or not SCD, 33.6% reported that they had not been diagnosed, and 2% had previous knowledge about the diagnosis of SCD. Thus, of the participants with positive samples for SCT, only 33% were aware of this information.

This study showed a prevalence of 3.4% of SCT in the community studied (Table 1), which is similar to surveys in other quilombos of the Northeast region of Brazil, whose prevalence is 4.1% (PEDROSA, FERREIRA and OLIVEIRA, 2004). In Brazil about 2 to 8% of the population has SCT, and the states with the highest prevalence are Bahia (5.3%), Pernambuco (4%) and Rio de Janeiro (4%). On the other hand, the southern region of Brazil has the lowest prevalence, such as the state of Rio Grande do Sul (2%) (CANÇADO and JESUS, 2007).

The prevalence of HbAS in European quilombola communities is moderate compared to African, Asian and Middle Eastern countries. In Africa, as in Brazil, the findings are heterogeneous, probably due to miscegenation. The people affected by SCT in Ghana corresponds to 13.3% of the total population, while in Kenya this figure is 3%. In certain regions of Asia and the Middle East, HbS is found in 25% and 11% of the population, respectively (OFORI-ACQUAH and OHENE-FREMPONG, 2007).

Sickle cell anemia is the most common hereditary disease in Brazil. Its prevalence is higher in the black population, affecting a proportion from 0.1% to 0.3% (RAMALHO, 1986). However, due to miscegenation in the country, there is a growing trend in the number of people affected. In this study, homozygous HbS presented a frequency of 0.7% in the quilombola communities of the Southwest region (Table 1). In the quilombola communities of the state of Piauí, the average found was 0.5% of the inhabitants (SOARES *et al.*, 2017).

In the socioeconomic aspects and risk factors for SCD investigated in the interview, it was observed that 64.4% of the individuals were unaware of the heterozygosis for HbS. A study in the Patioba community of Sergipe state showed that 72.3% of the inhabitants did not have adequate knowledge about SCT and SCA; and another study conducted in quilombola communities in Piauí showed that 81% of the residents did not have knowledge about SCD (MENEZES *et al.*, 2015; SOARES *et al.*, 2017). The lack of knowledge about the health condition reflects directly on the deficiency and/or absence of public policies directed to the screening of SCD.

The information of this population about SCD brings with it a challenge for recognition and medical follow-up. This population has no access to genetic counseling, and therefore, they are unaware of the risk of consanguineous marriage and the morbidity linked to SCA. Therefore, government programs aimed at quilombola communities are needed to disseminate information about SCD and reduce the morbidity and mortality of SCA.

It is noteworthy that the adherence of only 30% of the population of both quilombola communities may be an important limitation of our study. This implies that the probability of selection bias becomes greater, mainly due to the fact that people who participate in this type of activity are usually those with greater knowledge about their health. In addition, the distance between the sample collection site and some farthest residences may favor low adherence.

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# Prevalence of cardiovascular risk factors in two Brazilian quilombola communities in Southwest Bahia State

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***Abstract*****—** *Cardiovascular diseases represent one of the leading causes of morbidity and mortality in the world, accounting for approximately 17 million deaths per year. Despite the severity of these diseases, the risk factors are well established. They include systemic arterial hypertension, diabetes mellitus, dyslipidemia, smoking, black ethnicity and low socioeconomic conditions. Quilombola communities are predominantly composed of black individuals and generally present low socioeconomic indicators, with strong indications of a high stratification of risk factors, although still poorly studied.* ***Thus, the present*** *cross-sectional study was conducted in 2017 with 116 residents of the Maria Clemência and Oiteiro quilombola communities, aged 20 or older. The following indicators were considered: serum triglyceride (TG), total cholesterol (TC) and cholesterol fractions (LDL and HDL) levels; Castelli Index I (CT/HDL-c) and Castelli Index II (LDL-c/HDL-c); TG/HDL-C ratio; Framingham score, Body Mass Index (BMI); waist circumference (WC); fasting glucose (FG); glycated hemoglobin (HbA1c); and blood pressure (BP), which was subdivided into systolic (SBP) and diastolic (DBP) blood pressure. Statistical analyses consisted of the Student's t-test and Chi-square ($\chi^2$) test. A significance level of 5% and confidence interval of 95% were adopted. In general, the Framingham risk score, WC, FG, TC, LDL, TG, FG, Castelli indices I and II indicated moderate to high cardiovascular risk in the population, especially in individuals older than 50 years. Regarding the sex of the individuals, the men's averages were higher than those of the women only in the Framingham Score; in the other indicators (DBP, SBP, BMI, WC, TC, LDL, HDL, TG, TG/HDL-C ratio, Castelli indices I and II, FG and HbA1c), women were statistically more susceptible to cardiovascular diseases. The study established that the Quilombola community studied presents moderate to high cardiovascular risk factors, especially among females. The results may guide actions aimed at reducing risks as well as treating individuals with already installed diseases, in order to minimize or neutralize the damage caused by cardiovascular diseases.*

***Keywords*****— cardiovascular diseases; epidemiology; risk factors; quilombo; African descent population.**

## I. INTRODUCTION

Cardiovascular diseases (CVDs) represent the leading cause of death worldwide, accounting for about 17.13 million deaths per year (Mendis, 2011). In Brazil, about one third of deaths are caused by cardiovascular problems. In addition to the morbidity and mortality of CVDs, there is also a socioeconomic impact that includes decreased

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productivity at work and decreased family income (BRASIL, 2011).

Cardiovascular diseases include coronary artery diseases such as angina and acute myocardial infarction, stroke, hypertensive heart disease, rheumatic fever, cardiomyopathy, cardiac arrhythmia, congenital heart disease, valvulopathies, carditis, aortic aneurysm, and peripheral artery disease, and venous thrombosis (MALACHIAS, 2016). The underlying mechanisms vary according to the disease in question. For example, coronary artery disease, stroke, and peripheral artery disease involve atherosclerosis, which can be caused by high blood pressure, smoking, diabetes, lack of exercise, obesity, high cholesterol, improper diet, and excessive alcohol consumption.

Among the deaths from cardiovascular disease, 13% are caused by hypertension, 9% by tobacco, 6% by diabetes, 6% by lack of exercise, and 5% by obesity (BRASIL, 2014). Thus, lifestyle (modifiable factors) is essential to predict the present and future risks of CVD. Access to health, physical inactivity, smoking, obesity, lipid profile, systemic arterial hypertension (SAH) and diabetes mellitus (DM) are the main modifiable factors related to these risks. Age, race and family history are also important but not modifiable (XAVIER, 2013); (SIMÃO, 2014; BONOW, 2017).

The extension of these concepts to the context of Quilombola communities is more serious because these communities have a history of social vulnerability. They are normally far from large urban centers, living in rural areas, and their access to health and education is precarious (FREITAS, 2011). Furthermore, because they are a mostly black community (BRASIL, 2001), individuals have greater genetic susceptibility to certain health problems, including hypertension (XAVIER, 2013).

Quilombola communities are still poorly studied and there is hardly any specific data on the risks of CVD, despite these recognized aggravating factors. Consequently, there are no statistics on the extent to which these diseases affect these communities, as for example in terms of quality of life, economic situation, disability or premature death. Thus, it is difficult to propose prevention and risk reduction actions in this community, with a view to improving the quality of life and well-being of individuals.

In this context, the aim of this study was to identify the prevalence of cardiovascular risks in adults living in the Quilombola communities of Lagoa de Maria Clemencia and Oiteiro in southwestern Bahia. It has been found that these communities had a moderate to high risk for cardiovascular diseases.

## II. MATERIAL AND METHODS

This is an experimental cross-sectional study conducted with residents of the Quilombola communities of Lagoa de Maria Clemencia and Oiteiro. This article is part of a larger project entitled: Genetic counseling for patients with sickle cell trait and identification of chronic diseases and their risk factors in Quilombola dwellers in southwestern Bahia. This project was submitted and approved by the Research Ethics Committee of the Southwest Bahia State University, under number CAAE 73479917.6.0000.0055.

All residents were invited and spontaneously accepted to participate in the project. People who wished to participate in the research and signed the Informed Consent Form were included in the study (in the case of those who could not write, fingerprints were collected). The exclusion criteria in this study were: individuals under the age of 20 or those who, during the project, gave up participating. After applying these criteria, the residents of these communities were listed in this study. The volunteers were interviewed to collect information about their socioeconomic conditions, educational level, previous medical history, smoking, and usual consumption of alcohol, according to an adapted questionnaire (SILVA, 2016).

Subjects were also assessed for systolic blood pressure (SBP) and diastolic blood pressure (DBP) and were measured twice in the left arm after a 10-minute rest in the supine position with sphygmomanometer and stethoscope. Individuals with high blood pressure (SBP $\geq$ 140 and/or DBP $\geq$ 90) had their blood pressure measured once again after 1 week. The nutritional status was estimated based on Body Mass Index (BMI) and Waist Circumference (WC) according to recommendations of the World Health Organization, as they are simple indicators, easy to apply in population studies (WHO, 2000).

Body mass index is a ratio of weight to height obtained from the calculation of weight in kilograms divided by height in meters squared. A digital scale with capacity of one hundred and fifty kilograms with scale of 100 grams, properly calibrated was used to measure weight, and a mobile stadiometer measuring up to 210 cm and with 0.1 cm accuracy was used to measure height. Waist circumference was measured with a 150 cm inextensible measuring tape with precision of 0.1 cm, and the measurement occurred at the midpoint between the last rib and the iliac crest (MELLER, 2014).

Blood samples (about 20 mL) were collected from patients after 10 - 12 hour fast by venipuncture through a vacuum collection system using a needle (venipuncture) to obtain the blood to be used for laboratory tests, which was put in 2 dry tubes and 1 tube with EDTA, both with

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separating gel. Serum was used for laboratory determination of fasting glucose (FG), glycated hemoglobin, total cholesterol (TC) and fractions - high density lipoprotein (HDL) and low density lipoprotein (LDL) -, and triglycerides (TG) (BURTIS, 2008). Lipids were dosed by enzymatic methods with an automatic multichannel chemical analyzer (AU680 Clinical Chemistry Analyzer) at the Central Laboratory of Vitória da Conquista, Bahia, Brazil. Glycated hemoglobin (HbA1c) was determined by the National Glycohemoglobin Standardization Program (NGSP) certified immunoturbidimetric method using the Flex kit. Fasting glucose was measured by the glucose oxidase method using the Dimension RXL system (Siemens Healthcare, Newark, NJ, USA) under standard laboratory techniques.

Existing risks for cardiovascular disease were also calculated by the Castelli Index I (CT/HDL-c ratio), Castelli Index II (LDL-c/HDL-c ratio), and Framingham risk score (CASTELLI, 1983; D`AGOSTINO, 2008).

Table I below lists the indicators selected for this study and their respective parameters for cardiovascular risk analysis.

*Table 1 – List of cardiovascular risk analysis indicators and parameters*

| *Cardiovascular risk indicators* | *Benchmarks assigned to risks* |
|---|---|
| *BMI (kg/m2)7,15* | ≥ 25.0 kg/m$^2$ for adults |
| *WC (cm)* | ≥ 94 cm in men and ≥ 80 cm in women |
| *Index of Castelli I* | > 4,4 in women and > 5,1 in men |
| *Index of Castelli II* | > 2,9 in women and > 3,3 in men |
| *Risk escore of Framingham:* | Low risk - probability < 10% |
| | Medium risk - probability in between 10% and 20% |
| | High risk - probability > 20% |
| | ≥ 27.0 kg/m$^2$ for seniors |
| *Blood pressure (mm/Hg)* | Systolic blood pressure ≥ 140 mmHg and/or |
| | Diastolic blood pressure ≥ 90 mmHg and/or |
| | Use of antihypertensive medication |
| *Total cholesterol (mg/dl)* | ≥ 200 mg/dl |
| *HDL-cholesterol (mg/dl)* | < 50 mg/dl in women and < 40 mg/dl in men |
| *LDL-cholesterol (mg/dl)* | ≥ 130 mg/dl |
| *Triglycerides (mg/dl)* | ≥ 150 mg/dl |

*HDL: High density lipoprotein; LDL: Low density lipoprotein; TG: Triglycerides; BMI: Body mass index.*

The Kolmogorov-Smirnov test was used to check the normality of distribution of the variables. Differences between means of numerical variables of males and females were tested with the unpaired Student's t test. The Chi-square test ($\chi 2$) was used to compare categorical variables, for comparisons of age groups, which were divided into <50 years and ≥ 50 years. The significance level of $p < 0.05$ and 95% confidence intervals were adopted. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) in its twentieth edition.

## III. RESULTS AND DISCUSSION

The total population studied in the Quilombola communities was 116 individuals, distributed in 69 (59.5%) women and 47 (40.5%) men. The median age of the population was 49.5 years. Means and standard deviations of risk indicators are presented in Table 2, where comparisons between men and women are also presented.

The means found for men were higher than those of women only in the Framingham Score; the other indicators (DBP, SBP, BMI, WC, TC, LDL, HDL, TG, TG/HDL-C ratio, Castelli indices I and II, FG and HbA1c) had higher means among. Of these, the difference in BMI, TC, LDL, Castelli I Index, FG and HbA1c means were statistically significant. In the comparisons between age groups under 50 and over 50, there was a high prevalence of cardiovascular risk in the older group. As to the indicators described in Table 3, the Framingham score, BP, WC, FG, TC, LDL, FG, Castelli Index I and Castelli Index II presented statistically significant difference between age groups.

The Framingham score showed that moderate risk was present in 25% of the individuals, and females

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corresponded to about 80% of the findings. Among those with moderate cardiovascular risk, 20.8% were men and 79.2% women. Moderate risk was present in 25.9% of the total population, and of these 46.7% were men and 53.3% women. Comparatively, men presented higher means, specifically 10.5 in contrast with 8.7 in women. It is worth noting that in the study, no one participant under the age of 50 presented high risk. Also, individuals under age 30 received a score of zero for age.

A mean BMI of 25.6 was found in the study. Most of the population (54.3%) was above the appropriate level. Regarding WC, the prevalence of people at risk was 54.3%, with a higher ratio in individuals over 50 years, 67% of those at risk. The present study revealed that the Quilombola communities of Lagoa de Maria Clemencia and Oiteiro present a moderate to high risk of developing CVDs. The indicators supporting this finding were the Framingham risk score, WC, FG, TC, LDL, TG, FG, Castelli Index I and Castelli Index II. Specifically regarding the Framingham score, approximately 48% of the study population had a moderate to high risk of developing a CVD within the next 10 years, which would lead to increased morbidity and mortality resulting from these diseases (MENDIS, 2011; D`AGOSTINO, 2008).

*Table 2 – Average and standard deviation of general of cardiovascular risk indicators and according to sex.*

| | Average ± SD | | | |
|---|---|---|---|---|
| | General | Feminine | Male | p* |
| Age (years) | 49.5 ± 16.4 | 49.6 ± 17.1 | 49.3 ± 15.5 | 0.912 |
| Systolic blood pressure (mm/Hg) | 126.6 ± 19.3 | 128.7 ± 20.6 | 123.5 ± 17.0 | 0.157 |
| Diastolic blood pressure (mm/Hg) | 79.8 ± 10.5 | 80.3 ± 11.0 | 79.0 ± 9.8 | 0.534 |
| Risk score of Framingham | 9.4 ± 8.3 | 8.7 ± 8.4 | 10.5 ± 8.2 | 0.247 |
| BMI (kg/m2) | 25.6 ± 4.1 | 26.6 ± 4.1 | 24.0 ± 3.6 | 0.001 |
| Waisting circumference (cm) | 85.2 ± 9.68 | 86.0 ± 9.6 | 84.0 ± 9.7 | 0.263 |
| Total cholesterol (mg/dl) | 181.2 ± 42.1 | 189.9 ± 43.6 | 168.5 ± 36.6 | 0.007 |
| LDL-cholesterol (mg/dl) | 118.9 ± 65.6 | 133.4 ± 71.6 | 97.5 ± 49.0 | 0.002 |
| HDL-cholesterol (mg/dl) | 50.6 ± 14.6 | 50.6 ± 12.0 | 50.53 ± 18.1 | 0.98 |
| Reason TG/HDL-C | 2.2 ± 0.86 | 2.3 ± 0.9 | 2.1 ± 0.8 | 0.108 |
| Triglycerides (mg/dl) | 106.9 ± 33.8 | 112.6 ± 35.2 | 98.5 ± 30.1 | 0.027 |
| Index of Castelli I (CT/HDL-c) | 2.6 ± 1.74 | 2.9 ± 1.9 | 2.15 ± 1.4 | 0.021 |
| Index of Castelli II (LDL-c/HDL-c) | 3.8 ± 1.11 | 3.9 ± 1.2 | 3.5 ± 1.0 | 0.052 |
| Fasting blood glucose (mg/dL) | 91.9 ± 31.1 | 95.7 ± 38.2 | 86.3 ± 14.1 | 0.064 |
| HA1C | 5.8 ± 1.2 | 6.0 ± 1.4 | 5.4 ± 0.6 | 0.006 |

* Student's T test comparing mean between sexes. BMI:body mass index; LDL: Low density lipoprotein, HDL: High density lipoprotein; CT: total cholesterol; TG: triglycerides

Serum lipid concentration is a major determinant of cardiovascular risk. High LDL and TC as well as low HDL serum concentrations predispose individuals to atherosclerotic disease (LIPSCHITZ, 1994). The risks inherent in changes in HDL, TC and LDL concentrations were present in 58.6, 31 and 31.9% of the total Quilombola population. Furthermore, the risk related to LDL and TC increased when individuals were stratified by age group, affecting the individuals aged 50 years or older. This may be related both to physical inactivity, because people in this age group tend to practice less physical exercise, and to the higher chance of hypertension and DM, which are closely linked to dyslipidemia, in this age group (SPOSITO, 2007). In the stratification by sex, the mean risks associated with TC and LDL were higher in women than in men. The prevalence of hypertension in women and men is known to differ significantly; in the former, hypertension gradually increases with age due to menopause. In this phase, there is also a decrease in estrogen, and this is an important factor for lipid metabolism and has a protective effect in cardiovascular function. Another important aspect is that women tend to

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exercise less than men. They are more sedentary, and this constitutes another risk factor for dyslipidemia (SILVA, 2002).

Other indices may add to the lipid analysis, including the Castelli Index I and Castelli Index II, which are useful in assessing the combined influence between risk factors. High values indicate that the individuals are more likely to have future CVDs (CASTELLI, 1983). In the study, both indices obtained values with $p < 0.005$ and CI > 95%.

The World Health Organization states that the BMI and WC are important predictors of CVD risk, either directly or indirectly, leading to the development of chronic diseases (WHO, 2000). When associated with dyslipidemia, SAH, DM, BMI and WC may increase the risk of acute myocardial infarction, stroke, among other CVDs (Lipshitz, 1994). More than half of the Quilombola population presented increased BMI and WC, especially individuals over 50 years old. Thus, these risks can be changed through encouraging these people to perform some physical activity, aiming to reduce physical inactivity and consequent high BMI and WC (WHO, 2000).

The Framingham criteria are a worldwide recognized means for stratifying cardiovascular risk. They allow predicting the likelihood of an individual acquiring a CVD within the following 10 years (D`AGOSTINO, 2008). According to these criteria, 20.7% of the population in this study had high cardiovascular risk and 25.9% moderate risk, among which women represented 80% of cases. In a cross-sectional study on the African continent in southwestern Nigeria, the rates of medium and high cardiovascular risk were 22.9%, and women represented 70.6% of the cases (OLUYOMBO, 2014). Thus, in this study, approximately 1 in 2-3 people had between 10 and 20% of chance of presenting a CVD in the next 10 years.

*Table 3 – Frequency of cardiovascular risk indicators by second age range.*

| | Average ± SD | | | p* |
|---|---|---|---|---|
| | 20-49 years | ≥ 50 years | Total | |
| Blood pressure (mm/Hg) | | | | <0.001 |
| High risk | 41 (77.4%) | 28 (44.4%) | 69 (59.5%) | |
| Low risk | 12 (22.6%) | 35 (55.6%) | 47 (40.5%) | |
| Risk score of Framingham | | | | <0.001 |
| Low risk | 49 (92.5%) | 13 (20.6%) | 62 (53.4%) | |
| Medium risk | 4 (7.5%) | 26 (41.3%) | 30 (25.9%) | |
| High risk | 0 (0%) | 24 (38.1%) | 24 (20.7%) | |
| BMI (kg/m2) | | | | 0.769 |
| Normal | 25 (47.2%) | 28 (44.4%) | 53 (45.7%) | |
| Risk | 28 (52.8%) | 35 (55.6%) | 63 (54.3%) | |
| Waist circumference (cm) | | | | 0.004 |
| Normal | 32 (69.4%) | 21 (33.3%) | 53 (45.7%) | |
| Risk | 21 (39.6%) | 42 (66.7%) | 63 (54.3%) | |
| Blood glucose (mg/dL) | | | | 0.001 |
| High risk | 49 (92.5%) | 42 (66.7%) | 91 (78.4%) | |
| Low risk | 4 (7.5%) | 21 (33.3%) | 25 (21.6%) | |
| Total cholesterol (mg/dl) | | | | 0.009 |
| Normal | 43 (81.1%) | 37 (58.7%) | 80 (69.0%) | |
| Risk | 10 (18.9%) | 26 (41.3%) | 36 (31.0%) | |
| HDL-cholesterol (mg/dl) | | | | 0.267 |
| Normal | 19 (35.8%) | 29 (46.0%) | 48 (41.4%) | |
| Risk | 34 (64.2%) | 34 (54.0%) | 68 (58.6%) | |
| LDL-cholesterol (mg/dl) | | | | 0.006 |
| Normal | 43 (81.1%) | 36 (57.1%) | 79 (68.1%) | |
| Risk | 10 (18.9%) | 27 (42.9%) | 37 (31.9%) | |
| Triglycerides (mg/dl) | | | | 0.514 |

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| | | | | | |
|---|---|---|---|---|---|
| | Normal | 49 (92.5%) | 56 (88.9%) | 105 (90.5%) | |
| | Risk | 4 (7.5%) | 7 (11.1%) | 11 (9.5%) | |
| Index of Castelli I | | | | | 0.032 |
| | Normal | 50 (94.3%) | 51 (81.0%) | 101 (87.1%) | |
| | Risk | 3 (5.7%) | 12 (19.0%) | 15 (12.9%) | |
| Index of Castelli I | | | | | 0.014 |
| | Normal | 21 (39.6%) | 12 (19.0%) | 33 (28.4%) | |
| | Risk | 32 (60.4%) | 51 (81.0%) | 83 (71.6%) | |

* Chi square test ($\chi 2$). TG: triglycerídes; CT: total cholesterol; HDL: high density lipoprotein; LDL: low density lipoprotein; BMI: body mass index.

Another important aspect of CVD control is hypertension. This parameter alone is the main risk for CVDs. In the Brazilian population, the prevalence is 20 to 25% of the general population (BRASIL, 2014). However, in the study the prevalence was almost double (39.7%). A similar study was conducted to diagnose the prevalence of hypertension in Quilombola communities in the state of Sergipe. The result showed that 26% had hypertension (SANTOS, 2019). Thus, even in relation to other Quilombola communities, Lagoa de Maria Clemencia and Oiteiro have high rates of SAH cases. This may be directly related to the residents' lifestyle, low socioeconomic conditions, poor access to health, and also the black ethnicity (LEAL, 2011). The black ethnicity has a prevalence of hypertension approximately twice as higher as that found in the white population (LESSA, 2006).

Diabetes mellitus is a disease that increases by 3 times the risk of an individual to develop CVDs, mainly due to macro and microvascular complications and metabolic changes, typical of diabetic patients (MALERBI, 1992). Of all participants, 11.2% had DM. In comparison with Quilombola communities of Sergipe, whose prevalence was 9.23%, the percentage found in this study was higher (SANTOS, 2019). The FG measured in the study also had a higher correlation with older individuals (84%), and 21.6% of the participants had high glycemic levels. In contrast with other Quilombola community, this time from Maranhão, where there was a rate of 17.33% of hyperglycemia (> 100mg/dL), the indices shown in southwestern communities of Bahia (21.6%) were 4.27% higher (BARBOSA, 2015).

The present study has some limitations, including the moderate adherence of the community. Only approximately 30% of the community underwent examinations. Thus, there is a chance of selection bias because it is more common that unhealthy individuals seek to participate in the study with the objective of finding a diagnosis. The distance of collection sites, where samples were collected for the exams, in the case of some more distant residences, despite the fact that there were two collection points, was also an important factor leading to low adherence. A low socioeconomic level was identified in the study and this may have also interfered with the collection of exams, because, although informed about the ideal time of collection, some individuals did not have enough food and spent 10 hours fasting. Despite these variables, very few studies have evaluated cardiovascular risk indices in Quilombola communities.

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# Environmental Impact due to incorrect waste disposal in River Miriti-AM

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***Abstract*****—** *The present work is an exploratory and descriptive research, which seeks to expand knowledge about the degradation of the Miriti River located in the municipality of Manacapuru-AM, to present the main characteristics of this degradation. The research was conducted in July and august2019,and was mainly related to the observational method that highlights the characteristics of the observed facts. The work that is presented is classified as field research and unsystematic observation because it did not have a guiding script. Data collection took place on Sundays, the day when the flow of people in the Miriti resort is higher and sought to verify people's care in relation to the waste produced in the use of the living space of the resort. The results indicate the presence mainly of plastic and metallic waste such as bottles and cans of beverages. Contact with people in informal conversations indicate that many agree that users of the site lack awareness of the disposal of solid waste.*

***Keywords*****—** *Solid Waste; Miriti; Degradation.*

## I. INTRODUCTION

One of the most common practices today is the disposal of solid waste in rivers which leads us to a necessarily sanitary problem in urban areas, as it has reached an numerous number of ecosystems, in this case rivers, lakes, oceans and others. According to Botelho (2011), the search for people for leisure spaces and other activities, causes them to ratify and channel rivers, thus modifying their ecosystems, without considering river geomorphology and hydrology thus causing various types of environmental degradation.

According to Cempre (2010) the responsibility to take care of the environment and give the best disposal of waste produced by human beings is an obligation of the public authorities, companies and of course of the population, that is, it is everyone's, this is also very clear in the new Law d and solid waste (Law No. 12,305 of August 2, 2010), where it clarifies us that everyone should give the best destination to waste produced and consumed.

Also, in this context of environmental damage and how to preserve the environment, just as governments play a key role in this issue, other actors also play a relevant role, such as educators, Non-Governmental Organizations (NGOs) and the media communication. In this sense Silva (2010) in studies describes to us that environmental education is very important in solving this problem, since the actors mentioned can encourage people to know and do their part, such as avoiding water waste and improper disposal of solid waste. In addition to these factors, a more educated society is able to consume products from environmentally friendly companies and charge more its representatives to comply with environmental legislation.

Santos (2015) reports to us that the disposal of solid waste in rivers has caused major environmental damage in these ecosystems and is a permanent concern of all involved. Water resources have been greatly affected by pollution, and this causes concern for the importance of this natural resource for all forms of social organization to carry out their activities. It is worth remembering that throughout the history of humanity, the rivers in became the backbone of the cities, because they organized themselves near their banks as a way to promote human development, through the benefits of maintaining life. Rivers are able to structure urban fabric and become axes of development of the design of cities, but their importance is forgotten when people by their actions start to degrade this resource.

We realized in Almeida's words (2010), that if we take into account the history of the occupation, modification and degradation of rivers, especially those located near the cities, these are relatively recent, since the history of human beings in land is at least two million years old and the processes cited increased on a higher scale from the 1st Industrial Revolution, i.e. 150 to 200 years ago.

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Theriver, object to this study is of great importance to the city of Manacapuru, whether in the environmental or tourist issue, aspects that justify the study on the environmental damage that the river has been suffering over the years. On this we will realize that the river is showing clear signs of environmental problems, due of course by the large number of solid wastediscarded its banks, which cause bad smell, dirt and various other types of damage. All aspects mentioned justify this study, because its data, research and examples of combating environmental damage will serve as a socio-environmental parameter for all those who care about future generations.

In view of the problem, the objective of the work was to report and analyze the physical processes (environmental problems or damage) resulting from the inappropriate disposal of solid waste in the Miriti River, located in the municipality of Manacapuru/AM, in the area where the Miriti Resort is located. The disposal of solid waste in the river has direct connection to the environmental damage that the river has been suffering over time, as it is these waste that cause problems such as water pollution, bad smell, whistling and various other problems that should be avoided.

## II. MATERIAL AND METHODS

### The search

Regarding the objectives, this work is an exploratory research defined by Zanella (2013), as one that "aims to expand knowledge about a given phenomenon". Thus, the work that is presented now seeks to expand the knowledge of the characteristics that define river degradation and the recognition of the reasons that lead to this degradation.

The work is also a descriptive research, explained by Zanella (2013) as "the one centered on the concern of identifying determinant or contributing factors in the triggering of phenomena". In seeking to identify the reasons that cause the degradation of the Miriti River, the work presents them as causative stemming from them and seeks to describe its origin of these causes.

As for the approach, the research is classified as qualitative, defined by Zanella (2013) as "the one that is based mainly on qualitative analyses, [...], characterized in principle, by the non-use of statistical instruments in the analysis of data." Thus, the identification of the characteristics of environmental degradation of the Miriti River, in Manacapuru-AM, occurred from the observation of the actions and impactful processes.

### Collection Area

The Miriti River is located about 7 km from the urban area of the city of Manacapuru/AM (Figure 1) has a population of 96,236 inhabitants (IBGE, 2018), and with approximately three hectares including the beach and river area. Also, the Miriti River is one of the main sights of the municipality, welcoming many visitors during the week. For the study, on-site visits were performed every 15 days during July and August 2019.

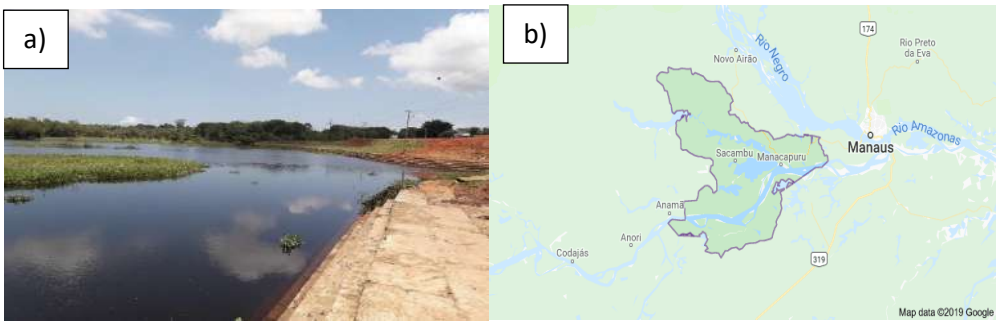


*Fig.1 -: a) Image of the Miriti River; b) Map of the municipality of Manacapuru – AM Source: Google Maps 2019).*

The present study is characterized as qualitative research, since it aims to observe, record, and correlate facts or phenomena, trying to describe them, classify them and interpret them for the purpose of studying and observing the damage caused by the disposal of solid waste in the Miriti River, a river located in the municipality of Manacapuru - AM. Thus, all the content obtained was analyzed, that is, the reports of the observations, the analysis of documents and the other information available, such as reports and observations on site. In addition to seeking foundation in theorists who treat the environmental cause with different looks, using texts of their works in the theoretical foundation.

Data collection consisted of the on-site visit aiming at observational verification, described by Zanella (2013), as the highlight of a set, of objects, people, animals, in order to list its main characteristics.

As for the observation made to elaborate the present work, it can be classified as field work, given its particularities, and unsystematic observation, because it

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does not have a guiding script or guide, but with the focus on objectives and problem of work.

**Data Analysis**

Data analysis consists of reading and interpreting the content of the collected documents, as well as on-site observation records. This research procedure is a tool for always renewed action due to the increasingly diverse problems that it proposes to investigate.

In this way you can describe and interpret the contents of the entire class of documents and publications read about the subject covered. This analysis leads to systematic, qualitative or quantitative descriptions, helping to interpret messages and achieve an understanding of their meanings at a level that goes beyond a common reading.

The analysis of the collected data is fundamental so that we can know if there are in fact serious environmental problems, as well as its causes and consequences. With the analysis of observations, for example, we note that often because there are not enough containers for the collection of these materials and the lack of education, residents and bathers end up throwing the waste used on the banks of the river, demonstrating lack of concern for the environment. Another issue that helps in this practice is the lack of on-the-spot surveillance, which favours the infringement, since many people only realize the mistake made when they receive a warning.

## III. RESULTS AND DISCUSSIONS

Fresh water with characteristics suitable for consumption, has great importance for humanity, and its availability is limited only to rivers, lakes and other superficial sources, so that according to Silva (2018) if we consider only the characteristics suitable for consumption, available water represents 0.4% of.

In a study on the main characteristics of the springs used as sources of supplies in the municipalities of the Solimões-Amazonas River, Azevedo (2016), points out the Miriti River in Manacapuru-AM, as a superficial source of supply of the municipality, however, it indicates that the river is threatened by the launch of domestic sewage, and according to the data collection for the present work the threat also lies in the large-scale presence of solid waste, since its presence in water bodies can harm animal life.

The Miriti River is an important source of leisure and supply in the city of Manacapuru/AM, and for these reasons an analysis of the possible environmental impacts caused by the disposal of solid waste in the region was carried out. Technical visits were made during 07, 14, 21 and 28 july and on 04, 11 and 18 august 2019, with the objective of visualally verifying possible impacts and causatives. It was observed that along the Miriti River there is a wide variety of solid waste discarded on the banks of the river, especially in the Balneário region of the same name. In Table 1, we can see some of the materials found.

*Table 1 - Waste found in the Miriti River Resort.*

| Class | Waste |
|---|---|
| **Plastic** | Plastics, PET bottles, cup, pot, packaging, Bags, hammock, straws, covers and other. |
| **Paper** | Newspaper, packaging, disposable diapers, cardboard. |
| **Glass** | Pieces of glass and bottles. |
| **Metal** | Soft drinks, iron. |
| **Wood** | Popsicle toothpick, barbecue skewers, crates and matchsticks. |
| **Organic** | Leftover sours, fruits and feces of animals. |
| **Waste in general** | Debris from construction material, cigarette portfolios, fabrics and lighters and etc. |

Lopes and Jesus (2017) report that historically societies have always developed their economic and social activities based on water resources and the increasing diversification of human activities to develop economically and socially, has required higher volumes of water to meet various consumptions. Among so many forms of use of water resources, Souza (2014), points out that there are other non-consutive use that are activities related to recreation, leisure, landscape harmony and tourism.

In the case of the Miriti resort, the use is public and can be used at any time, however, it is noticeable that some users do not contribute to the maintenance of the quality of the environment they use, therefore, it is necessary that users have the design according to Brum et al (2013) that public spaces should be the main icons of defense of the environment, because their absence in the urban context, should be compensated with the correct use of these spaces especially when there are water resources in evidence.

It is essential that people know the various types of waste or garbage and do whenever possible the correct disposal, because if we do this with certainty we will have a less polluted environment. Another factor that can make a difference for people to better dispose of their waste is for governments to provide adequate places for waste collection, recycling and disposal. Table 1 demonstrates how solid waste is disposed of in days of great movement of people in the resort.

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*Table 2 - Disposal of waste, cleaning and organization of the Miriti River.*

| Spa of RiverMiriti Months of July and August | Clean | Organized | With waste scattered on the banks of the river | Deposited in the appropriate places |
|---|---|---|---|---|
| **07/07/2019** | No | No | Yes | No |
| **14/07/2019** | Yes | Yes | Yes | Yes |
| **21/07/2019** | Yes | Yes | Yes | Yes |
| **28/07/2019** | Yes | Yes | Yes | Yes |
| **04/08/2019** | Yes | Yes | Yes | Yes |
| **11/08/2019** | No | No | Yes | No |
| **18/08/2019** | No | No | Yes | No |

According to MMA, (2010), the use of packaging in commercial products and by-products is essential for the protection of inputs during its distribution, storage, marketing, handling and consumption stage. Among the functions of the packaging is in ensuring safety and quality of life for the population, allowing access to different products from food or medicines to electronics and utensils in general in all regions of the country. Incorrect disposal of packaging is the major problem with regard to the necessary consumption of these inputs.

The main criterion for if one could know if the site is clean, organized and with adequate waste disposal or not, went to observation on site, because with the observation of the place we can see how they are to the physical characteristics, such as if there are garbage thrown on the banks and on the beach, as well as the behavior of the river goers in relation to this problem. The data covered above are nothing more than the vision I had of how the site was in the memento of the visit and observation.

When analyzing the characteristics of environmental impacts on water bodies, it is possible to realize that elements capable of identifying degradation in these places, according to Braga and Azevedo (2013) are mainly due to increased density population that without proper planning begins to launch its domestic effluents into water bodies, causing their pollution.

Albuquerque (2014), comments that although it is one of the most important waterways in the municipality of Manacapuru-AM, the river suffers each year from intense human actions that impair water quality.

The site presents on weekends a large number of regulars, this ends up facilitating the irregular disposal of waste on the banks of the river, among other bad characteristics, and that we noticed in Table 1, is that the Spa of the Miriti River presents in some days waste is deposited improperly, in addition to disorganization and lack of cleaning. During the observations it was worrying to see how people do not care about making their disposals correct and keeping the place clean, which makes us think that there is much lack of awareness with the environment and future generations.

All these on-site visits were fundamental not only for the collection of real data, but also to better understand the situation and the problem addressed among other factors. Images 1; 2 and 3 show a small picture of the situation of the river and how it suffers from pollution, the lack of adequate place, in this case of dumpsters for the disposal of waste is only one example of the problem, in the images we also perceive the solid waste deposited both in the banks as in the river bed causing numerous environmental damage.

In informal conversations with residents and bathers in the resort, about what they think of the irregular disposal of solid waste on the Miriti River, they believe that what is lacking for people is more awareness and education in dealing with garbage, another aspect claimed by them , is that it should have more participation of the public authorities in raising awareness and care for the environment, because there are still adequate places to dispose of the materials, an example would be the lack of places for selective garbage collection and dumpsters in the resort and Nearby. These are just one of the examples that could be applied to at least minimize the problem of pollution of the Miriti River, both by residents and bathers.

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*Fig.2 - State of the dumpsters in the spa of the Miriti river; solid waste deposited on the riverbed and waste thrown the banks of the Miriti river.*

## IV. CONCLUSION

Given the observations made in the Miriti River, especially in its locker room, it is perceived that the changes made from the need to provide attractions, to visitors to the municipality, it was found that the place suffers and will continue to undergo changes with incorrect waste disposals, because, even in view of the presence of dumpsters throughout the public use area, it is common to find residues through the ground and water, thus increasing environmental impacts such as water pollution, degradation in the area among other aspects, this is increasingly visible by the fact that the river already presents to its margins materials derived from plastic, metals and others that even take years to decompose.

Polluting sources are diverse, however, measures can be taken, initially by the municipal public authorities in partnership with the community and other environmental workers, where they can define and implement environmental education, signage and monitoring of the area with environmental guards in which when developed can at least mitigate the pollution problems of the Miriti River, since only through education and actions aimed at raising people's awareness, will it be possible to a change of attitude, since the main causes of environmental degradation are human beings. Awareness work should cover residents of marginal areas of the river who are also polluting sources and should be contemplated by government action to reduce the impacts already caused on the water body.

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# Analysis of Solid waste from the Port of Manaus

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***Abstract***— *The concern with the waste generated by society can directly or indirectly affect the environment. search to maintain an ecologically conserved environment, without risks to human health and natural resources a relevant concern. Therefore, with the general objective of investigating how the disposal of material from the activities carried out in the Port of Manaus occurs and the specific ones are to highlight which materials, quantities and their final destination, propose the implementation of waste management and show the of impacts caused to the environment by its misuse. The intention advocated here is to provide a reflection and show how the management of municipal solid waste is quite complex and depends on a wide review of the in force, including those that concern capitalist progress itself and the ways of conquer happiness. Therefore, it necessary to carry out further studies on environmental management in the port sector, which according to a showing the lack of a sector that is responsible for the disposal of these waste.*

***Keywords***— *Solid Waste, Environmental Management, Environment.*

## I. INTRODUCTION

Solid waste, called "garbage" by common sense, represents one of the major contemporary environmental concerns. This waste comes from industrial, domestic, commercial, agricultural and service activities, solid waste (ANDRADE and FERREIRA, 2011), and can directly or indirectly affect the environment.

In the greenest view, solid waste management may include the separation of waste at the source to which they are generated. Among these programs we can highlight the selective collection system, the direction of part of waste for recycling and composting programs. Thus, the basis would then be laid for the waste to have minimal interference in the environment and public health (MOTA et al., 2010).

The untreated disposal of waste generated daily has become a worldwide problem, as these discarded incorrectly can cause damage to soil, water and air. Soil contamination can alter its physicochemical characteristics, which poses a serious threat to public health by becoming the environment conducive to the development of disease transmitters (BARBOSA FILHO, 2011). On the other hand, water pollution can alter the characteristics of the aquatic environment by percolation of the liquid generated by the decomposition of organic matter present in waste, associated with rainwater and springs existing at the discharge sites waste. While air pollution can cause the formation of natural gases in the garbage mass, by decomposition of waste with and without the presence of oxygen in the environment, leading to risks of migration of gas, explosions and even respiratory diseases, if in direct contact with the Same.

The Port of Manaus, inaugurated in 1907, is considered the most original in Brazil. Built on a floating pier, it follows the level of the waters of the Negro River, in times of great floods. The Port of Manaus had its structure for reception of tourists recently renovated. In addition to serving for the boarding and disembarkation of passengers and goods that go and from the cities of the interior of the state, receives large transatlantic tourists from various parts of the world. Also disembarks products destined to the Industrial Pole of Manaus, as well as serves

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as a shipment for products manufactured in the city and that are intended for various parts of Brazil and the world (SILVA, 2012).

Seeking the path of environmental sustainability, integrated solid waste management can adopt as measures to reduce and reuse waste by composting and recycling processes, actions to be encouraged through educational actions aimed at more conscious consumer attitudes on the part of the population. Acting with market forces, promotion actions can be developed that lead to new forms of environmentally sustainable production, and can be carried out with less burning of fossil fuels, the main villain when referring to climate change global. Recycling, on the other hand, can be driven through selective collection and waste screening, although for this there are difficulties in most Brazilian municipalities (GOUVEIA, 2012).

In this article will be addressed specific aspects of the management of solid waste from the activities carried out in the Port of Manaus, with emphasis on the materials generated, quantities and their final destination. Furthermore, the implementation of waste management will be proposed and show the importance of impacts caused to the environment by its misuse.

## II. METHODOLOGY

The present study was carried out in the Port of Manaus located on the west coast of the Negro River in the Center in the city of Manaus, capital of Amazonas. We chose to develop this study in the port of Manaus, due to this being the main Port existing in the city, which supplies other moorings and Private Use Terminals (TUPs) (Figure 1). Thus, technical visits were made during the period from August to September 2019, in order to obtain an overview of the current conditions of the port regarding the management of solid waste. As part of the analysis, photographic records of the area were performed, thus obtaining a diagnosis of the study area.

In addition, a survey of logistics information was carried out with the company responsible for the administration of the port.


*Fig.1: Place of realization of the search Port of Manaus.*
Source: GOOGLE EARTH, 2019.

## III. RESULTS

The port of Manaus located in the city of Manaus is one of the places responsible for the disposal of products and people in the city daily. The port structure of the state of Amazonas has the port of Manaus as the main intermunicipal and interstate access, connecting the Amazon municipalities to other states (Pará e Rondônia).

Through the visits it was possible to verify that solid waste is collected daily by public cleaning officials. According to employees, an average of 8 to 10 tons of waste is collected daily around the waterfront as it mortra table 1. To obtain this quantity, 70 employees assigned by the city for the task are required. It is worth noting that the waste was collected both on the shore and in the waters near the margins.

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*Table 1. Amount of waste taken from the Port of Manaus.*

| Day | Weeks | Monthly |
|---|---|---|
| 8 Tons | 56 Tons | 224 mil Tons |


*Fig.2. Solid waste collected in the Port of Manaus.*

Figure 2 shows the presence of a very large variety of discarded waste, and even contaminant residues such as plastics, batteries, batteries, fish residues discarded by fishermen, among others. Despite this, the responsible officials signaled the absence of a separation of waste collected for further recycling or reuse. According to the information obtained on site by the cleaning team, all residue taken from the river and on the banks of the Port of Manaus, are taken daily to a ferry where the transfer is made and subsequently routed to the landfill of Manaus, as shown in the Figure 3.

*Fig.3: Collection and transport of waste on the banks of the river.*

According to Table 2, it shows the amount of waste taken monthly from the Port of Manaus, thus generating risks to human health that live in its surroundings, as well as to the environment, because rivers end up being contaminated with this waste. Bringing serious damage to health and the environment.

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*Table 2. Types and quantities of waste taken per month in the Port of Manaus.*

| Type | Amount |
|---|---|
| Cargo remains | 20 thousand |
| Packaging (pallets, plastic blades, cards) | 80 thousand |
| Household waste from the social sectors (canteens, workshops, laundries, toilets) | 30 thousand |
| Lubricants and hydrocarbons used, filters, varnishes, paints, solvents and batteries maintenance machinery and infrastructure | 40thousand |
| Debris from stowage goods | 54 |

Due to Manaus's dependence on the port system ports are used constantly and therefore, it is necessary a Port Environmental Management, mainly as to the search for environmental adequacy. Given this scenario, we consider that, in practice, public environmental management (and particularly port environmental management) is done fundamentally through environmental licensing. This is due to the fact that environmental licensing is the main instrument in operation that the Brazilian state has to control polluting economic activities, and thus to guarantee diffuse rights (FILHO, 2011).

Some ports do not have any physical space for the storage of waste, which are dumped in Rio, so some alternatives of correct storage of this waste in the Port of Manaus, would be of great importance for separation, reuse and revitalization of these materials that could serve as recycled material according to Figure 4.

These alternatives would generate employment, health and improvements for the Port of Manaus, which could keep the place clean and with greater visibility in front of several vessels and ships that stop in Porto. Also generating, the environmental conservation of rivers and the waterfront.

Precariousness and lack of adequate equipment of the urban cleaning system in most Brazilian municipalities can be identified in the light of the available data and information, despite the poor quality of many of them (Figure 3). It is understood that the axis of the urban cleaning system is in the structuring of home collection, cleaning public laurels and in the proper destination of waste collected (ANDRADE and FERREIRA, 2011). The sector suffers enormous lack of technical training, particularly in smaller municipalities.


*Fig.4. Types of collectors possible for use in the Port of Manaus.*

According to Borges and Pinto (2010), aspects related to solid waste management is also a cultural issue. The cultural issue comes from the action of launching discarded waste into the river, but still the habit of valuing or perceiving the value of the garbage that is produced, such as waste with reuse potential or requiring differentiated handling.

An environmental waste management policy presupposes the adoption of Integral Waste Management

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systems - GIR, with the combination of generation flows with methods of collection, treatment and final disposition with environmental benefits optimized from an economic point of view and Social. This system must be environmentally, economically and socially sustainable, with market orientation, flexible and operated on a regional scale. (BARAKAT, 2009)

Many unmet wastes in these contraindicated sites could contribute to the generation of employment and income in the country if they had been preliminary segregated and referred, for example, to waste pickers' associations Recyclable. Even after the advent of PNRS, many Brazilian municipalities still have the financing of urban cleaning activities linked only to the Urban Land and Territorial Tax (ULTT) – manaus case – which hinders the development of policies, goals and financially viable treatment techniques (HENDGES, 2012).

It is perceived, then, the importance that water has for the regional population. "All the paths of the Amazon ultimately lead to the ports of Belém and Manaus. All who move through the region start or end 38 their journey son in one of these ports" (idem). In Manaus, through the Port of Manaus Moderna, arrive and leave not only passengers, but also the most diverse types of cargo, ranging between food, appliances and even cars.

Regarding the movement of vessels in the Port of Manaus, on average 330, transit through the port complex of Manaus, and their average stay in the different moorings is 2.79 days. According to the tenant data, in 2011, 67 vessels attended Roadway Pier, and their average stay was 3.3 days.

## IV. FINAL CONSIDERATIONS

With the lack of environmental management in the Port of Manaus, the waste taken from the river daily is taken to the Manaus landfill, without proper separation and a process of reuse of these wastes. Until the present development of the study, it can be verified how important it is to implement an environmental management sector in the Port of Manaus, aiming at improving the correct disposal of these waste, which can generate jobs and environmental health to those who live in their Surroundings.

Incorrect waste management causes damage to the environment and influences the quality of life of people and other species. Some measures can mitigate environmental damage, including integrated solid waste management. Society and nature benefit from practical waste management actions.

3R's policy is a smart solution, being well implemented and within an integrated management proposal can provide many benefits for society in general. Organizes and gives better working conditions for garbage pickers, stimulates the organization and the waste reuse chain and provides population awareness of the rational consumption of goods and services.

Currently the organizational structure of the Port of Manaus does not have an environmental management unit, health and safety at work. The demands for management of this nature are outsourced, which is carried out through the operational licensing of the port complex.

Therefore, it is necessary to carry out further studies on environmental management in the port sector, which according to a study showing the lack of an environmental management structure that is responsible for the disposal of these waste.

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# The Intellectual Property Protection and Commercialization Management Process in a Technology Licensing Office

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***Abstract*— *In Brazil, the Technology Licensing Office (TLO) is responsible for protecting and commercializing the Intellectual Property (IP) in a Scientific and Technological Institution (STI). When TLO's operation is analyzed, it can be understood that TLOs still need to develop their organizational skills in order to achieve their goals, particularly on technology protection and commercialization strategies. This paper presents a process model with three key processes, namely Admit Techology, Protect Technology, and Commercialize Technology, with their respective subprocesses, and other support processes. With the operationalization of the process model presented, TLO can analyze the technologies and define the strategies for their protection and commercialization, enhancing their transfer to the productive sector. This model was successfully applied to a TLO of a military STI.***

***Keywords*— *intellectual property; technology protection; technology commercialization; technology licensing, technology transfer; technology licensing office; technological innovation.***

## I. INTRODUCTION

In Brazil, most research is done by Scientific and Technological Institution (STI). However, there is a distance between the STI and the companies, which hinders the access of companies to technologies created or developed by STI. Therefore, it is difficult to transfer the technologies developed by STI to companies. Thus, in order to improve the interaction between the STI and the companies, it was created, according Brazil (2004), the law 10.973, known as Innovation Law.

The Innovation Law requires that the each STI disposes of a Technological Licensing Office (TLO), with the aim to manage policies of innovation from the STI, including questions relating to intellectual property (IP). The intellectual property (IP), according WIPO (2015) and INPI (2014), regards the branch of law that deals with the legal protection granted to all creations of the human mind, such as inventions, literary and artistic works, symbols, names and images used for commercial purposes. The IP is divided into three categories: industrial property, copyright and sui generis protection, as will be further detailed in item 2. Santos (2011), describes that the IP is a theme that is gradually gaining prominence in private organizations, seeking as much use it with marketing purposes, such as to ensure a competitive position in the global economy, and also in public, especially in STI, which increasingly encounter a new reality composed of technology and innovation transfer processes.

Analyzing the statistics given by INPI, according to INPI (2014), it is possible to perceive that Brazil shows a relevant production of high technologies, when observing the quantity and quality of protection order deposits (i.e.: patents). However, to deepen this analysis regarding the commercialization of protected Technologies (i.e.: licensing) that are creating value; it is possible to realize that licensing is very limited. In other words, even though the amount of protection order deposits has increased in Brazil in the last decades and has become very important, this condition hasn´t significantly changed the innovative Brazilian environment that continues with a lack of actions to spread output technology.

For this to occur, according to Jannuzi at. al. (2008), the legal instruments to stimulate innovation, should be further worked for the intellectual creations generated from STI convert in technological innovations. In addition, the TLO should assume a role of mediator between the STI and the companies, in this case, for negotiations involving matters relating to IP. For Frezatti et al. (2014), Conley, Bican and

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Ernest (2013), Shahraki (2012), Germeraad (2010), Jannuzi et. al. (2008), O'Hearn (2008), Chesbrough (2007), Jain e Sharma (2006), I Gràcia (2005) e Feldman et al. (2002) one of the challenges for the TLO is to use multiple mechanisms to outline strategic decisions for the management of IP, considering the STI innovation strategy. This will allow to succeed in portfolio management technologies. From this perspective, define the organizational processes that will enable the protection and commercialization of creations generated in the framework of STI is essential to ensure efficiency and effectiveness in the management of IP.

Even with the minimal consequences defined by law, when TLO, in Brazil, is analyzed, it´s possible to realize that they are organizations that still need to develop their organizational abilities in order to achieve their goals, mainly for technologies protection and commercialization strategies, with the purpose to add potential value to the technology and promote its transfer to the productive sector.

Thus, the aim of this paper is to present a process model for the protection and the commercialization of technologies constant in a TLO portfolio, based on IP. Such model was applied to TLO from the Departamento de Ciência e Tecnologia Aeroespacial (TLO/DCTA), a STI of the defense area, in Brazil. This STI is a military institution that has as a mission "to increase the knowledge and develop scientific-technological solutions to strengthen the aerospace power, using teaching, research, development and specialized technical services, at the aerospace field" (CHIMENDES, 2011). From 101 technologies from the TLO/DCTA portfolio, there is no one commercialized to the productive sector before de development and application of the model that was suggested in this paper.

To achieve this aim, an case study in a TLO/DCTA was performed and supported by a literature review, conducting research in relevant books and periodicals on technological innovation and intellectual property, notably relating to the subject protection and technology transfer. Whereas the duties and responsibilities as well as the activities carried out by TLO vary according to the STI, in the case of the STI under analysis, the TLO functions aim to protect and market the resulting technologies from research and development projects (R&D) that are not considered strategic in to support technology transfer to the productive sector. The management of R&D and innovation management is carried out by other STI departments, without the direct participation of the TLO.

Evaluating the activities performed by this TLO, it was observed that it was a set of bureaucratic tasks, with no ability to make decisions on the need to protect a technology, the type of protection, the market potential of each technology, as well other issues of strategic nature. Since TLO, which handles complex decision-making issues, should be aligned with the corporate strategy and innovation at the STI. Specifically regarding the protection of technology, these decisions should take into account the potential of technology to become an innovation, and the markets where this technology will be more attractive. Thus, only then it is possible to define the best way for their protection, that is, a protection that adds value to the technology and facilities its the commercialization and transfer.

This article is structured, considering as fundamental literature Andrade, Soto Urbina, Chagas Jr. and Silva (2018), Andrade, Soto Urbina and Chagas Jr. (2017), Andrade, Soto Urbina and Follador (2016), Andrade, Soto Urbina, Follador and Follador (2016A) Andrade, Soto Urbina, Follador and Neves (2016), Andrade, Soto Urbina, Follador and Follador (2016B) and Andrade (2016)), in four parts, including this introduction. The second concerns the review of the literature that deals with the technology protection and commercialization concepts, according by the fundamental literature. The third presents the technology protection and commercialization process proposed, also considering the fundamental literature, and finally, the fourth part presents the final considerations of this study.

## II. LITERATURE REVIEW: PROTECTION AND COMMERCIALIZE TECHNOLOGY BASED ON INTELLECTUAL PROPERTY

### 2.1 Technology protection

According Cruz (2008) from the time when the nations were recognizing the economic importance of applying knowledge to develop technologies, mainly because they perceive that market were ruled only by the competition among prices, but also by the competition between creations or inventions that were transformed into innovations, began the search for ways to ensure the ownership of such knowledge or technologies. However, the big question was: how to ensure the ownership over an immaterial good, which use or the use or disclosure cannot be restricted?

This question points to the need and the importance of protecting the technologies developed by STI. It is the protection, in its proper format that will ensure ownership of the created technology, making the STI to enjoy the benefits arising from the R&D activities. At this moment, Pinheiro (2012) and Chen e Wang (2010) indicate that protection is one of the basic assumptions to ensure the marketing rights

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of established technology, and for Silva e Silva (2013) technology protection goes hand in hand with innovation.

Thus, according to Cruz (2008), the solution was the concept of the extension property, originally created for tangible assets on the intellectual manifestations. However, this extension took place without proper analysis of mismatches generated by this type of appropriation. In this context, to ensure profit from the production and marketing of intellectual property, monopoly rights over these assets were created. However, the protection of intangible assets was not able to exist on its own. That is, it needed the support of a supreme and sovereign authority to guarantee compliance with the rules within a delimited territorial space. Thus, the State was responsible for creating and legitimate rights IP.

Such an statement shows the need to assess what are the markets where the technology developed must be protected, because it is not enough to protect the technology only in the market where it was created. After all, the market for use or manufacture may be other, then it is necessary to adequately characterize the market, and only then, to decide on what would be the viable markets, where to protect technology. This review has positive implications on marketing issues of technology.

Also, before you start formatting protection, it is necessary to perform analysis related to technical issues related to the technology created or developed, and to the marketing aspects of such technology.

Aparecido Dias and Silveira Porto (2013) corroborate such a statement and describes that the technology needs to be understood in detail, including its purpose and the problems that it is intended to solve, the possible applications, the identification of the differential in relation to other existing technologies, among other issues.

Still Jungmann and Bonetti (2010), describe that to protect a technology, another important aspect is the definition of its ownership. In other words is necessary to define who really is the owner of the intangible asset. In this same aspect, as Fitzpatrick and DiLullo (2005) pointed out, joint research with other organizations should be regulated through contractual agreements, which should describe how the u are appropriated, marketed and / or used, protecting, thus, the rights of IP. This definition is important because, as Mello (2009) and Leal Souza and Solagna (2014) discussed, like every right to property, the IP is exclusive, that is, excluding third party use and enjoyment of the right of the object, guaranteeing exclusivity and the control of these to the right holder.

These evaluations indicated in the above paragraphs, among others, are important to direct the strategies and instruments for the protection of technologies. Closs et al. (2012) indicate that the TLO is an organization, whose function is to make such assessments.

Thus, the results of such assessments will subsidize the TLO for choosing the most appropriate instrument for the protection of technology. Legal protection is obtained through protection of IP instruments, which are identified as Copyright, Industrial Property and Protection Sui Generis.

Furthermore, adapting de Almeida, Fleet and Barreto Jr. (2012), Bieberbach (2012) and Jungmann and Bonetti (2010), the same technology could have various types of protection, covering different aspects by the use of appropriate instruments IP, depending on the different protection strategies. Using different options for protection ensures a competitive edge even stronger. Caerteling, Halman and Doree (2008) and Dechenaux et al. (2008) reinforce this point, indicating that different mechanisms, namely the terms of protection, affect the marketing opportunities of technology, particularly with respect to the value of the business transaction. However, this will depend on the strategy used by STI, because not always a STI protects a technology with marketing purpose. There is no single strategy for all technologies to be protected, and not all technologies will be protected by patent. For example, for each technology, one must study what is the best protection format, verifying the need of STI, which may include confidentiality (eg. Trade secret), as in the case of a military STI, which may develop sensitive technologies (sensitive technologies, according to Long (2012), are those which are maintained out of access by a particular country or group of countries, because of usafety reasons, and they can then be protected by trade secret). Other approach considers to include protections to ensure a share of the market for the organization that adopts any given technology (eg. patent). Also, it may be that the same technology can have more than one type of protection format (eg. Utility model patent and trademark registration). Also, it can be that a technology can be divided into parts, so that protection is formatted for each part individually. Thus, in the context of diverse protection alternatives, the strategy for the protection of technology should be defined on the basis of assessments, performed preliminarily, as previously described.

Further reinforcing this issue, considering Spivey, Munson and Wurth (2014) and Gonzalez-Gelvez (2013), to protect the created technologies is a key action for STI. However, in order to make this protection, it is necessary that managers of

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the TLO devote more time to the formulation of strategies designed to make the best decision about the format of the most suitable protection for each technology. Thus, the formulation of strategies for the appropriation of technologies, adapting Ram (2007), depends on the organizational capabilities of the TLO, the external environment, and the institutions that the TLO interacts.

Thus, according to Al-Aali and Teece (2013), a very sensitive element of the protection of technology through the IP, is the use that will be given to the technology. Thus, a business model should be developed for this technology, with the purpose of supporting the development of strategies for protection, and subsequent commercialization of this technology. After all, once it is known how technology can be used or applied, it is easier to develop such strategies. To that end, Di Minin and Faems (2013) describe that technology, its business models, and the IP management strategies do emerge as three inextricably linked dimensions. Any change in one of these three strategic dimensions has implications for the other two. Considering and adapting from Teece (2010), a business model will articulate and demonstrate the logic of how the TLO and the STI intend to create value, with the technology, whose IP must be managed taking into account its stakeholders. Almeida, Barreto Jr. and Fleet (2012) point out that a business model consists of the following elements: market segments interested in the technology; value proposition to customers/ potential recipients of technology; cost structure; revenue generation; distribution channels; strategic partnerships and organization's position, namely of the STI, in the value chain; and competitive strategy. According to WIPO (2010), due to continuous changes in the IP system, new business models are emerging, challenging the policies and practices already established. These models aim to increase the efficiency and effectiveness in the management of the IP in a TLO.

Thus, considering the possible business models to be adopted, the chosen protection format will impact directly in the marketing process of technologies, as well as in its transfer process to other organizations. Making an allusion to Arora and Ceccagnoli (2006) and Fitzpatrick and DiLullo (2005), efficiency and effectiveness in protecting a technology do increase the propensity or success to commercialize it.

Another point of great relevance in this context is the monitoring of protected technologies, since the violation of IP rights is a huge matter of concern to the holders of the protected technology. Jungmann and Bonetti (2010) emphasize that to avoid losses, STI must be careful to manage the protection of their IP assets through periodic assessment, in order to identify possible unfair competition. To define the best mechanisms to ensure compliance with the law, by a third party, reduces or limits the amount of law violations in the protected IP, ensuring to the organization the due benefit or return generated by that intangible assets. Complementing to Chaudhry, Cordell and Zimmerman (2005), the problem of unauthorized use of a technology is significant and growing, and the implementation of actions to curb counterfeiting is still a problem for organizations. These situation points to the need to establish mechanisms for monitoring the protected technologies, in order to assess whether there is misuse of technologies in protected markets, or even in other markets. So, that TLO can take steps to rectify the situation. Such monitoring could also be used to seek technologies that are already more modern that the ones protected by the STI, and thus feed back into the process of commercialization of technologies, and also the R & D processes.

Still, considering this question of the violation of IP rights, you can reinforce the need for a proper analysis of the created technologies, and design a business model to use, and only then develop strategies for their protection, because according to Bezerra (2010 ) and Pisano and Teece (2007), a strong technology protection hampers its imitation and generates economic benefits for its holder. Still, in this sense, as Bezerra (2010) points out, the protection will be considered weak in conditions in which knowledge is easily disseminated and easily accessible, and will be considered as strong as it is higher the difficulty of imitation.

Finally, from the literature review it can be said that the protection is a factor that directly impacts the commercialize and the transfer of technology. The type or form of protection, including the markets where technology is protected, can make the technology attractive for a given organization, due to the competitive advantage that this protection brings with it. Thus, considering Ritter Junior (2015) and Kelm et al. (2014), developed technologies should be secured in the manner that is most appropriate to STI, without ignoring the issues related to the promotion of innovation. It is therefore necessary that the strategies for protection and commercialize are integrated in order to transform the opportunity that new technology offers into competitive advantage. According to Arora and Ceccagnoli (2006), a strong protection strategy translates into a greater reward in the commercialization of technology. And for Bezerra (2010), protection of technologies is presented as a

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way to facilitate technological innovation, among other possibilities.

**2.2 Technology commercialization**

In cases where it´s important to transform technologies on innovations, it´s necessary that the developed technology by the STI be transferred to an organization that will use it in its process or will embody in their products and services, creating a competitive edge. Along the same line, Jorge, Lotufo and Cortez (2008) describe that a technology protection is relevant only if it was transferred, generating beneficiaries, thus fostering innovation. However, when Teece (1986) is considered, the invention or creation of a technology by a researcher in a STI doesn´t mean that it will be automatically transferred to another organization and it doesn´t mean that this technology will turn in an innovation either.

For Mattos and Guimarães (2005), the innovation is divided in two parts: one of them is the generation of an idea or the invention itself; the other is the conversion of that idea or invention in a business or, other useful application. Thus, it can be said: Invention + Commercialization = Innovation. This same concept can be applied to the Technologies that compose a TLO portfolio. Thus, the TLO receives and protect the technology developed by the STI. Afterwards, it´s necessary that such technology be commercialized by the TLO, and, only, then, be transferred to another organization that will use it, turning this technology into a process, product or service, making it been part of a society, and potentially creating, innovation. After all, considering Chimendes (2011), a technology developed by a STI and properly protected is an asset able to be Commercialized and Transferred.

Since commercialization promotes technology transfer, it´s necessary to establish a set of activities for the commercialization of the technologies managed by the TLO, such as: the strategy planning to search for potential interested organizations of this new technology, offer it to the organizations and, negotiate the transfer of it. To Miller and Acs (2013), Chimendes (2011), and Sine, Shane and Di Gregorio (2003), the commercialization of the Technologies created by a STI is an economic event, once, it´s a way to generate value, including social value. Still, to highlight what was already said before, the technology commercialization activities are vital in a STI, because there is no way to accomplish a technology transfer, without a previous negotiation first.

The technology commercialization, according to Bandarian (2007) and Shane (2002), involves an expertise to negotiate it by a STI to another organization, and, still, considering Lichtenthaler (2011), Haeussler (2008), Chesbrough (2007) and Teece, Pisano and Shuen (2000), to commercialize a technology is just an strategic issue, which is linked to the competitive forces of a STI.

In the same way, as there is not only one way to protect the technologies, there is not one way to commercialize it either. According to Jungmann and Bonetti (2010) and Rocha, Sluszz and Campos (2009), from the information analyses about the goods or assets of IP, or, about the technologies, and also the interests of the STI, it is possible to define the structure to access to a particular technology, which is more appropriate. Such structure can consider: making licensing or franchising contracts; sell the good to another company or transfer the know-how, create spin-off or start up and joint ventures; encourage the incubation of the companies or the generation of a company with an specific purpose, licensing in the form of cross-compensation to gain access to a partner´s technology, among other possibilities.

It is also necessary to point out that in some organizations, such as companies of capital goods, technologies are developed focusing the market needs, aiming its commercialization. On the other hand, in a military STI, technologies are developed for internal usage, focusing its application. Just some of them in that case, just the technologies which present civil and military application possibilities, will be send to the TLO to be commercialized and transferred. These are only a few examples to show that not all technologies developed by a STI have the goal to be transferred to another organization.

In order to explore the commercialization process, it must be pointed out that for each technology a commercialization strategy must be defined. To elaborate this strategy it´s necessary to know precisely the technology and also it's potential in the market. Dechenaux et al. (2008) and Lin and Kulatilaka (2006) deepen this definition, describing that to succeed on a technology commercialization, the market information where this technology will be placed must be considered.

Therefore, to Rocha, Sluszz and Campos (2009), on the whole, the definition of a more suitable modality and, afterwards, the means or strategies to an effective commercialization depends on several factors, among them: the stage of the development of the technology (bench stage, laboratory, prototype, validation, etc.); protection existence and its nature ( patent, utility model, register, brand,

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industrial secret, etc.); demand an specific market; plan of action (radical or incremental); different kinds of transfer contracts (with or without exclusivity); ease of copying by third ones, applicable law to the technology; and investments to end or to place the product in the market.

Still, Still, Altuntas and Dereli (2012) and Rahal and Rabelo (2006) present a set of other points that are critical to promote the commercialization of the protected technologies, such as the technology itself; the nature and the refinement of it, the scope of the technology; identification of points where technology is more fragile or superior to the others that exist in the current market; the qualitative and quantitative benefits realized by the potential user; the necessary time to end the development of the technology to a market; innovation speed diffusion; the entrance barriers; a prototype available; the technical viability; the rapport with others technologies, the inherent risks, the developing company; the technological market needs; the size and the growth fee of the potential market; the short time to the technology get into the market; and, the short term return on the investment.

Based on this two previous paragraphs, and considering Kotha, George and Srikanth (2013), Mohan (2012) and Dong-Hyun et al. (2007) it´s possible to conclude that the commercialization process requires a reliable evaluation method from the incoming technology to the TLO. Moreover, according to Barbieri and Alvares (2005), the technology commercialization, as IP, is different from the tangible assets, including those ones that incorporate new technologies, as machines, equipments and productive inputs. It is a business that happens in a highly asymmetrical market, where the buyer doesn´t know what he/she is effectivity buying. That´s why it is normal that negotiations flow slowly than in the case of business involving well known goods and services. In this case, the reputation of the company that is selling is also another facilitating factor in the negotiations.

Also, according to Feldman et al (2002), the attractiveness that the potential receiver realizes about the offered technology is an enabler factor to the technology transfer. Fujino and Stal (2004) strengthen this idea, describing that to be succeeded on technology commercialization it´s necessary that the potential technology receiver realizes how this technology can add value to his/hers/its business

Therefore, even knowing that the processes of commercializing technologies and the tangible goods are different, there is no way to commercialize a technology, before offering it to the market, or, introducing it to potential demanders. So, it´s necessary to utilize, as Turani and Tais (2007) and Santos (2003) indicate, communicative or promoting marketing tools because they have been essential to activities related to innovation. Thus, Fujino and Stal (2004) and Kotabe, Sahay and Aulakh (1996) describe that a marketing strategy should be used to technology commercialization. They argue that there is not a specific strategy, so that the marketing strategies to offer a given technology must be built focusing in such technology, specifically.

Thereby, it is important to carry out an analysis about the possible consumer markets, which would react to develop strategies to the technology under analysis, including the right way to offer it to all potential stakeholders. According to Kotler and Keller (2006), the promotion covers all those communication tools which get the message to the target audience.

In order to offer a technology to its potential demandant, Dias and Porto (2013) and Keinz and Prügl (2010) indicate that for each technology it should be created a business profile, with a short report describing: the real problem that can be solved by the technology in its specific area of application; the market potential, and its growth rate; the replaceable and/or rival technologies; the potential clients or retailers; the strategic options related to technology commercialization (licensing, exclusive rights, a new company starting, etc.). This profile should be sent to the organizations with potential to receive technology, as a way of disclosure.

Another meaningful issue related to the technology commercialization is the definition of the price, or, placing monetary value to an IP. Although relevant, set a price to be paid for the technology demandant is a very difficult point, because there are no completely clear or accepted methods among the technology managers. Aziz, Harris and Aziz (2012), Closs et al. (2012) and Lopes (2008) corroborate such statement when they affirm that a technology valuation doesn´t mean to be an easy task. It´s just the other way around, it´s one of the most critical tasks in an IP management.

Almeida, Barreto Jr. And Frota (2012) and Chesbrough (2010) describe that the price of a technology is determined by the business model used to bring it to the market. The same technology taken to the Market by different business models will ensure in different settlement values. So, it´s important to build a business model to support the preparation of a technology commercialization strategies, which include issues related to valuation or technology pricing. This is important because, according to Reillly (2013), the IP value is affected by the actual value of the

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future income expected for the technology. Given this business model it´s possible, then, to break through valuation. Marques (2010) describes that there is a wide range of models, approaches, and theories that try to valuate the technologies. Therefore, Ferreira, Guimarães and Contador (2009) point out that is necessary to look for the necessary subsidies among the available models so that the price can be better valued.

Considering the available models, Lopes (2008) indicates that, generally, the technology valuation is commonly done following three distinct approaches: one of them is based on price (it´s about to define the price that can be supported by the acquisition or a construction of an asset with the same utility); another approach is based on the market (uses the prices of the identical or similar active markets); and, the last approach, the one based on an income flow, calculated using utility tactics to convert future monetary values in a present one, so that this value be based on the expectations of a current market about future returns. To apply theses approaches, Oliveira and Beuren (2003), describe that accounting can contribute, establishing standards to measure, register and prove the intellectual property.

For Teece (1998), the value of the commercial transactions with IP may vary depending on the sector in which the technology can be placed, and the kind of protection achieved. This way, Alván (2012) describes that one of the most required instruments to pay a STI for its researches are royalties. The royalties are a kind of compensation paid for those who have the IP rights over a technology. According to Jungmann and Bonetti (2010), the value of a royalty fee is commonly calculated as a percentage of a net value from the selling of the products or the licensing services. To establish a fair and realistic value for royalty to the parts on the contract, it´s suggested that a solid business model be used. This must include financial settings and calculation of profitability from licensing objects, as well as the economical advantages it might bring in to the licensing company. The royalties calculation is based on: the competitive advantage from the licensing (distinction of the products due to innovation, impact on the production costs, etc.); the competitive edge time connected to IP protection period (e.g.: validity of a patent); the licensing activity of profitability; the market size opened to licensing.

So, the TLO can to use the business model initially made to support the valuation, yet, during the business commercialization of the technology, it´s necessary to request the business model that the potential receiving of this technology intends to apply to it, in order to get a fair value for both parts.

On the other hand, according to Fujino and Stal (2004), for a given STI, the best conditions during a commercialization technology stage do not end when the price to be paid to the technology transfer is settled. There are other aspects to be considered, such as the human resources training, and the possibility to apply and increase the knowledge about the technology transfer. Another aspect that deserves a special attention at the technology commercialization stage, is the drafting of license agreements, where all the previous traded aspects will be detailed. For Garnica and Torkomian (2009), the technology commercialization using contracts that include IP shown present in the reality of TLO, and, as an identified difficulty factor in all processes, the highlight was the slow pace of legal and administrative area for the execution of the contract. They also indicate that it was clear to everybody involved that it was possible to consolidate the partnership quickly presenting at the beginning to the technology receiver that the transaction has a long waiting period and that sometimes there is a lack of information during the procedure, which could be discouraging. According to Davis (2008), a TLO and the potential receiver of the technology must devote efforts to settle a contractual agreement as soon as possible.

To expedite the legal administrative processes, it´s possible to make models of processes previously approved by the legal administrative area, and, in these models the aspects of the negotiation with the company which will receive the technology can be included. For Audrey and Sansing (2014), the legal section from STI can help with these new models of contracts.

Still, according to Jungmann and Bonetti (2010), an extremely important issue to the management of contracts of technology transfer is to make a periodic verification of the performance of the licensing object. That is, to monitor if the contract is been fulfilled, from time to time. This type of monitoring is crucial, inclusively, to guarantee the estimated financial return, and it must be seen as a good business practices, to be adopted by TLO, which can be used to detect plausible problems, and to encourage best performance from whom is receiving the technology.

Considering the issues addressed until here, it´s possible to observe that the commercialization of protected technology by IP is not a process completely known by some Brazilian TLOs yet. For Harman (2010) and Lach and Schankerman (2004), this theme is little discussed, and they talk about missing international benchmarking on the market. Harman

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(2010) supplement their idea describing that technology commercialization lacks of comprehension, organizational support and a proper set of standard for doing such commercialization. However, the definition of the mentioned process must be discussed and controlled by TLO. After all, according to Buenstorf and Geissler (2012), to succeeded on technology commercialization, among other aspects, it is necessary to have a experienced team experience at the TLO that will negotiate the technology itself.

Although this activity won´t be controlled by TLO, the commercialization of the technologies, created and protected by IP, is a very important issue because according to Potter, Minutolo and Mainier (2012), Acuña, Schemal and Klein (2011) and Xu and Qin (2010), these activities represent a source of resources to support or to get the return with Research and Development (R&D) developed by STI. According to Albuquerque (2011), one of the most tendencies to STI is a higher level of the charge by its sponsor, by the income capacity of the commercialization results from R&D. This makes STI looks for innovation in its management models, to search for better efficiency and efficacy in its process. Bhargava, Kim and Sun (2013) indicate that the success of the technology commercialization demands practical knowledge of the business. In the same line, Lotufo (2009) describes that increasingly the STIs are trying to adjust their TLO to a development business profile and Martinez (2013) and Araújo (2010) point that it´s necessary to boost the commercialization process of the technology with new techniques and management policies, developed to a more effective way to promote technology transfer.

Strengthen the issues described so far, for Granstrand and Holgersson (2013), Abassi, Attar and, Hajihoseini (2012), Buenstorf and Geissler (2012), Ziedonis (2007) and Sung, Gibson and Kang (2003) the protected technology commercialization is not an ordinary activity, but a complex one, which must be emphasized properly by STI, specially by TLO. It´s a much more complex activity than to simply analyze the items of the contract, differently from what it is done in most of the Brazilian TLO. Taking this complexity into account, Barboza (2011) and Lichtenthaler (2011) describe that an important approach to IP management in a TLO, and at the same time a big challenge, is to elaborate and draw a strategy establishing mechanisms for the technology commercialization really to happen. In another words, it´s necessary to identify the opportunities to commercialize the technology, to plan and take actions instead of waiting for the potential receivers of it getting in touch.

## III. THE PROCESS MODEL FOR TECHNOLOGY PROTECTION AND COMMERCIALIZATION BASED ON IP APPLIED TO TLO/DCTA

Briefly, it was performed a diagnosis of the flow of activities for protecting and commercialization technologies at the TLO/DCTA, as a first step of this case study, are described below:

- A researcher at a STI (or an independent inventor) invented and developed a technology. If this STI had an interest in protecting it and in taking it to the market, it communicated this invention to the TLO, in an appropriate form;
- When the statement of invention is received by the TLO, it evaluates the technical issues related to the type of intellectual protection (eg.: if meets the criteria for the type of protection required);
- When it was possible to protect the invention (technology), TLO could hire an office to draft the application for intellectual property protection, or could do this essay with internal resources, and submit the application for protection to the protective body (in Brazil, the INPI);
- TLO was responsible to makes the control of the "requirements" and the remuneration to be paid;
- The technology was incorporated into the portfolio of the TLO technologies and is available to companies interested in its licensing.
- TLO waiting for a potential company to get interested in doing business (licensing).

Note, therefore, that the TLO has not a proactive role. In this context, none of the protected technology were transferred. which doesn´t mean that the DCTA doesn´t make the transfer of the created technologies. On the contrary, there are several technologies that were transferred by other kind of arrangements that do not considerate the intermediary help of the TLO. Despite this type of technology transfer, it should be pointed out that this paper is focused on studying the promotion of technologies that are expected to be transferred only by TLO.

So, it was necessary to review the activities already done and create a model of process to point out the issues related to the Technologies Protection and Commercialization. The guidelines to create this model of process, as well as its activities and tools were chosen after analysis of several

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TLOs, performed by the authors of this paper along with other researchers, that were developing a public financed project called PRONIT. Results obtained by this project, which included results obtained from the most important universities centers of Brazil, allowed to construct a benchmarking of best practices.

Then, it was developed, by Andrade (2016), a process model to manage the intellectual property in a TLO and applied to manage the technologies portfolio from TLO/DCTA, which is composed by 3 processes (Admit Technology, Protect Technology, Commercialize Technology) and their sub-process. This process model is presented on the Figure 1.

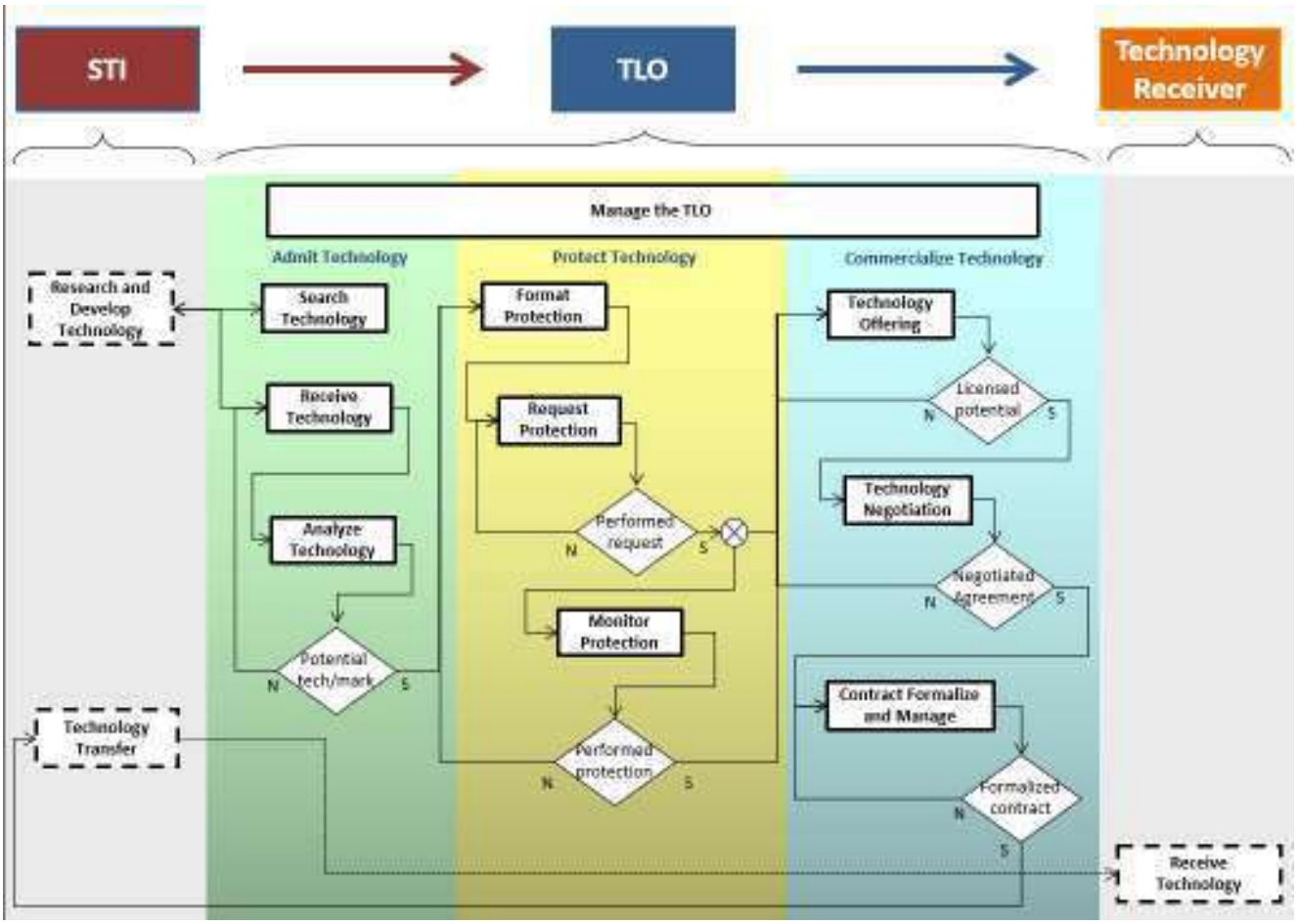


***Fig.1:*** *Process model to protection and commercialize the technology in the TLO/DCTA Andrade (2016)*

Theses process model are described below:

- **Admit Technology** (Andrade, Soto Urbina, Chagas Jr. and Silva (2018), Andrade, Soto Urbina and Chagas Jr. (2017) and Andrade (2016))**:**
    - **Search Technology Sub-process:** this sub-process is the achievement of a diligence to STI to assess whether it has invention or intellectual creation, referred to herein as technology, still not protected. Such due diligence should be performed by a team of TLO professionals and members of the areas of R&D from STI. The team, to perform due diligence, interviewing researchers at the STI, checks the results of R&D projects developed, including those developed jointly with companies, and at the end of the investigation, describes a report, pointing, or not, invented or created technologies by STI, not yet protected, and which may have the potential for protection and transfer. This report is forwarded to the responsible (higher court) by STI, which

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must decide the adoption of the recommendations, or ask or not, the protection of technologies from TLO. In the case of STI decide for protecting technologies found, it must require the protection and transfer of technology to the NIT, which will follow as the process Receiving Technology. This sub-process is justified by the possibility of identifying technologies invented or created within the STI, which the researcher has not identified potential for application, and thus has not requested their protection.

- **Receive Technology Sub-process:** this sub-process is to receive, register and formally verify documents included the protection of applications and technology transfer and opinions on R&D contracts sets with other organizations, submitted to the TLO. Receiving the Protection Application and Technology Transfer, it should be checked all the requirements specified in the rules / procedures / instructions specific TLO, to be observed by the applicant STI. This sub-process is important to identify, preliminarily, if all the elements necessary for the intended protection request are met, and to subsidize the sub-process Analyze Technology, as the technical and market analysis. Reaffirming, in this sub-process, in addition to other items, it is important to evaluate all contracts or research agreements that STI has entered into with other organizations in order to ensure that the rights to the IP, have resulted from this interaction, are safeguarded. With regard to the request for protection and technology transfer, it is necessary to assess whether all documents necessary to promote the drafting of application for protection (Case Protect Technology) were attached to the request, in order to avoid wasting time with the documentation returns, impacting the productivity of the TLO.
- **Analyze Technology Sub-process:** this sub-process is the technical and market analysis of incoming technologies. The analysis is performed in order to characterize in detail the technology and give its technical and market potential, so that they can support the decision-making process on the protection and commercialization of technology. Thus, beyond the measures listed in item Receive Technology should schedule one or more meetings with representatives of the research unit of STI and the responsible inventor, in order to address any differences and resolve procedural questions, and thus adequately analyze the technology. This sub-process is of fundamental importance to the success of all other processes and sub-processes indicated in this proposal because it is through him that the strategies for the protection and commercialization are developed. As a result, special attention should be given, as an error or mistake in technical or market analysis can mistakenly target the actions of protection and commercialization of technology, including direct to protection technology that presents no technical or market potential for such (protection of a technology that has already Similar to generate better results, for example).

- **Protect Technology** (Andrade, Soto Urbina and Follador (2016), Andrade, Soto Urbina, Follador and Follador (2016A) and Andrade (2016)):
  - **Format Protection Sub-process:** this sub-process is to identify the best form of protection (Invention Patent, Utility Model Patent, Industrial Design Registration Computer Program registration, Trademark, Industrial secret or other more complex forms of protection, or a combination of them) and format protection. This sub-process is justified by the decision on the strategy to be adopted for technology protection and the protection of the adopted format (eg .: drafting the patent application). The items in this sub-process are of fundamental importance because the strategies and decisions set forth herein, and the quality

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with which these are performed, influence the potential value added to the invented or created technology. End of this sub-process takes place theoretically for the sub process protection request.

- **Request Protection Sub-process:** this sub-process is to call for the protection of technology, in accordance with the provisions of the preceding sub-process (Format Protection), the competent body (eg .: INPI, STI source technology - in the case of trade secret, or other) and ensure that the request was rejected. In knowledge protection processes, techniques and inventions, attention should be paid to providing for the laws and regulations on the subject, so that it is ensured in a shortest possible time, the privilege of rights, production and / or marketing in selected markets. Protection may be held in the form of statutory or industrial secrets. This sub-process is the implementation of the protection strategy defined and formatted in the Format sub-process protection. End of this sub-process takes place theoretically for the sub process Monitor Protection.
- **Monitor Protection Sub-process:** this sub-process is to monitor the progress of the application of protection, until its consummation, and after that, until the end of its term of validity. After the publication of the deposit protection by the statutory or completed all protection activities through trade secret, you should monitor and control the process, in order to ensure compliance with all legal and administrative requirements for the realization protection as appropriate. Monitoring of protection may be realized in the form of statutory or industrial secrets. This sub-process is similar to a process of controlling, in which case, has three different objectives: 1) to monitor the appropriation of technology, started in the previous sub-process, 2) monitor the misuse of proprietary technology by third parties, and 3) monitor the creation or invention of similar technologies, and its use. These three elements are important for proper management of the portfolio of technologies in a TLO. This is an ongoing process that provides information to feed himself Technologies protection methods as well as activities related to the commercialization of technologies.

- **Commercialize Technology** (Andrade, Soto Urbina, Follador and Neves (2016), Andrade, Soto Urbina, Follador and Follador (2016B) and Andrade (2016)):
  - **Technology Offering Sub-process:** this sub-process consists of providing intel about the technology, identify the stakeholders (consolidated companies or new ones – spin-off or start-up) and attract them to a possible negotiation with recommendation analysis and technology protection. This sub-process is important because it traces strategies to search for potential stakeholders on the technology and leads the information about it to them. It plays like marketing and promotion. So, the sub-process aims to attract the potential stakeholders on technology to a negotiation of the transfer aspects with TLO. It´s a continuous sub-process, and its actions must be held until a potential stakeholder on its transfer and a commercialization contract be formalized. When a letter of interest is received the sub-process should change to Technology Negotiation.
  - **Technology Negotiation Sub-process:** this sub-process consists of the formal presentation of the technology to the stakeholder, besides the main technical and commercial points, related to a better response to the proposal formalization and its closure according to both parts using legal procedures and everything else to keep the information secret. The beginning of this sub-process takes place with the letter of interest from a potential organization interested on the technology transfer, due to the foreseen actions on the technology offering. The technology transfer can be negotiated and done by two

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different means: transfer with exclusivity or transfer without it. The definition of the most suitable way of the Technology Transfer is done using drafted strategies, considering the technical and market aspects, the characteristics of the technology, the economic sector and the niche market valued at that moment. The TLO manager with the person responsible for STI have to decide how the negotiation of the technology transfer is going to happen. This sub-process is about the activities related to the protected technology commercialization. It´s a vital process, because the terms settled in it will be the terms of the technology transfer to be considered on the formalized/management contract, and, naturally, that will guide the Technology Transfer. After this sub-process is ended, the next step is Formalize and Manage Contract.

- **Contract Formalize and Manage Sub-process:** This sub-process is about a draft contract designed and negotiated at the formalization of the contract and its management activities, to monitor its fulfillment. By the time of the formalization of the contract, the technology transfer can be initiated. During the technology transfer and along the contract, it should be managed. The management of the contract must happen, mainly, as a preventive way to potential problems, because if all the preventive actions were taken and the manage of the contract were serious, problems with the terms of the contract can be avoided. That´s why this activity is so important.

Theses process and sub-process create capabilities to make the TLO/DCTA more proactive and dynamic and make this TLO capable of assessing technologies that are forwarded to the TLO, and only then, make decisions, and define strategies for the protection and commercialize of technologies. Such process was successfully implemented, creating the first technology commercialization done by TLO/DCTA.

Afterwards, a pilot study with this same process model was conducted at TLO from the Instituto Nacional de Pesquisas Espaciais (INPE), as reported in Andrade, Chagas Jr., Soto Urbina and Silva (2017). As preliminary results, it was possible to highlight the development of an action plan to realignment the flow of activities as well as to customize the model proposed to culture and INPE-TLO structure.

To enable TLO to carry out its activities more efficiently and effectively, it is important to adopt a management information system, where it is possible to configure the activities provided for in the process model presented, according to Andrade et al. (2017A) considerations.

A technology surveillance system could be implemented within the TLO process framework as a way to collaborate with STI research teams. One of the possible applications for this system is the possibility of anticipating the technologies or technological routes that can be applied to projects under development, or subsidizing the creation of new research projects, as related by Andrade et al (2017B)

This process model can be adapted to other TLOs to assist in intellectual property management and to enhance technology transfer (as reported in Andrade et al. (2018)).

## IV. FINAL CONSIDERATIONS

This paper presents a process model for the Intellectual Property Protection and Commercialization performed in a TLO, which allows you to view and analyze the characteristics of the technology developed by a STI, and only then, trace the strategies for their protection and their commercialization. Such strategies should provide the aggregation of potential value to technology. Thus, the strategy used for one kind of technology may or may not be valid or realistic for another one. In other words, for each technology, a different strategy has to be designed.

For a TLO to succeed in the process of protecting and commercializing technologies, thus promoting the transfer of technologies developed in its ITS, it is necessary to go through a technology admission process that enables a thorough analysis of the technology, considering the technical and market aspects. marketing. Only after this, then, should the strategies of protection and commercialization of the technology be elaborated.

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# Quality of Life in Voice, Vocal Changes and Voice Intelligibility of Teachers

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***Abstract*** *— Objective: to analyze the quality of life in voice and vocal changes in teachers of Reference High Schools, and to analyze the levels of noise in classrooms and intelligibility of the teacher's voices in the same schools. Methods: the present study was performed in five all-day schools and half-day schools in the city of Petrolina/PE, Brazil. Three classrooms in each school were evaluated (n=15) in the morning and in the afternoon shifts. Eighteen teachers participated in the study and the following instruments were used: Quality of Life in Voice Protocol (QVV) and a semi-structured interview script. In order to verify noise, a decibel meter and a dosimeter were used. Results: Teachers had lower vocal quality of life in the total and physical domains, while most reported feeling vocal alterations. On the other hand, the environmental analysis indicated high levels of noise and a possible interference in the intelligibility of the teacher's speeches. Conclusion: The data demonstrate the need for more studies regarding the topic, and more care with the voices of the teachers.*
***Keywords*** *— **Quality of life in voice; Vocal changes; Noise; Intelligibility of speech.***

## I. INTRODUCTION

Voice is defined as "the sound produced by the passage of air through the vocal folds and modified in the resonance cavities and articular structures" [1], by which the perception in spite of its quality results of the combination of biological, psychological and social factors.

Vocal quality involves the voice characteristics and it is related to the impression that it transmits, considering the physical, psychological and social educational dimensions of the construct. The first aspect contemplates the physiological and anatomical attributes of the individual, while the psychological dimension takes in account the subject's personality and his emotional state in the moment of his speech. The socio-educational dimension, on the other hand, pays attention to factors that are culturally transmitted, such as the accent, slang and specific expressions of a particular group. In the analysis of vocal quality, it is also important to identify nonverbal voice-related signs, such as constant throat clearing, breath tremor, among others, which influence oral communication [2]. Therefore, voice-related quality of life includes the perception of the subject about vocal health and its alterations [3], being important the analysis of the individual and what is his understanding about his own health, so that it is possible to develop appropriate interventions for these subjects.

The human voice may present limitations when transmitting the verbal message or alteration in its quality, and the difficulty or alteration of the natural voice is called dysphonia, which is configured as a vocal limitation, which can present in different levels of speech. intensity. The mild degree of dysphonia is characterized as occasional, resulting in minimal difficulty in performing vocal activities, which makes the voice still audible in moderate degree, however, the individual presents efforts to speak and fatigue eventually. The vocal aggravation occurs in intense and extreme degrees: in the first, the dysphonia is constant and the voice barely audible, causing an effort to perform or even the inability to perform vocal activities; In the extreme degree, the voice becomes inaudible, with absence or almost absence of voice [1].

The constant presence of noise provokes health damage to the individual. The occupational exposure level to noise, to characterize the ambient insalubrity, according to Brazilian law, NR-15, annex 1, of the Ministry of Labor, to an 8-hour daily exposure is of, at maximum, 85 dB(A) [4]. In every raise of 5 dB(A) it is made necessary to reduce

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the period of exposure by half or add other protection measures (as the use of PPE to prevent hearing damage. Although it is necessary to point out that the reduction of this noise should not be lower than 30 dB(A), so it doesn't adapt to the background noise, because when it is very low, any noise, as low as it may be, starts to bother the worker [5].

In a work environment noise varies according to the activity developed, with high frequency noises causing the most disturbance. Noises can cause damage in verbal communication, making it difficult to understand the message when its intensity increases. In verbal communication there is a need not only to hear or to be heard by another person, but also to understand the message. This understanding of speech is related to background noise and the speaker's voice, and for it to occur effectively it is necessary that the speaker has a voice level of at least 10 dB (A) higher than background noise when dealing with familiar matters. When the subject is unfamiliar, it needs a difference of, at least, 20 dB (A) [6]. That is, in a high noise environment, speakers need to increase the level of their voices for verbal communication to occur, and this can cause from medium to long term vocal damage.

In the special case of school environment, the recommended environmental noise level varies according to the ambience, between 45 and 55 dB for circulation environments, 35 to 45 dB for libraries, drawing rooms and music rooms, and between 40 to 50 dB for laboratories and classrooms [7].

The teaching-learning activity often demands intensive use of voice and lack of care due to various vocal changes. Teachers with vocal alterations present more pronounced symptoms due to the use of voice, such as hoarseness, voice loss, tiredness and effort to speak, when compared with professionals who do not present these alterations [8].

Among the factors that may be associated with the worsening of teachers' quality of life are the bad working conditions, vocal tiredness and poor relationship with students, which may lead to the absenteeism of these professionals [9]. In addition, environmental factors standout such as noise level, for example, if an individual is exposed to a noise level above 60 dB for an extended period, they may have difficulty concentrating and learning [10].

Literature data indicate that in most situations, conditions in the school environment do not favor the vocal health of the professionals who work there. For example, when comparing teachers and professionals who did not use their voice professionally in Belgium, it was found that the prevalence of vocal complaints was significantly higher in teachers than in other professionals. The most frequently reported symptoms were hoarseness, vocal loss and loss of voice amplitude [11].

At national level, the study by Fabrício, Kasama and Martinez [3] found that the symptoms of vocal disorders most prevalent in university teachers in the city of São Paulo / SP were hoarseness, cough, dry throat and difficulty to be heard in noisy places. These professionals also reported that attitudes towards symptoms did not involve the search for appropriate treatment, but the use of strategies such as reducing voice use or simply not doing anything, and that when they sought some treatment, they opted for the homemade ones (gargling, for example). Nevertheless, the participants in this study assessed themselves as having a good quality of life in relation to voice.

Rossi-Barbosa, Barbosa and Caldeira [12], in turn, found that public school teachers in the city of Montes Claros/MG had a good quality of life in voice, with most participants (76.6%) having stated that their voice was 'excellent' or 'good'. It was also verified a relation between the time of profession and vocal quality, demonstrating that longer teaching time was related to a greater impact on the participants voice.

Behlau et al. [13] conducted an epidemiological study comparing the frequencies and adversities of vocal disorders in full-time teachers and non-teachers (professionals from various professions), with participants from all Brazilian states. In the results, they observed that the group of teachers manifested more vocal alterations at some point in their lives, and that they currently show a higher prevalence rate of these alterations (11.6% for teachers and 7.5% for non-teachers).

With the objective of improving the quality of secondary education, the state of Pernambuco creates the Integral Education Program by Complementary Law No. 125/08, thus establishing all-day full schools and half-day, being named Reference Schools in High Schooling. These schools have differentials compared to regular schools, such as the fact that teachers have exclusive dedication, working hours of 40 hours (full) or 32 hours (semi-full) weekly. Also, an increase in salary, receiving a bonus of location, being added 199% to the base salary of the teacher with 40 hours per week, and 159% to the base salary of those with 32 hours per week [14].

Given the above, this study aimed to analyze the quality of life in voice and vocal alterations in teachers of Reference Schools in High Schooling in the city of Petrolina/PE, and to investigate its relationship with noise in the classroom environment in these schools.

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## II. METHODS

The present study was conducted in five high school reference schools in the city of Petrolina/PE (all-day and half-day). In these schools, three classrooms were chosen (n = 15), each corresponding to one of the three high school grades, to assess the noise levels. The choice of each room was made by on-site visit, having as criteria the rooms facing the noisiest road.

The sample consisted of 18 teachers (17 female teachers and 1 male teacher) who teach in the selected classrooms of each school. The ages of these teachers ranged from 31 to 55 years (M = 43.28; d.p= 7.93). The criteria for inclusion in the sample were: to be a semi-full or full school teacher from the public school in the city of Petrolina/PE, to teach in the classrooms chosen for environmental analysis, to have at least one year of experience as a teacher and to participate in the study voluntarily. And as exclusion criteria: being away from work or on leave for health reasons and just being a physical education teacher.

## III. INSTRUMENTS

To assess the teachers' quality of life in voice, the Quality of Life Voice Protocol (QVV) [15] was used, composed of 10 items that are divided into the physical and social-emotional domains. To analyze the vocal alterations, a semi-structured interview was performed, asking the teacher: "Have you ever felt vocal alterations? If so, which ones? How did it go?" And "Have you ever felt that you forced your voice too much when teaching? Occurs frequently? Are you careful to avoid problems with your voice?".

To analyze the environmental noise level in the classrooms, it was used an Instrutherm decibel meter, Sound Level Meter DEC-5030, with an octave and a third of an octave band filter. It was used the weighting circuit "A", response circuit "low"; measuring range from 30 to 130 dB(A), properly calibrated. For the measurement of occupational noise, an Instrutherm dosimeter model DOS-500, weighting circuit - "A", response circuit - "slow - slow" and measuring range 70 to 140 dB were used. The analyzes followed the Brazilian norms NBR 10.152 [16] and NR-15 [4].

## IV. DATA COLLECTION AND ANALYSIS PROCEDURES

The Voice Quality of Life Protocol is a self-applied instrument that was delivered to participants to fill individually in their own work environment and according to their availability.

Noise analysis was performed using a decibel meter in the classrooms with the presence of students, in the morning and afternoon shifts, at seven previously selected points (as shown in fig. 1). One of these points sought to measure the signal from the transmitter, that is, the sound pressure level of the teacher in the classroom during the classes. The data found were compared with the following current standards: NBR 10.152 [16] and NR-15 [4].

The interview with the teachers took place individually, in a place in the school itself, with as little interference as possible.

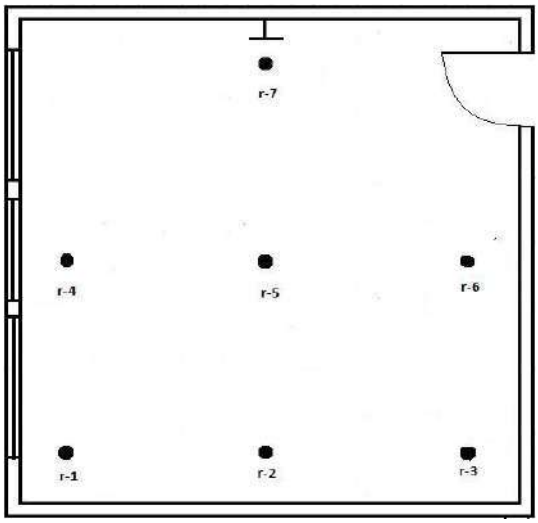


*Fig. 1: Classroom noise measurement points*

The interviews were analyzed using the content analysis technique [17], following the following steps: first there was a fluctuating reading; then categories were formed that grouped responses with similar content and an analysis protocol was created. Next, there was a careful reading of all interviews, answering the protocol and observing the categories that emerged in the speeches. Finally, the categories were numbered and entered into a database using the statistical software SPSS, version 20.0, through which all quantitative analyzes were performed.

## V. ETHICAL ASPECTS

The study was approved by the Human Research Ethics Committee of the Federal University of Vale do São Francisco, under number 48795115.5.0000.5196. Collection began only after compliance with the ethical requirements provided for in Resolution No. 466/12 of the National Health Council.

## VI. CONCLUSION

A In general, teachers' quality of life with voice had high scores in the three domains evaluated (total, physical and socio-emotional). These scores could vary between 0 and 100, so that the closer to 0 the worse the vocal quality. The domain that presented lower mean score than the

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others was the physical one (M = 73.28 ± 17.61), while the socio-emotional one had the highest index (M = 85.06 ± 16.62), and the total domain presented the average score of 78.97 (± 15.46). Spearman's test indicated the existence of positive correlations between the total domain and the physical domain (s = 0.92; p <0.01), and socio-emotional (s = 0.76; p <0.01), and between the physical domain and the social-emotional domain (s = 0.70; p <0.01).

88.9% of respondents stated that they already felt some kind of vocal alteration that interfered with their activities. Among the reported vocal disorders, the most common was hoarseness, followed by vocal cord callus and pharyngitis (Fig. 2). As reported by P1, this type of change is very common in teachers' daily life: "Yes, yes, normal... we use a lot of our voice... But there is no way you can work nine classes every day and not feel your throat irritated, voice a little tired, already a little hoarse, I think it is natural" (P1).

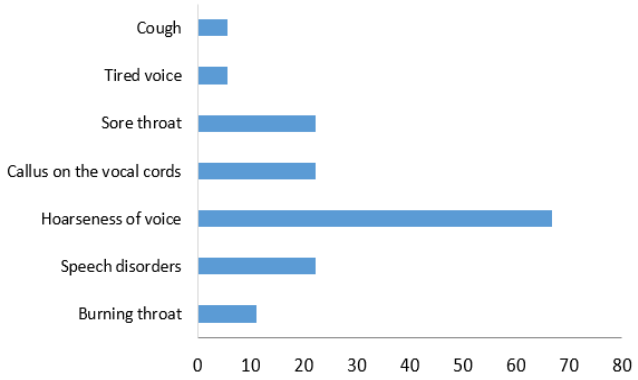


*Fig.2: Voice disorders in teachers*

When asked what actions they took to take care of their voice, they highlighted water intake (44.4%), gargling (16.7%), talking less and less intensely (22.2%), natural medicines (11.1%), eating apples (11.1%), not eating citrus fruits (5.6%), using a microphone (5.6%), and using medicines (5.6%) . No participant stated to have treatment with speech therapist, or perform procedures guided by this type of professional during the period of the interviews, except for water intake. Finally, 11.1% said they had no specific care for their voices. Despite this apparent neglect, almost all respondents (94.4%) stated that they have already forced their voice too much when teaching, and out of these, 38.9% said that this occurs with significant frequency.

Environmental noise assessments in classrooms were conducted from March to October 2016. The standard for acoustic comfort is NBR 10152 [16], which recommends that the noise level in the classroom be between 40 and and 50 dB(A). In addition, NR 15 [4] of the Ministry of Labor and Social Welfare provides that workers should not be exposed to a noise level exceeding 85dB(A) for a daily workday of 8 hours without adequate protection.

The analysis of Table 1 indicates that all classrooms presented average noise levels higher than recommended by NBR 10152[16]. The classrooms that presented the highest noise level were the afternoon 3rd year of school A and the 2nd morning and afternoon of school D. In these classrooms, it is important to note that in the afternoon of the 3rd year of school A the teacher delivered the tests at the beginning of the class, causing concern and, even after the end of the delivery, the students continued talking a lot. In the class in which the measurement took place in the class of the 2nd morning class of school D, a content review activity was performed, and the students discussed the questions among themselves and the teacher. In the afternoon shift, the revision activity was corrected, and the subject teacher had to raise the intensity of the voice several times and complain to the students to pay attention, because they were very restless.

For the teacher's voice to be intelligible, Bentler [18] recommends that the level of his speech be higher than the noise level of the room. In addition, the signal to noise ratio (S/R) must be greater than 1.0 dB(A) for the voice to be audible. Another fact that indicates that the teacher's voice in the analyzed schools may be compromised is that even when the Signal is higher than the noise, the S/R index presents values very close to 1.00, which indicates that the noise may be interfering in the speech intelligibility of these professionals. However, even with the teacher's speech being compromised by noise, the teachers reached, in most of the rooms investigated, values above 80 dB(A), and in some almost 90 dB(A).

As can be seen in Table 1, in some rooms the average noise level was higher than the teacher's speech, which may cause impairment of the professional's speech over time. In the remaining classrooms, even with a positive Signal-Noise difference, the value of this difference was low, which also suggests the prevalence of interference with teachers' speech intelligibility in those environments.

Concerning occupational noise, in all analyzed schools, except for the room of the 3rd morning school year E, participants were exposed to a noise level higher than recommended by NR 15 (levels above 90 dB(A)) when it comes to worker exposure in a high noise environment. That is, the rooms that did not comply with the standard do not present acoustic comfort for their participants (Table 2).

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*Table 1: Ambient noise level*

| School | | 1st year | | 2st year | | 3st year | |
|---|---|---|---|---|---|---|---|
| | | Morning | Evening | Morning | Evening | Morning | Evening |
| School A | Leq=R | 84.49 | 82.42 | 82.04 | 83,76 | 79.72 | 86.07 |
| | Sign | 89.2 | 85.50 | 80.5 | 81,00 | 83.3 | 88.5 |
| | S/R | 1.06 | 1.04 | 0.98 | 0,97 | 1.04 | 1.03 |
| | S-R | 4.71 | 3.08 | **-1.54** | **-2,76** | 3.58 | 2.43 |
| School B | Leq=R | 76.33 | 78.08 | 82.78 | 81.86 | 73.81 | 78.32 |
| | Sign | 77.9 | 77.7 | 86.1 | 84.9 | 76.4 | 79.8 |
| | S/R | 1.02 | 1.00 | 1.04 | 1.04 | 1.04 | 1.02 |
| | S-R | 1.57 | **-0.38** | 3.32 | 3.04 | 2.59 | 1.48 |
| School C | Leq=R | 83.0 | 79.60 | 75.41 | 77.92 | 78.29 | 79.87 |
| | Sign | 86.6 | 84.00 | 79.4 | 78.8 | 81.4 | 74.5 |
| | S/R | 1.04 | 1.06 | 1.05 | 1.01 | 1.04 | 0.93 |
| | S-R | 3.60 | 4.40 | 3.99 | 0.88 | 3.11 | -5.37 |
| School D | Leq=R | 84.8 | 79.63 | 86.06 | 86.85 | 83.21 | 79.91 |
| | Sign | 85.4 | 78.2 | 89.6 | 90.7 | 81.1 | 82.7 |
| | S/R | 1.01 | 0.98 | 1.04 | 1.04 | 0.97 | 1.03 |
| | S-R | 0.60 | **-1.43** | 3.54 | 3.85 | **-2.11** | 2.79 |
| School E | Leq=R | 82.0 | 85.6 | 79.5 | 84.0 | 81.4 | 78.0 |
| | Sign | 87.9 | 89.0 | 83.3 | 83.3 | 81.2 | 82.2 |
| | S/R | 1.07 | 1.04 | 1.05 | 0.99 | 1.00 | 1.05 |
| | S-R | 5.93 | 3.45 | 3.80 | **-0.80** | **-0.17** | 4.25 |

Leq - equivalent continuous sound level

*Table 2: Average occupational noise level*

| School | Turn | 1st year | 2st year | 3st year |
|---|---|---|---|---|
| **School A** | Morning | 94.98 | 89.43 | 92.70 |
| | Evening | 91.94 | 97.97 | 97.97 |
| **School B** | Morning | 94.68 | 95.83 | 87.37 |
| | Evening | 87.60 | 91.70 | 93.29 |
| **School C** | Morning | 95.89 | 91.78 | 91.42 |
| | Evening | 81.07 | 91.21 | 91.74 |
| **School D** | Morning | 94.68 | 95.83 | 87.37 |
| | Evening | 87.60 | 91.70 | 93.29 |
| **School E** | Morning | 91.07 | 88.52 | 83.21 |
| | Evening | 10.,15 | 94.41 | 93.96 |

Regarding the classroom of the 3rd morning of the E school, the measurement occurred with the presence of 15 students, when the normal would be more than 30 students, which may have reduced the noise due to the small number of students in the classroom.

## VII. DISCUSSION

The average score of vocal quality of life in the participants approached 100, which indicates that the perception of health that these individuals have about the voice is very good, corroborating the findings of Rossi-Barbosa, Barbosa and Caldeira [12]. Another noteworthy fact is that although the scores were high in all domains (physical, socio-emotional and total), what presented the lowest average score was the physical domain, suggesting that the physiological aspects of the voice are more easily perceived than the emotional ones. This facilitation can happen as a result of the direct relation of physical aspects with the impairment of work and routine activities. On the other hand, questions related to socio-emotional domain start from the perspective of the influence of vocal quality on subjective aspects (for example, they become depressed or anxious).

Although the quality of life of the participants had high average scores, in the semi-structured interview most participants stated that they had already felt vocal alterations. These data corroborate the study by Fabrício, Kasama and Martinez [3], in which the teachers presented high average scores in the instrument that evaluated the vocal quality of life, although they also stated that they felt vocal alterations. This suggests that the participants in the present study have not yet developed identifiable harms by objective measures, but that they have some level of awareness of how stressful the teaching profession can be for the voice, to the point that most claim that the profession caused vocal symptoms.

The acoustic factors presented values higher than recommended by NBR 10152 [16], reaching values of almost 90 dB(A). According to Millanvoye [10], noises above 65 dB(A) can cause the individual to suffer with difficulty in concentration and learning, which would be a worrying factor for a classroom environment. In addition, it is recommended that the individual remain up to 8 hours in a maximum 85 dB(A) [4] environment. Since teachers at reference schools have a high workload in the same classrooms, exposure to these noise levels can have negative health consequences for these professionals, as well as impairing student learning.

The findings of the present study corroborate the studies by Coutinho Filho [19], Silva, Silva and Coutinho [20], Dalvite et al. [21], and Silva and Santos [22], in the sense that care with the acoustic environment in classrooms seem to be an overlooked or ignored factor by the responsible authorities. It is noteworthy that the studies mentioned above were performed in regular schools, unlike the present study, which was conducted in Reference Schools. However, it is clear that the data on the acoustic conditions of the classrooms are similar in both types of schools mentioned here.

Another fact that draws attention is the fact that much of the noise identified in classrooms is caused by the operation of fans and air conditioning, which points to the need for appropriate ergonomic planning for these environments. This factor is one more that contributes to teachers to increase the intensity of the voice, which may cause damage to their health.

In addition, most teachers stated that they had already forced their voice too much when teaching and associated with it, it was found that teachers, at the time of class, had high voice index (signal), reaching levels above 80 dB(A).

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Such reality may have serious consequences for their vocal health, if there is no intervention to improve the quality of environmental conditions in the investigated classrooms. In this regard, it is important to remember that participants often reported feeling vocal changes such as hoarseness, throat inflammation, vocal cord callus and speech problems. In addition, they reported not developing preventive attitudes in caring for their voices, which may lead to more severe negative consequences in the future. This lack of search of adequate treatment in relation to the voice of the participants of the present study corroborates the findings of Fabrício, Kasama and Martinez [3], in which the participants, when looking for some kind of care, mostly chose to reduce the voice intensity or resorted to home treatments.

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# Simulation of Energy Efficiency Labeling in Homes in the City of Manaus/AM

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***Abstract*****—***Energy efficiency is one of the strategies to conserve energy, which means reducing consumption and reducing costs. For this, measures to increase energy efficiency are necessary to mitigate the impacts on the electricity sector. The objective of this study is to simulate the application of the Energy Efficiency Labeling system in four residences, seeking to evaluate their level of energy efficiency, the residences presented low levels, for not using cross ventilation, besides the choice of the types of material to be used in buildings to reduce this heat transmission to the interior of the buildings. However, this is the reality of most residences in the city of Manaus, most of them still old, the lack of structure and knowledge about this process of energy efficiency, makes it necessary policies that are more effective and actions to minimize this condition of most residences.*
***Keywords*****— RTQ-C, efficiency, labelling.**

## I. INTRODUCTION

Seeking to ensure the optimization of energy generation and consumption with a view to rational use, energy efficiency is having its most evident moment, given the perception about the importance of energy conscious use, besides becoming something yet more economical and contribute to the environment.

Energy efficiency should be considered as an essential factor of long-term sustainability. Policymakers in private sector partner should encourage economic growth from investment in energy efficiency, showing new business models, technological innovations and economic measures [1].

Energy efficiency programs are linked to the government as the electricity distribution service is linked to a public scale, which promotes market transformation and stimulates the development of new technologies, always in search of benefits as a form of energy saving [2].

The National Electric Energy Conservation Program (Procel) together with the National Energy Conservation Label (ENCE) indicates to the consumer the products that have the best levels of energy efficiency within its category, informing the classification of products ranging from the most efficient (A) to the least efficient (E) depending on the product. The Brazilian Residential Labeling Program follows the same principle where it allows quantifying the gain with energy efficiency following changes that seek to combat waste, besides presenting proposals for bonuses for more dwellings Efficient [3].

Thus, INMETRO launched the National Energy Conservation Label for multifamily homes and buildings, taking into account population development in recent years we have seen the increase in housing, and sequentially the increase in the quantity of electronic devices. Thus, we tried to demonstrate in a simulated way the labelling service for these dwellings in order to present the performance of cost reduction [4].

The National Energy Conservation Label (ENCE) is obtained by evaluating the building based on the requirements contained in the Technical Quality Regulation applied to Residential Buildings RTQ-R, which consists of a classification method, through prerequisites, which generates a score on the energy efficiency of the residence [5].

The labeling process consists of two consecutive steps, the design inspection and inspection of the built building, after which ence is issued for project (optional for existing buildings) and the ENCE of Built Building, Respectively.

The aim of this study is to analyze the application of the Energy Efficiency Labeling system in homes proposed in the Technical Quality Regulation applied to Residential Buildings (RTQ-R) seeking to evaluate the level of this energy efficiency and have measures to increase this level by proposing bonuses, depending on their classification.

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## II. MATERIAL AND METHOD

**Area of Study**

In this study for energy efficiency analysis, four residences located in the east of Manaus/AM were evaluated. In order to obtain sizes of the rooms, and the materials used in the construction for the proposition of the analysis.

The study was divided into two parts, the first data collection and the second, the application of the RTQ-R manual to obtain the level of energy efficiency on site and presenting an action plan for increasing this level if necessary.

The proposed method for evaluation was based on the evaluation process of the Eifice PBE, the RTQ-R, which assesses the wrap, the water heating system and bonuses and for the calculation base. The "performance calculation spreadsheet of the housing unit (UH) developed by the Brazilian Center for Energy Efficiency of Buildings was used in partnership with other bodies [6].

**Data collection**

Data were collected in four residences, which are located on the same land, with a size of 56m² (R1), 56m² (R2), 55.25m² (R3) and 48m² (R4). With the performance of a previous survey, it was found that the analysis evaluating the water heating system was not considered, being excluded from the study.

It was necessary to obtain the coefficient of the bioclimatic zone of the region, according to ABNT NBR 15220-3 (2003) "Thermal performance of buildings - Part 3", which classifies the Brazilian territory in eight bioclimatic zones, with its respective recommendations and constructive strategies for single-family homes of social interest, for the different areas of [7].

As described in ABNT NBR 15220-3 (2003), the city of Manaus/AM is located in zone eight, described in the ZBBR software, according to Figure 1 [8].

*Fig. 1: Bioclimatic Zoning of City Manaus/AM*
*Source: [8].*

The level of efficiency in residence described in the RTQ-C manual as a standalone housing unit is the result of the following (equation 1):

$$PT_{UH} = (a \times EqNumEnv) + [(1-a) \times EqNumAA + Bonuses$$

*Equation for total efficiency level score (1)*

Where:

- $PT_{UH}$*:* total score of the efficiency level of the autonomous housing unit;
- *a:* resulting coefficient according to the geographic region in which the building is located, where the coefficient in the North and Northeast regions, is equal to 0.95 and must be changed to 0.65 whenever there is a water heating system designed or installed.
- EqNumEnv*:* numerical equivalent of the thermal performance of the wrap of the autonomous housing unit when naturally ventilated;
- EqNumAA*:* numerical equivalent of the water heating system;
- Bonuses*:* score attributed to initiatives that increase the efficiency of building.

The level of the classification, the level of efficiency is assigned according to the score of the result of this equation, in which it is presented in the table 1.

*Table 1: Efficiency level classification.*

| Score (PT) | Efficiency Level |
|---|---|
| PT ≥ 4,5 | A |
| 3,5 ≤ PT < 4,5 | B |
| 2,5 ≤ PT < 3,5 | C |
| 1,5 ≤ PT < 2,5 | D |
| PT < 1,5 | E |

Source: [4].

## III. RESULTS AND DISCUSSION

The residences were analyzed individually to obtain their energy efficiency levels as shown in Table 2. R1 corresponds to the residence number one, R2 to residence number two, R3 to residence number three and R4 corresponds to residence number four.

Through the maps generated for the analysis and occupation of the soil in the city of Manaus, from 1985 to 2015, it was possible to analyse the process of balance of the areas with vegetation (green areas) and increase of the areas of ubrban occupation (red area) regardless of the type of the use of the soil, with the losses of arborisation, landscape and further information that characterize these region.

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*Table 2. Results obtained from requirements.*

| REQUIREMENTS/ RESIDENCES | R1 | R2 | R3 | R4 |
|---|---|---|---|---|
| **Absortment of the external façade (α)** | 66,5 | 65, 6 | 73,6 | 41,0 |
| **Thermal transmittance of the walls (W/m²K)** | 1,85 | 1,85 | 1,85 | 1,85 |
| **Thermal capacity of walls materials (kJ/m²K)** | 1,61 | 1,61 | 1,61 | 1,61 |
| **Thermal coverage transmittance (W/m²K)** | 1,75 | 1,76 | 1,76 | 2,05 |
| **Thermal capacity of components (kJ/m²K)** | 21 | 16 | 16 | 232 |
| **The windows of the long-stay environments (m²)** | 6,36 | 5,76 | 5,9 | 5,76 |

*Source: Authors, (2019).*

The requirement of absortment to solar radiation provides us with the coefficient of solar radiation rate absorbed by a surface, by the rate of solar radiation incident on the same surface (NBR 15220-1, 2003). The absortment values of the facades of the residences correspond to the colors, terracotta, yellow, blue and orange, respectively. Values obtained based on a study conducted [9].

R3 has greater absortment on its façade because it is a darker color compared to the others. Solar absortment has a great impact on thermal performance, as they determine heat gains due to the incidence of solar radiation, that is, when radiant energy reaches an opaque surface, part of this energy is reflected and another absorbed [10].

The colors of buildings, as simple as it may seem, can provide us with a gain in relation to reducing energy consumption by cooling systems, as it can be easily changed without large financial investments. Remembering that absortment exerts greater influence on situations of need for cooling than heating [11].

The values of the requirement of thermal transmission and thermal capacity (of the walls and roofs presented), refer to heat transmission through an element or component, in this case refers to walls and covers, and the coefficient of radiation rate that crosses the element or component. As all residences have the same constructive material on the walls, then the values are equal and were obtained based on the "Manual A of the bioclimatic zone eight" [12].

A portion of the energy spent on the air conditioning of an environment owes thermal exchanges between external and internal media, that is, the form that occurs the heat passage of a wall in a given direction, this energy is being transmitted from a larger surface temperature for lower temperature [13].

The cover is the element most exposed to the incidence of sun's rays, since part is reflected to the outside and part is absorbed by the material and consequently being emitted into the interior in the form of heat [14].

The requirement of the windows of extended environments in the residences gave us information on the use of natural lighting and natural ventilation. Naturally ventilated buildings have the potential to offer thermal comfort in different Brazilian regions, it is worth mentioning that the wrap is one of the main elements of transmission of heat external to the environments [15].

For the application of the RQT-C manual, the spreadsheet (Made available by the Brazilian Center for Energy Efficiency of Buildings (CB3E) was used to calculate and obtain the level of efficiency of the residences [6]. After completing all the data in the worksheet, the following results were obtained (Figure 4).

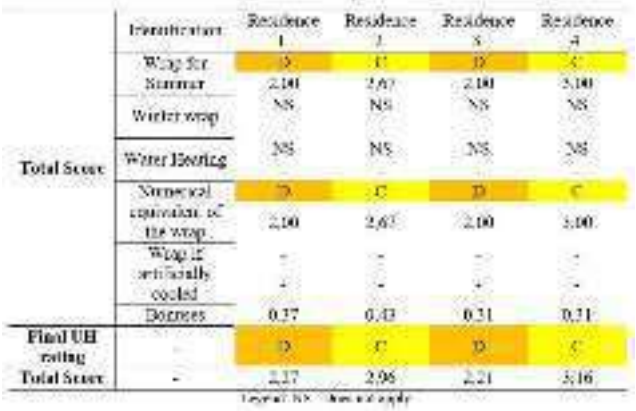

*Fig. 1*: *Bioclimatic Zoning of City Manaus/AM*
*Source: Authors, 2019..*

Given the results obtained, we noticed that households have a media classification to low energy efficiency. In the residences it was observed that the fact occurs given the amounts of openings are insufficient for the environments, or due to their positioning, which ends up making it difficult for questions such as natural ventilation, so on typical summer days, there is an increase in electricity demand for cooling.

R1 uses two-sheet aluminum windows, i.e. only part of the window provides us with opening. The other residences use two-leaf wooden windows, and provides us with the total opening of the same.

Although residences two and three have better results compared to the others, the non-use of cross

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ventilation makes their energy efficiency level not the most indicated. When the environment has only one opening, fresh air does not enter, because there is a pressure inside the site that does not allow its entry, when the ambient openings are on adjacent walls, the direction of the airflow behaves differently relatively to what happens in openings rented on opposite walls [16].

To increase wrap score, cross ventilation should be improved by positioning windows on facades so that it has better lighting during the day and makes it allow for better wind passage [3].

In the city of Manaus there is a lower average speed of air, that is, a lower wind intensity, in addition to the average temperature of 30 °C, which would cause the heating of the environment instead of allowing better conditions in terms of thermal comfort [16].

We also have to take into account the choice of types of material to be used in buildings, where we can reduce the portion of solar thermal load that is transmitted to the inside of buildings. Currently there is a great search for the improvement of known techniques for the reduction of electricity consumption aimed at obtaining thermal comfort [17].

All residences presented a significant level of bonuses, due to the use of natural lighting, and the use of air conditioners with Procel seal. The gain of these bonuses guarantees for homes an average improvement of 10% in performance [3].

To achieve bonuses in the water rationing ite, and as a way to reduce waste of water use, techniques are used for its reuse of rainwater for non-drinking purposes [4].

Through the final score of the survey it is perceived that the residences have the same standard, having a low level of energy efficiency. In view of this, investment in energy efficiency becomes an advantageous alternative when compared to energy production, since it is cheaper to save energy than to produce. In addition to contributing a lower energy expenditure can provide the user with better environmental comfort inside their residence [18].

## IV. CONCLUSIONS

The labeling system for energy efficiency in homes can be paramount, with regard to energy consumption, indicating improvements in this process and obtaining economic and environmental results in order to satisfy the use of the resource efficiently.

In the residential units, the need for adequacy was noted, given the lighting, ventilation and material part used, mainly linked to the climatic conditions of the region, where they are.

However, this is the reality of more than 50% of the residences of the city of Manaus, given the lack of government incentives, mostly still old housing projects, in addition to the lack of structure and knowledge about this process of energy efficiency.

Thus, more effective policies and actions are needed that minimize this condition of most homes, since use of the parties, which are in fact considered today concerns only appliances and lamps.

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# Effect of Cabrio® Top and Macuco Bean (Pachyrhizus spp.) Extracts on Soil Mesofauna

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***Abstract*** *— Macuco bean (Pachyrhizus spp.) Is an atypical horticulture that has toxicity in its seeds and has potential for disease control, but its effect on soil stability is unknown? Among the bioindicators to evaluate soil quality is the analysis of fauna diversity, considered to be the most sensitive for presenting rapid response to changes. Therefore, the objective of this study was to determine the effect that macuco bean extracts and Cabrio® Top fungicide have on the soil mesofauna, with a completely randomized block design with three treatments and six replications. The treatments were: bean extract (1: 1000), a solution of Cabrio® Top (1: 250) and the water control. Pipes 100 mm in diameter were inserted into the soil 10 cm deep, one pipe being the experimental unit. For the extraction of mesofauna the Berlese-Tullgren method was used. After eight days in the extractor the samples with the mesofauna were removed for proper counting on the stereoscope. Moisture, group richness and abundance of individuals were evaluated. The results showed that soil moisture favored the richness of the edaphic mesofauna. Extract and Cabrio® Top compared to water increased the richness of faunal groups, but water presented higher abundance of specimens. However, all evaluated variables did not show significant variability between treatments. Therefore, Macuco bean extract and Cabrio® Top maintained soil quality without imbalancing the edaphic mesofauna.*

***Keywords*** *— **Collemboli, Mites; Group wealth; Abundance of specimens.***

## I. INTRODUCTION

The use of pesticides in Brazil was regulated by Decree 24,114 in 1934 and was registered with the Ministry of Agriculture. From 1990, with Law 7802/89 (regulated by Decree No. 4.074 / 02), it became mandatory the environmental assessment, for registration and marketing, or what is mandatory for most registrations based on organochlorines with loss. of validity (IBAMA, 2009). Currently, the registration of pesticides begins with the Ministry of Agriculture, Livestock and Supply - Map, followed by the Ministry of Health - MS and ends at the Ministry of Environment - MMA (BRESSAN; SOUZA, 2018).

Borsoi et al. (2014) states that soils of agricultural use, showing changes in mesofauna, in number of species, when compared to virgin soils, show changes in the soil, mainly in the middle of the use of pesticides, causing changes in their structure and leaving purposes the mortality of species and the proliferation of other resistances. The same author states that this disturbance disperses the organisms and facilitates the arrival of hosts, being necessary or used for another pesticide, interfering with the availability of food waste and weakening the natural regeneration of the soil.

As plants, they may offer natural elements, but they are potentially toxic to some organisms, where these may be an alternative option or replace pesticides with products of biological origin, given the environmental perspectives (JORGE, 2017).

Yam bean (Pachyrhizus spp.) Also known as jacatupé, is an atypical but adaptable horticulture that can produce up to 108 t $ha^{-1}$ (SILVA et al. 2016). Its roots are edible and rich in proteins and minerals (VASCONCELOS, 2018), such as seeds and leaves that cause toxicity by containing a rotation in their composition (LEUNER et al. 2013), a natural inhibitor of mitochondrial complex I, a cell death (CATTEAU et al. 2013). Its seeds have been shown to be genotoxic and cytotoxic (ESTRELLA-PARRA et al. 2014) showing potentiality in disease

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control. Thus, even with all knowledge about its toxic properties, it is unknown or the effect that causes stability on the soil.

Among the bioindicators for assessing soil quality is an analysis of fauna diversity, which is considered to be most sensitive because it has rapid response to change, being a mesofauna used for testing, for using change for change and important for soil nutrient mineralization (CARVALHO, 2014). The colembolis and mites are part of the editorial mesofauna, are organisms expressive in quantities, which move through pores to soil, influence the transport of mineral and organic materials, and participate in chemical decomposition, contributing to nutrient cycling (OLIVEIRA FILHO; BARETTA, 2016).

Therefore, the aim of this study was to determine the effect Cabrio® Top fungicides and yam bean extract have on soil mesofauna.

## II. MATERIAL AND METHOD

### 2.1 Area of study

The experiments were conducted in a grassy area, with no history of pesticide use, of the National Institute of Amazonian Research - INPA (03 ° 05 '29' 'S and 59 ° 59' 34 " W), in Manaus - AM, with further analysis in the Institute's terrestrial invertebrate laboratory.

### 2.2 Treatments

1) Yam bean extract at 1: 1000 concentration, with ground and macerated seeds of P40 progeny for immediate application.

2) Cabrio® Top Fungicide (1: 250) and 3) negative control: water.

Twenty ml of the treatments were applied using a hand sprayer with a capacity of 500 ml (each jet = 1 ml).

### 2.3 Experimental Design

*Fig. 1: Experimental structure in undergrowth area. Source: Guimarães, 2019.*

Caption: 1 = Yam bean extract; 2 = Cabrio® Top; 3 = Water.

Pipes 100 mm in diameter were cut at a height of 15 cm, with 10 cm inserted into the ground and 5 cm free at the surface, with 50x50 cm spacing between blocks and plots (Figure 1). It was followed the completely randomized block design (DBC), containing three treatments and six repetitions, one barrel being the experimental unit.

### 2.4 Sample Collection

Soil samples were collected from 0-10 cm deep (Figure 2), where after four days of spraying, they were placed in plastic pots and taken to the laboratory, being properly weighed on a digital scale (error = 0.01 g) to obtaining fresh weight.

*Fig. 2: Samples taken for laboratory analysis. Source: Guimarães, 2019.*

### 2.5 Extraction of mesofauna from soil samples

The modified Berlese-Tullgren method (OLIVEIRA et al. 1999) was used for the extraction of mesofauna, which consists of a funnel lined with nylon mesh (2 mm) to hold the soil. glass (100 ml) with alcohol (92.8 °) for collection. The samples were placed in a cabinet equipped with a funnel socket structure and parallel incandescent light bulbs (40 W) (Figure 3). The lamps were switched on after 24 hours to avoid burning the mesofauna contained in the surface, keeping them on for eight days.

The heat supplied by the lamp dries the soil and forces the mesofauna to move downwards into the glass container with alcohol. The containers were removed from the extractor and boiled so as not to fluctuate the extracted mesofauna, thus facilitating the counting, being identified with the place, date and treatment, for proper counting on

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the stereoscope (40 times increase). The soils contained in the funnels were weighed again to obtain dry weight.

*Figure 3 - Mesofauna extraction apparatus from soil samples by the Berlese-Tullgren funnel method.*
*Source: Guimarães, 2019.*

**2.6 Soil Moisture Content**

Soil moisture was calculated using the equation:

U = ((Pf - Ps) / Ps) . 100

Where U = soil moisture content; Pf = fresh weight; Ps = dry weight. The unit of soil moisture content is given as a percentage.

**2.7 Mesofauna Count**

Alcohol samples (with mesofauna) were poured into 10 cm diameter Petri dishes. Their morphology was identified up to the Taxonomic Order level, the Collembola Order specimens were identified at the genus level. With this count was calculated the abundance (number of individuals) and the richness of the treatments, which was based on the number of groups (Order / Subclass) present in each treatment.

**2.8 Statistical Analysis**

Data were submitted to the Kruskal-Wallis test. Analyzes were performed using the SAS 9.4 PROC NPAR1WAY procedure (SAS Institute Inc, Cary, NC).

## III. RESULTS AND DISCUSSION

We found 1081 individuals within 11 taxonomic groups belonging to the Aracnhida, Hexapoda and Insecta classes. Of the total specimens, 387 were collected from water-treated soil, followed by 367 yam bean extract and 327 with Cabrio® Top (Table 1). Based on the results, it was observed that there was no significant difference in all variables analyzed between treatments (Table 2).

Soil samples with bean extract showed greater genus diversity and greater abundance of specimens in the Collembola Order (Table 1). Studies show that yam bean extracts have piscicidal action (CROMBIE et al. 1998), insecticide, acaricide (BÉJAR et al. 2000), viricide (PHRUTIVORAPONGKUL et al. 2002), fungicide (BARRERA-NECHA et al. 2004) and bactericidal (MARTINS; BENAVENTE, 2018).

Despite its toxicity, yam bean favored a diverse environment in faunal groups (Table 1). Even though no significant difference in group richness was detected between the treatments (Table 2), further studies of the substances released by the extract, which provided the edaphic fauna with possible dietary variability, are recommended.

Cabrio® Top was the treatment that presented the lowest number of collemboli with 33 specimens, but obtained richness in the total mesofauna (Table 1). Collemboli feed on hyphae of fungi, bacteria and dead plant material (PAUL; NONGMAITHEM, 2011; SILVA et al. 2014). By feeding on old hyphae, they help in the growth of fungi (RUSEK, 1998), that is, it creates a stable environment where new fungi reproduce, increasing the availability of food for colemboli that control the soil fungal biomass (BERUDE et al. 2015). Cabrio® Top is a systemic double action and environmental hazard class II fungicide (BASF, 2019), its effect did not harm the richness of the mesofauna, but reduced the abundance of specimens.

The water control showed greater abundance of specimens in the total mesofauna, but reduced its richness in faunal groups. However, the absence of significant variability between treatments (Table 2) shows that yam bean extracts and Cabrio® Top fungicide are promising for disease control without harming edaphic mesofauna.

*Tab. 1: Number of specimens extracted from soil samples in grassy area.*

| Class | Order/Subclass | Genre | Water | Cabrio® Top | Yam bean |
|---|---|---|---|---|---|
| *ARACNHIDA* | *Acari* (others) | | 318 | 268 | 290 |
| | *Acari Oribatida* | | 12 | 8 | 8 |
| *HEXAPODA* | *Collembola* | *Entomobrya* sp. 1 | 19 | 21 | 26 |
| | | *Entomobrya* sp. 2 | 14 | 3 | 5 |
| | | *Lepidocyrtus* | 2 | 3 | 9 |
| | | *Folsomides* | 11 | 4 | 5 |
| | | *Proisotoma* | 0 | 0 | 1 |
| | | *Sphaeridia* | 0 | 2 | 1 |
| *INSECTA* | *Coleoptera im.* | | 1 | 0 | 0 |
| | *Diptera* | | 0 | 2 | 0 |
| | *Diptera im.* | | 0 | 1 | 0 |
| | *Homoptera* | | 3 | 1 | 4 |
| | *Hemiptera ad.* | | 0 | 0 | 2 |
| | *Hymenoptera* | | 5 | 7 | 7 |
| | *Psocoptera* | | 2 | 5 | 6 |
| | *Thysanoptera* | | 0 | 2 | 3 |
| Total | | | 387 | 327 | 367 |

*Source: Authors, 2019.*

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The Acari group prevailed in all treatments, with 83.62% of the total number of individuals (Table 1), being the most abundant of the soil mesofauna, reaching 84.7% in pastures (MORAIS et al. 2013). The Collembola Order had a participation of 11.65% of the total of individuals (Table 1), with lower representation when compared to Acaris, corroborating the results found by Chelinho et al. (2014); Pinto (2018).

Of the total acarofauna, the water treatment promoted the largest abundance of individuals with 36.5%, followed by 32.96% yam bean extracts and 30.53% by Cabrio® Top (Table 1). Since there was no significant difference between treatments (Table 2), the fungicide and the extract maintained the soil quality. The edaphic mesofauna, in particular the mite population abundance, is one of the main indicators of soil disturbance (CARVALHO, 2014), acting as predators and important in nutrient cycling, in addition to improving soil physical attributes such as porosity and aeration (PEREIRA et al. 2012).

*Tab. 2: Kruskal-Wallis test for comparison of variables between treatments.*

| Source of Variation | | Wilcoxon Scores | | | Kruskal-Wallis | |
|---|---|---|---|---|---|---|
| | | Water | Cabrio® Top | Extract | $X^2$ | P |
| Fresh Weight (g) | | 10,33 | 10,33 | 7,83 | 0,88 | 0,64 |
| Dry Weight (g) | | 10,33 | 10,50 | 7,67 | 1,06 | 0,59 |
| humidity (%) | | 8,25 | 10,58 | 9,67 | 0,58 | 0,75 |
| Abundance | | 8,83 | 9,00 | 10,67 | 0,43 | 0,81 |
| Group Wealth | | 8,17 | 10,17 | 10,17 | 0,56 | 0,76 |
| Order *Acari* | *Acari* (others) | 8,83 | 9,33 | 10,33 | 0,25 | 0,88 |
| | *Acari Oribatida* | 10,83 | 8,17 | 9,50 | 0,82 | 0,66 |
| | *Acari total* | 9,00 | 9,17 | 10,33 | 0,22 | 0,89 |
| Order *Collembola* | *Entomobrya sp. 1* | 9,33 | 7,67 | 11,50 | 1,59 | 0,45 |
| | *Entomobrya sp. 2* | 12,67 | 7,50 | 8,33 | 3,70 | 0,16 |
| | *Folsomides* | 10,00 | 9,33 | 9,17 | 0,12 | 0,94 |
| | *Lepidocyrtus* | 8,17 | 8,67 | 11,67 | 1,82 | 0,40 |
| | *Proisotoma* | 9,00 | 9,00 | 10,50 | 2,00 | 0,37 |
| | *Sphaeridia* | 8,70 | 10,08 | 9,92 | 1,07 | 0,59 |
| | *Collembola total* | 10,67 | 7,00 | 10,83 | 1,98 | 0,37 |
| Class *INSECTA* | *Coleoptera im.* | 10,50 | 9,00 | 9,00 | 2,00 | 0,37 |
| | *Diptera total* | 8,50 | 11,50 | 8,50 | 4,24 | 0,12 |
| | *Diptera* | 8,50 | 11,50 | 8,50 | 4,24 | 0,12 |
| | *Diptera im.* | 9,00 | 10,50 | 9,00 | 2,00 | 0,37 |
| | *Homoptera* | 9,83 | 8,33 | 10,33 | 0,73 | 0,69 |
| | *Hemiptera ad.* | 9,00 | 9,00 | 10,50 | 2,00 | 0,37 |
| | *Hymenoptera* | 9,00 | 9,92 | 9,58 | 0,10 | 0,95 |
| | *Psocoptera* | 7,50 | 10,00 | 11,00 | 1,56 | 0,46 |
| | *Thysanoptera* | 8,00 | 9,67 | 10,83 | 2,02 | 0,36 |

*Source: Authors, 2019*

The moisture content ranged from 9.4 to 19.3%, with an average of 13.6% for water treatment, 14.2% for extract and 14.7% for Cabrio® Top. Soil moisture favored the richness of edaphic mesofauna groups, although not presenting statistically significant difference in moisture between treatments (Table 2). Souto et al. (2008) states that the abundance of mites in relation to the colemboli is related to the ability of mites to support different moisture levels in the soil.

In this work, no significant correlation was found between the total of collemboli with the mites, but when correlating the humidity with the mesofauna groups, a significant difference was detected only for Diptera im. ($r = 0.47$; $p = <0.05$).

## IV. CONCLUSION

Yam bean extracts (1: 1000) and Cabrio® Top (1: 250) provide faunal diversity. Therefore, they do not unbalance the edaphic mesofauna and do not reduce soil quality.

Therefore, further studies are recommended based on a greater number of repetitions and different dosages, in order to know if different materials have similar results or to find new conditions that favor soil restructuring, with a view to pest control and better production.

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# Clinical and Epidemiological Indicatives of acute myocardial infrastructure in Patients attended in a Hospital of Emergency and Emergency inside Rondonia 2015-2018

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***Abstract***— *Acute myocardial infarction (AMI) or a so-called heart attack is an ischemic heart disease, which is one of the leading causes of death in men and women over thirty years of age. The objective was to verify the incidence of acute myocardial infarction in the municipality of Cacoal-RO from 2015 to 2018. The methodology was a retrospective, cross-sectional, documentary, descriptive and quantitative study with analysis of medical records in the Cacoal-RO emergency hospital. . The results were 44 cases within the surveyed period, 59.1% male and 40.9% female, age 61.36%> 60 years and 29.54% between 30 and 59 years old, brown 61, 36% and 77,27% belong to the urban area. As risk factors for the disease, males were 13.63% SAH and 22.72% smoking and female 25.0% SAH and 18.18% DM. As symptoms 61.36% precordial pain and 38.63% dyspnea, complementary exams requested ECG 90.1% of patients, CPK 50.0% of patients and CKMB 45.45% of patients, as prophylactic measures adopted 61.36% it was healthy eating, the drugs used in 70.45% of the patients the ASA and followed Clopidogrel 54.54%, in the evolution of the patient obtained cure in 70.45% and 29.54% died. It is concluded that due to the number of medical records analyzed, it can be inferred that the epidemiological profile of acute infarction in Cacoal-RO was low, showing a disease incidence of 0.50 / 1000 inhabitants, mortality 0.13 / 1000 inhabitants and annual average of 11 cases / year. It is noted that a precariousness of information in medical records and divergences in AMI protocols not performed according to SBC.*
***Keywords***— ***Acute Myocardial Infarction. Epidemiology. Evolution.***

# *Indicativos clínicos e epidemiológicos de infarto agudo do miocárdio em pacientes atendidos em um hospital de urgências e emergências no interior de rondônia entre 2015 a 2018.*

***Resumo***— *O infarto agudo do miocárdio (IAM) ou denominado ataque cardíaco é uma doença isquêmica do coração, que representa uma das principais causas de óbitos em homens e mulheres acima de trinta anos de idade. O objetivo foi verificar a incidência de infarto agudo do miocárdio no município de Cacoal-RO entre*

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*2015 a 2018. A metodologia foi um estudo retrospectivo, transversal, documental, descritivo e quantitativacom analise de prontuários no hospital de urgência e emergência de Cacoal-RO. Teve-se como resultados 44 casos dentro o período pesquisado sendo 59,1% sexo masculino e 40,9% feminino, faixa etária 61,36% > 60 anos e 29,54% entre 30 a 59 anos, na cor parda 61,36% e 77,27% pertencentes a zona urbana. Como fatores de risco para a doença apresentando o sexo masculino 13,63%HAS e 22,72% tabagismo e feminino 25,0% HAS e 18,18% DM. Como sintomatologia 61,36% dor precordial e 38,63% dispneia, exames complementares solicitados ECG 90,1% dos pacientes, CPK 50,0% dos pacientes e CKMB 45,45% dos pacientes, como medidas profiláticas adotadas 61,36% foi alimentação saudável, os medicamentos usados em 70,45% dos pacientes o AAS e seguido Clopidogrel 54,54%, na evolução do paciente obteve-se cura em 70,45% e 29,54% evoluíram para óbito.Conclui-se quedevido ao quantitativo de prontuários analisados pode-se inferir que o perfil epidemiológico do infarto agudo no município de Cacoal-RO foi baixo mostrando incidência da doença de 0,50/1000 habitantes, mortalidade 0,13/1000 habitantes e a média anual de 11 casos/ano. Nota-se que uma precariedade de informações nos prontuários e divergências nos protocolos de IAM não realizados conforme SBC.*

***Palavras Chaves*— *Infarto Agudo do Miocárdio. Epidemiologia. Evolução.***

## I. INTRODUCTION

AMI or acute myocardial infarction, also called heart attack is an ischemic heart disease, which is a major cause of death in men and women over thirty years of age. The diagnosis is made based on the clinical picture, electrocardiographic alterations and elevation of biochemical markers of necrosis (LOZOVOY *et al*., 2008).

According to the Ministry of Health (2014), acute myocardial infarction was considered nationally the first cause of death, which accounted for 100,000 deaths during 2014. The infarction presents classic symptoms in its early stages and can pass unnoticed that looks like routine pains of everyday life. Therefore in the chronic or advanced phase can trigger serious complications and being fatal to human life.

According to the World Health Organization (2012), smokers are more likely to develop AMI because, according to proven studies, it increases the risk of developing acute myocardial infarction five times, because nicotine is a constricting vessel that will reduce the thickness and caliber of the arteries hindering the passage of blood where they will cause damage to the wall (PIEGAS, 2012).

The South and Southeast regions are the most predominant and lead the ranking with the highest number of cases of AMI and with the lowest number of cases the north and northeast. (PREVIDELLI, 2013).

The general objective of the research is to verify the clinical incidence and epidemiology of acute myocardial infarction in the emergency hospital of Cacoal-RO between 2015 and 2018.

## II. MATERIALS AND METHODS

The study was submitted to the Research Ethics Committee - CEP, Cacoal Education Institution - FACIMED - Faculty of Biomedical Sciences of Cacoal, following the recommendations cited in Resolution No. 466 of December 12, 2012 and Resolution No. 510, of April 7, 2016 from CNS- National Health Council and after its approval received CAAE 12623819.1.0000.5298 and opinion concurring with the number 3.388,367.

The present study was presented as a retrospective, cross-sectional, descriptive document with a quantitative approach with individual analysis and medical records because the hospital did not have an electronic epidemiological database with the number of patients with the theme.

The research was conducted in the city of Cacoal-RO, and its data collection instrument was a semi-structured questionnaire with 8 multi-choice question topics that were extracted from the information contained in the patient records addressing the inclusion criteria of all patients (male and female). diagnosed with acute myocardial infarction - AMI residing in the municipality of Cacoal-RO from 2015 to 2018 and exclusion criteria notifications that did not have the necessary information for the study or patients not belonging to the municipality of Cacoal-RO.

The following variables were used for data collection: Identifying the socio-demographic profile of AMI victims; Present the epidemiology of AMI, treated at the Cacoal-RO Emergency Hospital; identify risk factors and comorbidities related to the incidence of the pathology; identify patients' lifestyle, medication, symptoms and evolution of AMI victims.

It started in September and ended in October 2019, and obtained a sample of 50 more patients. Due to the exclusion criteria, only 44 medical records were assigned to follow-up. The Informed Consent Form (ICF) was not applied because the data were not extracted

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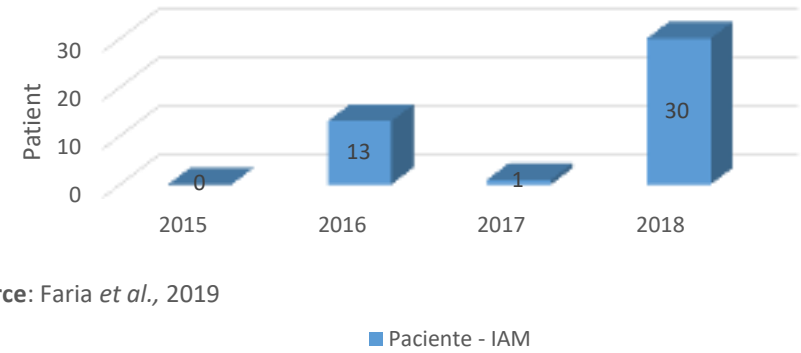
directly with the patient and performed through the analysis of the medical records, thus being asked to dismiss the ethics committee.

## III. RESULTS

The Cacoal Emergency Hospital (HEURO) was opened in March 2015 in order to meet the demands of high complexity care offered by the municipal health network. Due to its recent installation many medical records were not found not favoring a good result. search.

The manual search of the acute myocardial infarction records found 44 patients, which were divided between the years 2016 to 2018, and 2015 did not find any records with the theme addressed.

**Graph 1 - Epidemiology of AMI in Cacoal-Rondôna, Brazil - 2015 to 2018**




**Source**: Cacoal-RO Emergency Hospital - (HEURO)

Graph 1 shows the distribution of cases based on the years 2015 to 2018, it is noted that in 2015 no medical records with the research theme were found, unable to inform if there was no case of AMI or if there was a loss of medical records. as it was the year of implementation in the hospital in the old hospital São Daniel Comboni, in 2016 were found 13 medical records (29.54%) 2017 only 1 medical record (2.27%) and 2018 30 medical records (68.18%) were found ).

*Table 1 - Socio-demographic profile of AMI victims - Cacoal-Rondônia- Brazil - 2015 to 2018*

| **DICE** | | n | % |
|---|---|---|---|
| | | | |
| | Male | 26 | 59,1 |
| **Sex** | Feminine | 18 | 40,9 |
| | TOTAL | 44 | 100 |
| | | | |
| **Age range** | 18 a 29 | 2 | 4,55 |
| | 30 a 59 | 13 | 29,54 |
| | > 60 anos | 27 | 61,36 |
| | Ignored | 2 | 4,55 |
| | TOTAL | 44 | 100 |
| | | | |
| | White | 9 | 20,45 |
| | Brown | 27 | 61,36 |
| **Breed** | black | 2 | 4,55 |
| | Indigenous | 3 | 6,82 |
| | Ignored | 3 | 6,82 |
| | TOTAL | 44 | 100 |
| | | | |
| **Placeofoccurrence** | Urbanarea | 34 | 77,27 |
| | Countryside | 10 | 22,73 |
| | TOTAL | 44 | 100 |

**Source: Cacoal-Rondônia State Emergency Hospital, Brazil - 2015 to 2018**

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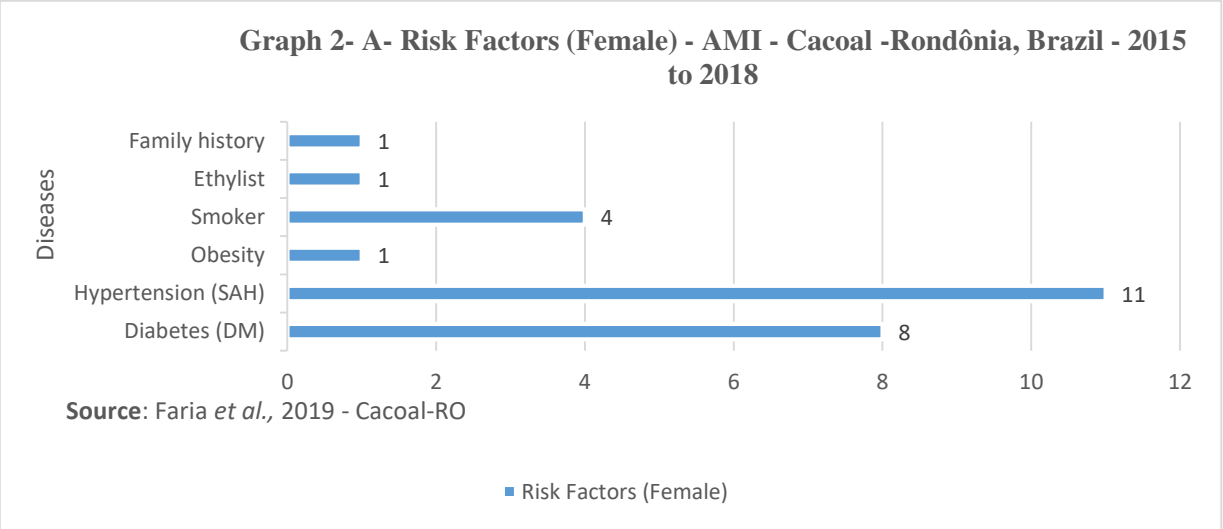
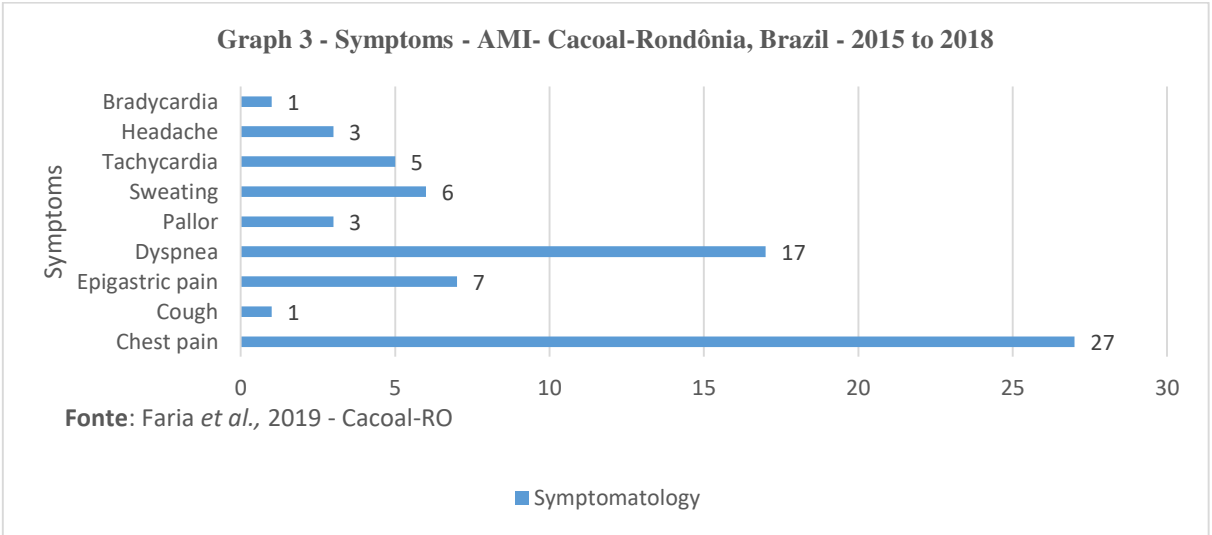
Table 1 shows the sociodemographic profile of patients diagnosed with acute myocardial infarction (AMI), corresponding to 44 cases reported from 2015 to 2018, of which 59.10% are male and 40.90% male. feminine. The age group 4.55% between 18 and 29 years old, 30 to 59 years old 29.54% and> (older) 60 years 61.36%. The brown color 61.36% had a higher incidence followed by the white color 20.45%, the patients belonged to urban area 77.27% and rural area 22.73%.

Graph 2 - A shows the risk factors that are related to acute myocardial infarction between the surveyed period. About 59.09% of females have some pre-available risk factor for the disease, such as hypertension. in 25.0%, Diabetes Mellitus (DM) in 18.18%, smoking in 9.1% and family history, alcoholism and obesity in 2.27%.




Graph 2 - B - shows the risk factors that are related to acute myocardial infarction between the surveyed period, about 54.52% of males have some pre-available risk factor for the disease such as smoking in 22.72 %, hypertension (13.63%), Diabetes Mellitus (DM) 4.55%, and alcoholic, hypercholesterolemia, congestive heart failure, chronic renal failure, family history and dyslipidemiawith 2.27%.




Graph 3- represents the general symptoms presented by the patients diagnosed with acute myocardial infarction between the investigated period, the research revealed in the analysis of the medical records that 61.36% (n = 27) had chest pain, 38.63% had dyspnea (n = 17), 15.9% had epigastric pain (n = 7), 13.63% had sweating (n = 6), 11.36% had tachycardia (n = 5), 6.81% had pallor and headache (n = 3) and 2.27% bradycardia and cough (n = 1).

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*Table 2 - Examinations / Guidelines / Medication / Evolution - Cacoal-Rondônia, Brazil - 2015 to 2018*

| DICE | | |
|---|---|---|
| **Additionalexamsrequested** | | |
| | **n** | **%** |
| CPK | 22 | 50,0 |
| CK-MB | 20 | 45,45 |
| ECG | 40 | 90,1 |
| RX TORAX | 8 | 18,18 |
| TROPONIN | 11 | 25,0 |
| ECO | 1 | 2,27 |
| TOMOGRAPHY | 2 | 4,55 |
| LDH | 7 | 15,9 |
| TGO / AST | 6 | 13,63 |
| Myoglobin | 1 | 2,27 |
| **Prophylacticmeasuresadopted** | | |
| Healthyeating | 27 | 61,36 |
| Guidanceondrug use | 14 | 31,81 |
| **UsedDrugs (Thrombolytics)** | | |
| ASS | 31 | 70,45 |
| CLOPIDOGREL | 24 | 54,54 |
| TICAGRELOR | 1 | 2,27 |
| TENECTEPLASE | 2 | 4,55 |
| ALTEPLASE | 2 | 4,55 |
| **Case Evolution** | | |
| Cure | 31 | 70,45 |
| Death | 13 | 29,54 |

**Source**: Cacoal-Rondôndia State Emergency and Emergency Hospital, Brazil - 2015 to 2018

Based on Table 2, it reports the complementary exams, guidelines, medications and evolution of the cases of patients who were diagnosed with acute myocardial infarction. Complementary tests such as ECG (electrocardiogram) were requested in 90.1% of patients, CPK (creatinophosphokinase) in 50.0% of patients, CKMB (creatine kinase / isoenzyme) in 45.45% of patients, TROPONIN in 25.0% of the patients, chest X-ray (chest X-ray) in 18.18% of the patients, LDH (lactate dehydrogenase) in 15.9%, TGO / AST (glutamic oxalacetic transaminase / alanine aminotransferase) in 13.63 % of patients CT (CT) in 4.55% ECO and MYGLOBINE in 2.27%. Prophylactic measures were adopted by the professionals for patients who had a positive evolution, being healthy eating in 61.36% of the cases and guidelines for the correct use of the drug in 31.81% of the patients. The drug protocol was used, being in 70.45% AAS (acetylsalicylic acid), 54.54% CLOPIDOGREL, 4.55% TENECTEPLASE AND ALTEPALSE and 2.27% TICAGRELOR. The evolution of acute myocardial infarction cases was cured in 70.45% of cases and death in 29.54%.

## IV. DISCUSSION

The city of Cacoal-RO in 2018 obtained about 68.18% of cases of acute myocardial infarction (Graph 1). The Ministry of Health shows that the disease is reaching the first position in both sexes and becomes a concern for Brazilian public health (BRASIL, 2019).

In this study, it is confirmed in relation to other studies with the same axis, as the male and more available for acute myocardial infarction disease. In the study conducted in Cacoal-RO, 59.1% of the patients were male (Table 1). According to Hernándes *et al*., (2014) he affirms the findings of this research, because according to him and more common the male gender is indicative to develop the disease taking into account several factors that will be addressed during the study. According to Oliveira & Magnabosco (2018) the male has a lot of difficulty knowing and providing his body needs, ie, reject the possibilities of taking care of the body.

Regarding age, the study found that the highest incidence occurred in patients> 60 years of age (Table 1). According to reports by Oliva *et al*., (2013); The age group

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with the most predisposition to the disease is between 40 and 65 years old, since it is correlated with the higher risk of ischemic heart disease. According to the author Howard & Rossouw, the age group is also correlated to the progressive accumulation of disease such as coronary atherosclerosis associated with risk factors.

According to Souza (2018), women over 40 years old may present some diseases such as cervical and breast cancer, skin, hypothyroidism and cardiovascular diseases due to decreased production of female estrogen hormone.

The Cacoal-RO study showed that brown patients are more likely to develop the disease (Table 1). In the study by Oliveira & Magnabosco (2018), it was shown that the disease is greater in white patients due to contributing to a high mortality rate. According to the Ministry of Health (2017) acute myocardial infarction points to the profile of browns and blacks as the greatest contrast of triggering disease and mortality.

The research presented patient data regarding the area of residence, being larger in the urban area with 77.27% of the cases (Table 1). According to a study by Segatto (2013), stress is a risk factor for the disease, being increased in urban dwellers, due to the day-to-day disorders producing discomfort on all sides.

Regarding risk factors for acute myocardial infarction, females predominate that hypertension 25.0% (systolic arterial hypertension) is the major cause of the disease (Graph 2- A). According to the authors, the research reports that there is a great direct similarity between SAH and heart disease (LÓPEZ *et al*., 2010; LÓRIGA, PASTRANA &QUINTERO, 2013). A similar research conducted in Venezuela points out according to research that hypertension may be correlated with population behaviors and lifestyle habits, which is a major factor in the development of the disease (GALANO *et al*., 2012).

Another study states that the main risk factors for the development of ischemic cardiovascular diseases are smoking, physical inactivity, dyslipidemia, obesity, type 2 diabetes mellitus and hypertension with 72.3%. (HERNÁNDEZ *et al*., 2014; TARRAGÓ *et al*., 2012; BATISTA *et al*., 2015).

Risk factors related to males showed that the highest correlation of cases is with smoking 22.72% (Graph 2 - B). Based on other research, similar results are found that smoking (95%) is a vasoconstrictor and is a major cause of cardiovascular disease in males (CÁRDENAS &LLANOS, 2019).

The symptoms presented in the patients by analyzing the medical records were chest pain 61.36% and dyspnea 38.63% (Graph 3). Professionals should be aware that the symptomatology of the disease can be confused with other diseases, thus, may go unnoticed and worsen (RODRIGUEZ, MARTINEZ &RODRIGUEZ, 2018). It is stated that the first symptoms of the patients suggestive for the described disease is very strong precordial pain radiating to the region of the upper limbs and scapulae.

Symptoms of acute myocardial infarction presented by the patient should be identified in the screening performed by nurses and immediately referred to emergency medical care (SOUZA, SILVA &BARBOSA, 2014).

Upon analysis of the medical records, it was observed who was requested additional tests to the symptoms presented by the patients during the clinical consultation at the emergency hospital of Cacoal-RO. , 0% and CKMB 45.45% (Table 2).

The Brazilian Society of Cardiology (2015) is recommended to perform complementary tests to help and confirm the diagnosis of acute myocardial infarction. Biochemical markers such as Creatine Kinase (CK) or Lactic Dehydrogenase (LDH) enzymes have traditionally been a measure of cardiac syndromes. Tromponines are myofibrillar regulating proteins that are not present in the smooth muscle of the heart but in the slow-twitch skeletal (NEWBY *et al*., 2012).

The CK-MB marker is still widely used in hospital practice, which are early marked which should be used in less than 6 hours. The ECG is low cost and highly available in the evaluation of patients with chest pain suggestive of acute myocardial infarction and should be monitored for 12 to 24 hours (CULLEN *et al*., 2013).

By analyzing the patients' medical records, it was observed that only in 61.36% prophylactic measures were adopted as guidelines regarding healthy habits (Table 2). According to Carvalho*et al*. (2018), physical activity reduces the risk of heart disease, which today is one of the leading causes of death worldwide. Physical inactivity is a major factor in the development of heart disease; daily physical exercise can rule out the chances of triggering an acute myocardial infarction (TEIXEIRA *et al*., 2015 &FÉLIX, 2018).

Although there is a protocol to follow, they are not exactly used as determinants by the Brazilian Society of Cardiology. In the research, it was noted that AAS (70.45%) and Clopidogrel (54.54%) were the most used drugs.

According to the medical care protocol of the Brazilian Society of Cardiology (2015), intravenous morphine sulfate pain from 2 to 8 mg, nitroglycerine (0.4 mg SL) or isosorbidemonitrate (5 mg) should be used for pain relief. An antinflammatory / anticoagulant platelet

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Acetylsalicylic acid from 160mg to 325mg Chewable use, Clopidogrel and Ticagrelor An attack dose of 300mg is recommended, Use of enoxoparin is recommended in a patient <75 years with a diagnosis of STEMI. (intravenous ST segment) 30 mg IV in bolus and 1 mg / kg SC and in a patient> 75 years old administering only 0.75 mg / kg SC every 12 hours, the use of beta-blockers as a preference for metropolol VO is also recommended. prehospital phase of the disease, antiarrhythmic drugs such as lidocaine help in reducing the mortality rate of the disease (SBC, 2015).

The evolution of cases of acute infarction in the city of Cacoal-RO was cured in 70.45% and death in 29.54%, with a higher incidence in 2018 (n = 9) (Table 2). According to Santos *et al .,* 2018 research similar to this one, where the number of deaths was higher in 2016 (n = 168). According to Paixão*et al*., 2019 the survey showed that in 2016 it obtained 16.03% of deaths.

## V. CONCLUSION

It is concluded that due to the number of medical records analyzed, it can be inferred that the epidemiological profile of acute infarction in the municipality of Cacoal-RO was low, showing a disease incidence of 0.50 / 1000 inhabitants, mortality 0.13 / 1000 inhabitants and annual average of 11 cases / year. It is estimated that there are more patients diagnosed with the disease due to the hospital being invaded in 2015, many of the medical records were lost.

It is noted that a precariousness of information in medical records and divergences in AMI protocols not performed according to SBC. It can be affirmed the little clinical knowledge of the newly graduated doctors, that due to the symptoms being confused with other diseases they can go unnoticed by the clinical look.

Nursing plays an important role in the care of these patients with heart disease, such as procedures to relieve pain and physical examinations and intermediate care performed daily by the team.

It is proposed that medical professionals, nurses and the entire multidisciplinary team when providing care to patients, making detailed notes and correctly following protocols to facilitate studies during the analysis of medical records.

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# Automotive Lubricating Oil Degradation as an Electric Power Generator using Geobacter Sulfurreducens

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***Abstract*** *— Electricity is the basis for the development of all humanity, moving the economy and being part of our daily life, unbridled consumption of electricity around the world, ends up making the continuous use of natural resources, making them increasingly scarce. This situation has led to numerous studies and research into finding alternatives for sustainability and clean energy generation. The objective was to highlight the use of microbial fuel cells in bacteria such as Geobacter sulfurreducens and Bacillus Subtilis with automotive lubricating oil as a way to generate clean electrical energy. The methodology used was the quantitative and qualitative bibliographic research in the main platforms of scientific journals, having as a selection criterion the period from 2015 to 2019. It can be concluded that studies involving these possibilities are capable of bringing great impacts, especially in the case respect for the preservation of the environment and the reduction of the use of natural resources.*

***Keywords*** *— **Sustainability, Clean energy, Bacteria, Disposable waste.***

## I. INTRODUCTION

The search for electricity generation from renewable sources has become one of the most commented agenda today, given its need for human life. Moreover, in the technological age, many products and machinery need electricity to function and to move the entire economy of society, focused on the use of electricity.

However, what persists is the use of water as a source of energy to supply the industrial community and for the operation of an entire city, involving the consumption of energy through hydroelectric dams, so the misuse of natural resources has caused the water can reach its critical state, especially in Brazil's hydroelectric reservoirs.

However, there are several other ways to generate energy in a clean and renewable manner, through conscious use of sustainable energy sources, such as the sun, wind, waves, waste and sewage, and in this particular case use of contaminated oils, such as automotive lubricating oil, which is often used and is discarded without proper treatment, causing irreparable damage to the environment.

In the mid-1970s, clean energy became the target of many countries, when oil scarcity caused many parts of the world to invest heavily to adopt new technologies aimed at reducing dependence on energy imports [1].

Thus, the search for clean technologies is increasing, as a way to avoid and prevent serious environmental problems that affect the whole society, avoiding that several gases are emitted causing pollution of the environment. Therefore, clean energy is focused on the use of natural and fully renewable means [2].

According to [3] renewable energy sources are of various types: hydro, solar, wind, geothermal, waves and tides, alcohol, natural gas and vegetable oils. Each uses a natural resource for transformation into energy. These alternatives draw from nature resources that do not bring scarcity, such as wind, sunbeams, tidal waves, which are not continuous and have a certain propensity to become extinct in the world.

Clean energy is about renewable strategies focused on sustainability, because to keep the natural resources active in society, it is not enough to spend more than what can be obtained, turning to this idea energy needs to be clean for it to be renewable and sustainable. resources do not become scarce over time for all mankind [4].

Clean energy sources are called this because they are the least polluting energy in the environment, slowly abandoning the excessive consumption of electricity, the

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creation of the tariff flag, where the consumer assigns the surcharge values related to the cost of kWh as a function of of the cost attributed to electricity generation [5].

The other forms of clean energy still correspond to about 29% of the sources of electric energy, characterizing Brazil as a country dependent on the available electric energy (hydro and thermal).

This fact has raised interest in conducting research to use clean and renewable energy as the main alternative for the generation of electricity in Brazil, causing no generation of polluting agents and no significant environmental impacts. From a global point of view, there is still a significant dependence on power generation for thermal sources, coal and the like, which allows a small comparison of world dependence compared to Brazil (Figure 1).

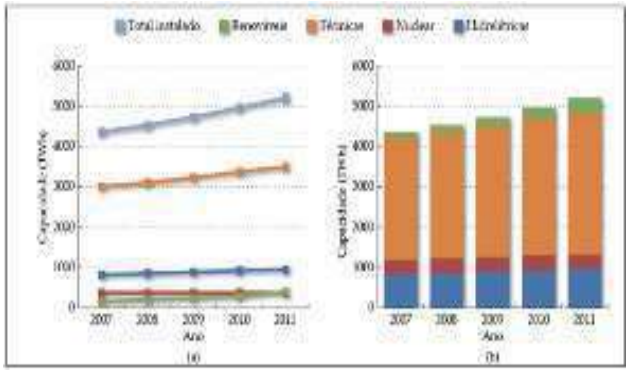

*Fig 1: Installed capacity of worldwide installed power sources.*

*Source: Authors (2019).*

Thus, the microbial fuel cell (MFC) is considered as a bioreactor capable of transforming chemical energy into electrical energy, becoming an alternative for energy generation due to catalytic reactions from within microorganisms [6].

For [7] cells can be called “electrochemical devices capable of converting chemical energy into electrical energy” with a considered high efficiency and small pollutant emissions, and can generate electric current being a good option for generating small scale energy.

According to [8], the microbial fuel cell is in alliance with sustainability, aiming at society's well-being through water quality, because microbial fuel cells are geared to operate as biosensors and can therefore be to determine the biochemical oxygen demand (BOD) in the sewage.

As a result, fuel cells start to draw attention for their ability to use bacteria to generate electricity. Starting from the premise that every living being has electrical energy, with this, the idea of generating energy from biodiesel as fuel for cells arises, however oxygen must be present otherwise the reaction becomes incomplete [9].

In a research carried out there is evidence of current measurements directed to the bacterium Geobacter Sulfurreducens DL 1, elucidating the factors involving the maximum capacity produced by a microbial fuel cell, where it was possible to observe the quantized current output of 92 (± 33). and 196 (± 20), fA are produced from well-isolated microelectrode parts [10].

In another study, it was found that these bacteria move electrons in their "breath", causing the movement of microorganisms, where it generates electricity in the same way as other energy generators that use nanotechnology, in the case of bacteria. Geobacter Sulfurreducens, its existence occurs within the earth, where the existence of oxygen is zero, and its survival is caused by the exchange of energy with the other organisms that live around it [11].

Another bacterium is Bacillus Subtilis, occupying the soil, where it becomes composed of prokaryotic and also eukaryotic microorganisms. However, turning to the field prokaryotes may be in distinct parts like plants, multiplying in internal tissues, thus surviving from the rest of the native microflora [12].

These genera of bacteria are recognized for their ability to provide biological control of plant diseases and their use allows the monitoring of phytopathogens, where producers may have dominance in pathologies. In a recent discovery they also realized that this bacterium can be used to develop new ways of generating energy through moisture in the air, with a technique called hydroscopy-powered artificial muscles that takes advantage of the ability of some microorganisms to remove from the environment moisture, at this time using the bacterium bacillus subtilis enters a dormant state and becomes a spore, which when in contact with water removes all liquid from it, causing its volume to increase by 6% [13] (Figure 2).

*Fig 2: Hydra system demonstration prototype using Bacillus subtilis.*

*Source: Machado (2015).*

This article aims to describe the use of bacteria geobacter sulfurreducens in consortium with bacillus

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subtilis in a microbial fuel cell using automotive lubricating oil as a way to generate clean energy, that is, emitting less pollutants, and renewable, without compromising the future existence of existing natural resources.

## II. MATERIALS AND METHODS

For the development of this article, bibliographic researches were carried out in the main platforms of journals, being, therefore, a qualitative study, for research focused on the generation of electricity using microbial fuel cell and the use of bacteria or microorganisms that can generate renewable electric energy.

As inclusion criteria were used articles published from 2015 to 2019, linked to research conducted with the cited bacteria or used in the junction of all cited items.

## III. RESULTS AND DISCUSSION

By applying the inclusion and exclusion criteria, it was possible to obtain the results shown in table 1, which indicates the comparative use of microbial cells for fuel cell generator use.

*Table 1: List of articles consulted.*

| Authors | Title | goal | Analysis Factors |
|---|---|---|---|
| [17] Fug, 2016. | Optimization of energy generation in a microbial fuel cell with Escherichia coli using polypyrrole electrodeposition modified electrode. | Construct a dual-chamber CCN for power generation from glucocester degradation by Escherichia coli. | Two types of electrodes were analyzed: graphite and graphite modified by polypyrrol electrodeposition. |
| [15] Silveira Duarte et al. 2016 | Microbial fuel cell used for electricity generation from sewage sludge and anionic surfactants. | To evaluate the influence of an anionic surfactant on membrane and membrane-free CCN. | Graphite rod electrodes were used and the MCC were fed with synthetic substrate and kept at room temperature. |
| [18] Felipe et al. 2017 | Microbial fuel cell power generation | Achieve microbial fuel cell performance by varying some factors in search of new results. | An Escherichia coli strain was used in a 5 ml B.H.I broth test tube. |
| [19] Galera et al. 2018 | Microbial Fuel Cell: Teaching Material for Microbiology Teaching | Use CCM as didactic material in the teaching of Microbiology, Chemistry and Physics for the secondary, technical and higher levels. | Materials such as 40 mm 10 cm pvc pipes were used; pipe connectors; iron and solder for the construction of a microbial fuel cell. |
| [16] Oliveira, 2019. | Alternative sources of energy with microbial origin: fuel cells and supercapacity nanostructures. | Analyze the development of yeast-based microbial cells. | Dibasic potassium phosphate (K2HPO4) and Saccharomyce as cerevisiae, strain 1026 were used. |
| [14] Ottoni et al. 2018 | Synthetic vinasse biotreatment and electricity generation using a microbial fuel cell. | To evaluate the use of a dual chamber CCM in the treatment of synthetic vinasse. | Reactor power was analyzed by CCM technology. |

*Source: Authors (2019).*

The relevance of using microbial fuel cells together with other microorganisms for the development of renewable electric energy was observed. Within this view, in the study by [14], tests were made with vinasse, it is a residue that comes from the production of ethanol, which in turn has a high concentration of oxygen or Biochemical Oxygen Demand (BOD5), a pH low and in contrast, an abundance of mineral and organic substances, this junction causes a discharge into the soil. For this study a prototype of a microbial fuel cell was needed to insert the synthetic vinasse and inoculate with pure culture of red cell sultate bacteria (BRS-IPT 032).

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In the study by [15], an analysis of this energy conversion was made, but now using the microorganisms found in the sewage sludge in conjunction with anionic surfactants, after 35 days of monitoring, it was observed in the experience that the addition of Sulphonated linear alkylbenzene (LAS) positively corroborated with the electric power generation, and within the membrane-free CCM had a current of 7.5mA / m², for the membrane-based CCM the current was 37.3 mA / m².

In the study by [16] the use of yeast for microbial fuel cell power generation, where it was prepared using two Teflon cylindrical tubes, resulted in the efficiency of the lowest cost yeast-based fuel cell. according to the combination of the proton exchange membrane and current collectors.

Thus, in the study by [17] it was possible to find an increase in coulombin efficiency in the system containing polypyrrol (17.18%) compared to the system that did not have (7.31%), which causes a better use of electrons that can be converted into electrical energy.

For [18] microbial cells are considered as a method of generating energy with the degradation of a certain organic material, in the study the materials used were not enough to generate energy on a larger scale, for this the author suggests that further studies be done to find more cost effective electrodes.

Thus, [19] showed that in his study, CCM goes beyond an analysis involving Biology, Physics and Chemistry, where it was observed that it is easy to build a low cost CCM, therefore to generate energy, it is understood that costs can be low if a way of generating this energy on a larger scale is created.

With the largest consumption of electricity in the world, several losses to the use of natural resources have been faced mainly regarding the use of water as a source of electricity in the metropolises. Therefore, exploring new ways of generating energy in a clean or renewable manner allows it to preserve the main natural resources, which, however, may become scarce for all humanity in the future.

Thus, further studies should be done frequently to expand more possibilities, making it possible to generate energy using items that are harmful to the environment and that are discarded. Sharing scientific knowledge about this innovation not only contributes to the advancement of humanity, but also to its own preservation through the natural factors and effects that have been present over the years in nature.

## IV. CONCLUSION

The microbial fuel cell is what makes it possible to generate electricity using bacteria or microorganisms of its own nature or in agreement with other elements that are also continuously discarded, such as automotive oils, sludge, solid waste, yeast, vinasse and many others. Combinations capable of causing the chemical reaction of the combination of these microorganisms and bacteria to generate electricity continuously.

Studies involving these possibilities are capable of having major impacts, especially for the preservation of the environment and natural resources, making electricity more accessible, cheaper and renewable, that is, something that is used inexhaustible source of nature, and therefore its use causes neither scarcity nor wear and tear over the years.

Incorrect use of oils that are disposed of in rivers or garbage can contribute to environmental pollution, and can also be a source of food for microorganisms capable of degrading them, so they can be used in conjunction with the microbial fuel cell, subject to chemical changes and which can generate electrical current.

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# Immediate implant with immediate loading in the anterior region using L-PRF to preserve gingival aesthetic profile

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***Abstract***— *One of the challenges of the immediate immediately loaded implantation technique in aesthetic areas is the preservation of aesthetic support structures such as marginal ridges and soft tissues. In order to preserve the peri-implant structures and maintain the aesthetic volume of the alveolar process and thus the emergence profile of the implant prosthesis. Bone grafts, connective tissue grafts and use of biological membranes can be employed to cover the surgical bed to protect and preserve the volume of the socket, maintaining the prosthetic aesthetic profile safely and predictablyThis paper aims to present a clinical case of a patient with tooth root fracture 21. Atraumatic tooth extraction was performed with immediate implant installation. For the preservation of the peri-implant structures and maintenance of the gingival aesthetic profile, a bone graft was performed, with i-PRF agglutinated xenograft, collagen membrane and covering the gap, the L-PRF membrane and immediately loaded using a plastic ucla abutment and a tooth. made with an additional silicone wall. The case was evaluated at 7 days and 30 days and immediately afterwards the definitive prosthesis was performed and 90-day follow up was performed. Based on the initial results obtained, it can be concluded that the treatment had benefits providing a favorable prognosis with longer implant survival at the end of the osteointegration period.*

***Keywords***— ***Immediate implants, Platelet-rich fibrina, Maxilla, Implants.***

## I. INTRODUCTION

Modern implant dentistry in recent years has sought minimally invasive procedures with rapid resolution and practicality. In this context, immediate implant placement in the extracted tooth alveoli has been an alternative to reduce treatment time and cost, preserve height, alveolar bone thickness and soft tissue size, and promote bone-implant contact (PAL et al., 2011).

However, some factors are considered determinant for obtaining a positive result in the treatment of implant placement placed immediately in the alveoli of teeth extracted traumatically in the anterior region of the maxila (SONI et al., 2019). These include preservation of the bony margins of the socket during extraction, primary implant stability in the apical portion or along the walls of the socket, strict control of the tissue flap, close closure adapted to the neck of the implant, vertical resorption of the implant vestibular bone crest during the healing process and the presence of a horizontal bone defect, gap (VIGNOLETTI; SANZ, 2014).

In order to improve the techniques, several materials are incorporated in order to increase the biological, physiological and mechanical connections responsible for the implant success and the health of the surrounding tissues since the relationship between them is paramount to the success of these treatments (PARITHIMARKALAIGNAN; PADMANABHAN, 2013).

In an attempt to preserve the tissue dimensions of the dental socket immediately after extraction and fill the space between the implant and adjacent tissues, grafting has been the technique of first choice. Being aware of some limitations of autografts, the market has developed biomaterials in order to replace and provide clinically satisfactory results (NATALE JÚNIOR et al., 2018; POMINI et al., 2019a).

In this context, xenografts have gained space in implant dentistry because they have osteoconductive properties and help in maintaining the three-dimensional structure during the bone repair process (POMINI et al., 2019b).

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Many previous reports have justified the use of this bone substitute with blood derivatives in order to provide a synergistic action in the tissue healing process. Among these blood products, fibrin-rich plasma, PRF stands out for its osteogenic properties, due to the presence of growth and angiogenic factors (JEE, 2019).

Thus, in order to preserve and maintain aesthetic results in the procedures, accelerate the process of tissue regeneration and protect the surgical site, it is possible to use a practical and low cost access technique with biological membranes, platelet rich fibrins, L –PRF (CHOUKROUN et al., 2006).

The present case report presents the clinical application of immediate implant placement with the combined use of i-PRF agglutinated xenograft, PRF membrane and immediate prosthetic load in the anterior maxilla.

## II. CASE REPORT

A 55-year-old male patient sought a private practice complaining of tooth sensitivity and discomfort 11 during chewing or palpation. On clinical examination the tooth presented percussion pain, but no sign of change in hard and soft tissues (Figure 1A-B), radiographically only a suspected root fracture, with no significant changes in periodontal tissues.

A cone beam computed tomography, CBCT was requested to complete the diagnosis of root fracture. Upon completion of the diagnosis, treatment options were given to the patient who decided to perform an immediate implant with the possibility of immediate loading (Figure 1C-D).

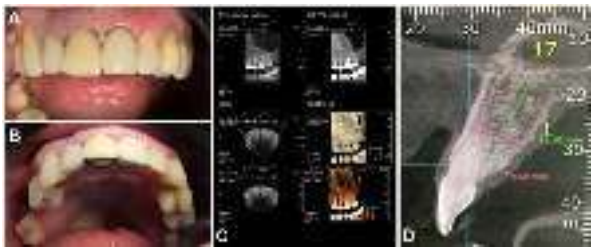

*Fig.1. A) Pre-treatment frontal aspect; B) Occlusal view pretreatment; C-D) CBCT images of jaws.*

Pre-procedure medications were broad spectrum antibiotic, amoxicillin 500 mg (generic medicine, Medley, SP, Brazil), 2 tablets 1 hour before the procedure, steroidal anti-inflammatory dexamentasone 4 mg (DecadronTM, Aché, SP, Brazil), 1 tablet 1 hour before the procedure and mouthwash with 02% chlorhexidine digluconac.

During the procedure, the patient was properly prepared with aseptic control and anesthetized with 2% mepivacaine + 1: 1000000 epinephrine, with vestibular and palatine infiltrates. The extraction of tooth 11 was done atraumatically, using a double periotome. After extraction it was possible to observe the fracture in longitudinal oblique direction (Figure 2A).

The implant of choice for immediate implantation was the Drive CM 3.5 x 13 implant (NeodentTM, PR, Brazil) implant with aqua surface treatment. Milling for implant installation occurred in a more palate position in relation to the dental socket, this allows a better positioning for the emergence of the prosthetic screw. The implant was installed with a torque of 50N/cm. A prosthetic component, CM conical abutment (NeodentTM, PR, Brazil) was installed over the implant to perform the immediate, provisional prosthesis. (Figure 2B-C).

*Fig.2. A) Atraumatic tooth extraction 11; B) CM 3.5 x 13 Drive Implant Installation; C) Occlusal view of upper arch after implant installation.*

To close this gap and preserve the emergence profile of the prosthesis over the implant, the stick bone, xenograft + i-PRF + collagen membrane Lumina-CoatTM + L-PRF membrane technique was performed.

Plasma processing followed the following protocol (Figure 3A):

1) 9mL Red Tube to obtain L-PRF;
2) 9mL white tube for i-PRF;
3) Centrifugation: 1300rpm for 14 min.

Obtaining the i-PRF and applied to the particulate bone (Lumina boneTM - Criteria, SP, Brazil), this graft polymerization was expected, approximately 14 min for application in the gap (Figure 3B-C). With a disposable syringe and suction tip, we collected the i-PRF from the white tube and then applied it to the particulate bone, left over from the i-PRF was applied to the bovine collagen membrane.

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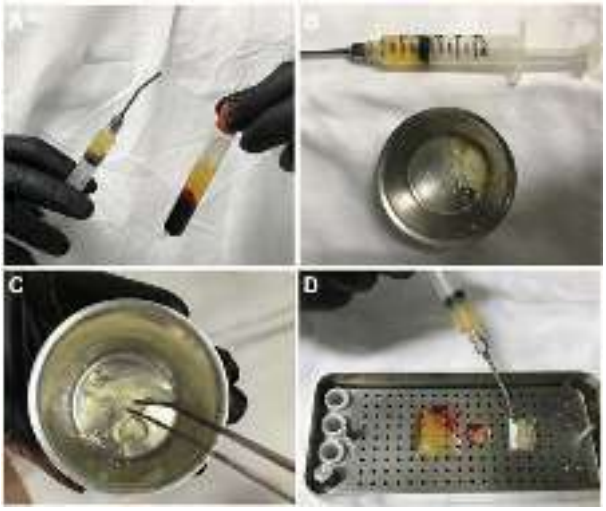

*Fig.3. A) Obtaining the PRF; B) i-PRF plus xenografto; C) I-PRF polymerized xenograft; D) L-PRF membrane manufacturing.*

An L-PRF membrane was also obtained for later application to the graft. The PRF clot was pressed over the grid of the PRF kit (Thimon™, Surgical Instruments, SP, Brazil) for 1 min (Figure 3D).

With the aid of forceps and a periotome, the stick bone was carefully adapted, filling the gap between the implant and the bone table (Figure 4A-B).

The collagen membrane was seated over the bone graft and extended into the gap, fully protecting the bone graft, avoiding soft tissue contact with the graft (Figure 4C).

Over the collagen membrane, the L-PRF membrane was placed and adapted with the aid of the periotome, adapting it over the entire length of the graft (Figure 4D).

Mattress-type sutures were performed using EthiconTM Mononylon 5-0 suture (Johnson & Johnson, SP, Brazil) to stabilize membranes and graft material under the tissues.

A conical abutment was used over the conical abutment to make the immediate provisional. To make this temporary a mock up system with the natural tooth was performed. Using a silicone wall and bisacrylic resin, Protemp 4TM (3M from Brazil, SP, Brazil) was made provisional. After finishing and polishing the patient was released. The suture was removed at 10 days.

Within 30 days the patient underwent a new x-ray to confirm implant stability and transfer impression was performed. At 45 days the patient performed the installation of the definitive prosthesis.

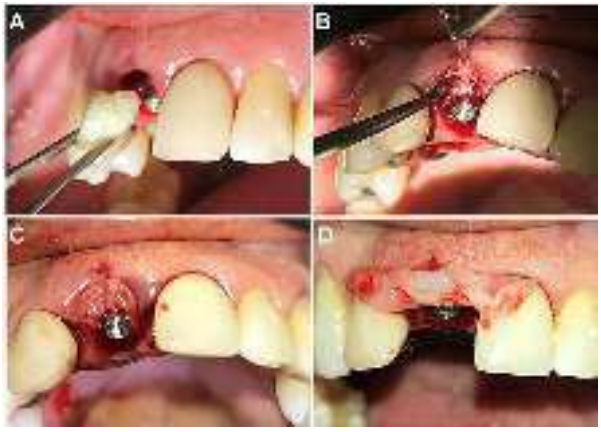

*Fig.4. A) Stick bone installation; B) Stick bone adapted in the gap between implant and bone table; C) Collagen membrane seated over bone graft and extended into the gap; D) L-PRF membrane adapted over the entire graft extension.*

## III. RESULTS

The use of PRF in the installation of immediate implants with its application on the implant surface and in filling the gap presented satisfactory clinical results. After 7 days, during the postoperative consultation, the gum over the implant was completely preserved, without inflammatory aspects and the patient reported no pain or discomfort (Figure 5A, C).

At 30 days postoperatively during the transfer impression procedure, the implant showed optimal stability and good periimplant health, with only slight tissue irritation under the provisional prosthesis.

At 45 days, the definitive prosthesis was installed, with the torque recommended by the manufacturer; CM abutment 32N / cm and implant prosthesis 10N/cm (Figure 4B).

Radiographically the implant presented good adaptation with the bone structures and full filling of the gap space between the implant and the alveolar walls.

*Fig.5. A) 7 days after surgery; B) 45 days after surgery; C) Periapical radiography at 30 days.*

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## IV. DISCUSSION

Knowledge about the phenomenon of tissue remodeling after tooth extraction is crucial to determine treatment planning and favorable prognosis. Thus, implant dentistry has improved in the search for procedures that provide alveolar bone regeneration with high implant survival rate and aesthetic patient satisfaction. (MITTAL; JINDAL; GARG, 2016).

Implant stability and periimplant tissue health decrease during the first weeks of healing due to changes occurring in bone and soft tissue, which cause aesthetic and biological concerns. Thus, it is necessary to establish a treatment protocol that provides the maintenance and preservation of periimplant tissues, with the focus on the installation of immediate loading implants (SEHGAL et al., 2018).

It is in this context that immediate load implants have been occupying more space in surgical procedures, in recommended clinical cases. Thus, the initial results of the present case report confirmed the benefits of the technique, providing a favorable prognosis with longer implant survival at the end of the osteointegration period (KOH; RUDEK; WANG, 2010).

Immediate placement of the implant with immediate loading offers advantages over bone preservation of the alveoli, reduction of trauma, as it is only a surgical procedure. However, there are some limitations regarding unpredictable site morphology, potentially limited amount of soft tissue and the risk of failure due to residual periosteal infection (SABIR; ALAM, 2015).

Despite these possible disadvantages, immediate implant placement and immediate implant loading were favorable in maintaining or increasing bone height around implants, especially when associated with the use of bone grafts (CHUNG; MCCULLAGH; IRINAKIS, 2011).

In an attempt to optimize the filling of gaps by bone substitutes, many authors have suggested combined use with blood derivatives, especially PRF, in the tissue repair and accelerating the osteointegration period, providing increased implant survival rate (CHOUKROUN et al., 2006). In addition, the use of the PRF membrane, called platelet and leukocyte rich fibrin (L-PRF), is a second generation of autologous platelet concentration and has a fibrin mesh composed of leukocytes, growth factors, proteins and cytokines (CORTESE et al., 2016).

It has been successful in bone reconstruction due to its dense three-dimensional fibrin structure, which reduces the risk of bacterial invasion and the presence of leukocyte, the immune system cell. In addition, it has a gradual release system of various growth factors for at least one week up to 28 days after implantation. This ensures a microenvironment conducive to tissue growth in the early stages of healing (ANITUA et al., 2013).

## V. CONCLUSION

Based on the initial results obtained and corroborated by previous studies, it is possible to conclude that immediately loaded implants successfully replaced central incisor in the maxillary region and the combined use of i-PRF and L-PRF for the maintenance of bone and soft tissue at the implant site. provided an adequate clinical condition for better aesthetics associated with immediate placement of the prosthesis.

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# Progress in the production of fungal lipases by submerged fermentation

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***Abstract*—***Enzymatic catalysis has numerous advantages over chemical catalysts such as high specificity and high catalytic efficiency. Among enzymes, lipases are considered versatile and of vast industrial application. The main source of obtaining these enzymes are microorganisms and studies that employ filamentous fungi, in general, present promising results. Thus, it is verified the need to analyze what has been discussed in recent scientific publications in order to identify the current state of research. Therefore, this study aimed to analyze the recent literature through a bibliometric study, to identify trends and gaps in research in the area of fungal lipase production through submerged fermentation. Quantitative and qualitative analyses were used for this purpose. The analyses showed the high versatility of fungal lipases in several industrial sectors and it was possible to conclude that recent research has been focusing on the optimization of liquid cultivation media and screening by lipase-producing fungi. Moreover, there is believed to be a research gap in the investigation of the use of whole cells of fungi to reduce the costs associated with lipase-catalyzed processes and make them competitive economically.*

***Keywords*—enzymes, filamentous fungi, biocatalysts, bibliometrics.**

## I. INTRODUCTION

Lipases occupy a prominent place among biocatalysts and catalyze hydrolysis reactions and long chain acyglycerol synthesis in aqueous and non-aqueous media. Its unique properties, such as selectivity and substrate specificity, position them as the most expansively used industrial enzymes (Mehta & Gupta, 2017; Sarmah et al.,2017).

Fungal lipases stand out as the main sources of lipases because of their catalytic activity, low production cost and relative ease in genetic manipulation. The production of fungal lipases has been successfully performed by submerged fermentation (FS) and solid-state fermentation (FeS) processes anddepends largely on microorganism species, culture practices, medium composition and bioreactor design. In addition, immobilized fungal cells have also been used to produce lipases using various support materials (Mehta&Gupta, 2017; Geoffry&Achur, 2018 ; Salihu et al., 2012).

The versatility of enzyme-produced lipases allows their application in relevant sectors such as in the food, textile, leather, paper and detergent industry. However, as much as industrial applications of fungal lipases have increased in recent decades there is an increasing need to explore new strands, which engage both hydrolytic and synthetic reactions. The most recent applications of lipases, but already successfully established, are seen in the synthesis of biopolymers, biodiesel production, effluent treatment, bioremediation and synthesis of drugs (Mehta & Gupta, 2017; Ray, 2015; Geoffry&Achur, 2018).

The relatively high cost of lipases combined with low operational stability remains a technological and economic bottleneck and that makes the industrial use of lipases less widespread. Research in the area suggests some alternatives such as the improvement of fermentation technologies, application of immobilization techniques and Protein Engineering (Lai et al., 2019).

As research on a given object, in a specific area of study, begins to grow there is a need to propose studies that help understand the stage of development of the object. Thus, some researchers have been looking to analyze the development of scientific research, which results in bibliometric studies. Bibliometric studies employ concepts of Bibliometrics, a statistical method used to evaluate and quantify the number and growth trend of a given subject (Mao et al., 2018). This analysis allows the visualization of the scientific and technological advances already made (Moreira; Xavier; Lira, 2018). Thus, it is believed that it is possible that technological advances in the area of research on fungal lipase production via FS can be identified through bibliometric studies.

The objective of this work is to contribute to the knowledge about trends and research gaps on fungal lipase

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production by submerged fermentation observed in recent literature. For this purpose, quantitative and qualitative analyses of recent publications were performed (published between 2010 and 2019), through a bibliometric study.

## II. METHODOLOGY

The bibliometric study was conducted in two stages. The first stage, the quantitative analysis, was performed in order to obtain the quantitative data of the publications and present them in the form of graphs. The second stage, the qualitative analysis, aimed to describe the themes discussed in the analyzed studies and discuss possible implications relevant to the objective of this work.

The database employed in the research was the Web of Science platform(WoS), belonging to Clarivate analytics. This basis was chosen because it was considered a data source with broad indexation of journals of scientific importance and because it has a great diversity of indexed metadata, which include the authors of publications, their affiliations and countries and basic bibliographic information (Paul-Hus; Desrochers; Costas, 2016; Olensky; Schmidt; Van Eck, 2016; Pereira et al., 2019).

Initially, an exploratory research was conducted, searching the WoS database for the term "lipases" and selecting the mode of search for topics. The period considered included the years 1945 (year limit of registration of works in the database) to 2019 and only papers published in English, Portuguese and Spanish (Margon; Freitas; Pinotti, 2018; Yaoyang& Boeing, 2013).

To refine the results obtained in exploratory research, the date of publication of the papers was restricted from 2010 to 2019, in order to identify research trends on recurrent lipases in the last decade. The results were filtered by the type of study, considering as relevant results only original articles, reviews and protocols of procedures.

The results of the research, carried out according to the methodology described above, were again refined with the insertion of new terms ("submerged" and "fungi" or "fungal"). In this step, a citation report was created with WoS data analysis tool. Based on the data obtained, graphs were constructed that presented the temporal evolution of the number of publications according to the years and countries related to the research (Catelan&Pinotti, 2019).

The articles found were read and selected according to content adequacy to the objective of this study. The articles, listed in Table 1, were discussed for their content. From the discussion, a table was elaborated (Table 2), which presents, succinctly, the main operational conditions of fungal lipase production by submerged fermentation studied by the studies analyzed here.

Based on the articles selected in the refined research, a SWOT analysis (Table 3) was performed, which is a tool that detects and corrects apparent problems in each area and allowed a better understanding of the proposed analyses. SWOT analysis consists of ways to analyze strengths, weaknesses, opportunities and threats and ways to convert threats into opportunities and weaknesses into forces (Margon; Freitas; Pinotti, 2018; Souza et al., 2018).

## III. RESULTS AND DISCUSSION

Exploratory research in the Web of Sciencedatabase, using only the term"lipases" and from 1945 to 2019, found 9,082 results. From the data obtained, a graph was elaborated that presents the number of publications according to the years in the period considered (Figure 1).

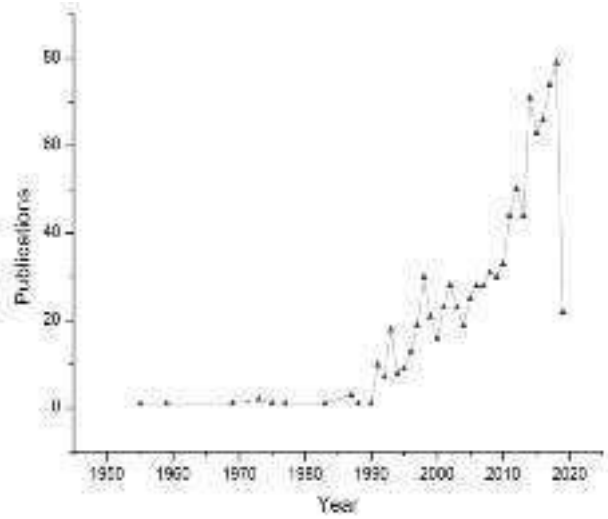


*Fig. 1:Results of the research term "lipases" by the number of publications in the period 1945-2019*

*Source: Adapted from Web of Science by authors (2019)*

Figure 1 shows that the first publications related to lipase research occurred in 1950. Although the scientific community's interest in lipase study apparently began in 1950, research began to intensify only in 1990, when there was a significant expansion in the number of scientific publications on the subject, noted by a 419% increase in the number of publications between 1990 and 1991.

In order to refine the results obtained previously, the time space was reduced for the period between 2010 and 2019 and new research terms were added, aiming to select only recently published papers, such as shown in Figure 2.

Figure 2 shows that in the period considered only in 2013 there were no publications related to the limited research clipping in this study. In 2011 and 2014, there was a slight increase in the number of published papers, with 4 publications published in 2011 and 5 publications in 2014.

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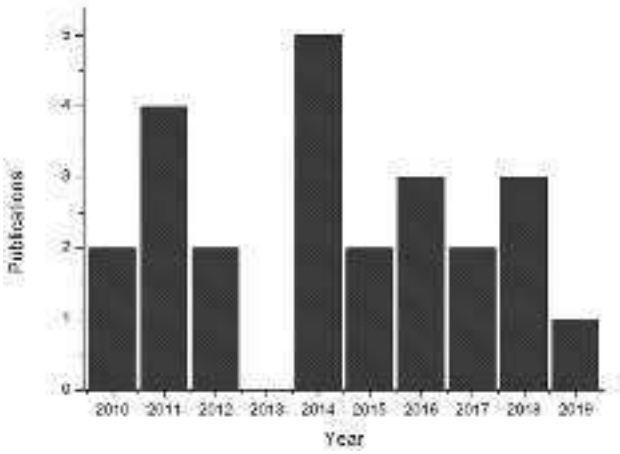


*Fig. 2: Publications of studies per year in the temporal space understood from 2010 to 2019*
*Source: Adapted from Web of Science by authors(2019)*

In parallel, the analysis of the number of annual publications was also listed the most prominent countries in the number of publications, between the years 2010 to 2019, as shown in Figure 3.

Figure 3 shows that the country with the highest number of publications is Brazil, with a total of 10 published papers. Secondly, India is in five polls, followed by Pakistan with 3 publications, and finally Germany with 2 publications. The other countries listed in Figure 3 presented only 1 publication each in the period considered.

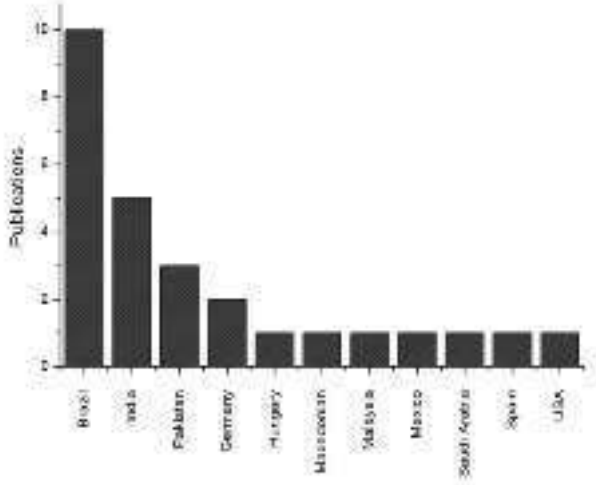


*Fig. 3: Publications by countriesin the temporal space understood from 2010 to 2019*
*Source: Adapted from Web of Science by authors (2019).*

As we can see in Figures 2 and 3, 23 articles were obtained using the time criterion (2010 to 2019) and the words ("lipases", "submerged fermentation" and "fungal" or "fungi"). The complete reading of scientific publications was carried out and careful analysis was carried out about the adequacy of its content to the scope of this work, in order to select only studies considered relevant, that is, only studies that addressed research related to the production of fungal lipases produced by submerged fermentation. Table 1 shows the selected papers as well as their respective authors, publication date and total number of citations and Table 2 presents the operating conditions found in this research.

*Table 1: Titles, authors and total number of citations of selected studies after selection and complete reading of the studies*

| Title | Authors | Total number of Citations |
|---|---|---|
| Lipase from marine Aspergillus awamori BTMFW032: Production, partial purification and application in oil effluent treatment | Basheer et al. (2011) | 37 |
| Surface response methodology for the optimization of Lipase production under Submerged Fermentation by filamentous fungi | Colla et al. (2016) | 17 |
| *Production and Characterization of Lipases by Two New Isolates of Aspergillus through Solid-State and Submerged Fermentation* | Colla et al. (2015) | 16 |
| *Production and characterization of Lipases and immobilization of whole cell of the thermophilic Thermomucorindicaeseudaticae N31for transesterification reaction* | Ferrarezi et al. (2014) | 14 |
| *Evaluation of lipase production using different strains of microorganisms isolated from dairy effluent through submerged fermentation* | Roveda et al. (2010) | 8 |
| *Selection of Lipase-Producing Microorganisms through Submerged Fermentation* | Colla et al. (2010) | 4 |
| *Coconut oil induced production of a surfactant-compatible lipase from Aspergillus tamarii under submerged fermentation* | Das et al. (2017) | 2 |
| *Mutagenic strain improvement of Aspergillus niger (MBL-1511) and optimization of cultural conditions for boosted lipolytic potential through submerged fermentation* | Sidra et al. (2016) | 2 |
| *Extracellular Lipase Production by Aspergillus nidulans (MBL-S-6) under Submerged Fermentation* | Niaz et al. (2014) | 2 |

*Source:Adapted from Web of Scienceby authors (2019)*

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Basheeret al. (2011) reported the potential of oily effluent bioremediation by extracellular fungal lipases synthesized by a marine isolate, identified as Aspergillus awamori. The production of lipases by A. awamori was influenced by the following factors: temperature, incubation time, soybean meal concentration and concentration of $KH_2PO_4$ and $(NH_4)_2SO_4$.

Colla et al. (2016) evaluated the influence of nine distinct factors (carbon source, nitrogen source, nitrogen concentration, inducer, concentration of inducers, fungus species, pH and agitation) on production by submerged fermentation of lipases. Fungi Aspergillus niger and Aspergillus flavus were selected as good producers and among the factors studied only the concentration of nitrogen source (yeast extract) and pH were considered as statistically significant factors.

Colla et al. (2015) they studied the production of extracellular lipases by the genus Aspergillus by FS and concluded that the enzymes produced by submerged fermentation were more thermally stable than the lipases obtained by solid state fermentation and presented high stability in acid pH (3.5-6.5).

Ferrareziet al. (2014) concluded that the catalytic application of whole cells of the filamentous fungus Thermomucor *indicaeseudaticae N31*immobilized in vegetable sponges indicated can be considered promising in synthesis reactions, since esterification and transesterification yields were considered satisfactory (28% and 13.2% using oleic acid and soybean oil, respectively), with a view to the possibility of employing the unpurified enzyme in several processes. The reactions mentioned above are essential to produce biodiesel via enzymatic catalysis. In this context, immobilized intact cells present the possibility of reducing the overall costs of biocatalyst lipase processes due to the possibility of reuse of enzymes and the use of unpurified lipase.

Roveda et al. (2010) aimed to evaluate the production of lipases by fungi isolated from effluent from milk production. Fungal isolates from the genus Penicillium, Aspergillus, Trichoderma and Fusarium were obtained. In submerged fermentation, fungi E-9 (Aspergillus), E-21 (Aspergillus) and E-20 (Penicillium) were the ones that presented the highest enzymatic activities, using as a means of cultivation the effluent collected from the treatment system. This study indicates that fungal strains isolated from effluents have the potential to be used in the treatment of fatty effluents, as well as indicate that the use of effluents as means of cultivation can be feasible to reduce the production costs of lipases.

Colla et al. (2010) they are screening lipolytic fungi by submerged fermentation. Fungal strains were isolated from milk and soil samples contaminated with diesel oil. The largest producers were identified as the fungi Penicillium E-3 with maximum lipolytic activity of 2.81 U, Trichoderma E-19 and Aspergillus O-8 with maximum activities of 2.34 and 2.30 U, respectively.

Das et al. (2017) found that the maximum production of lipases by the fungus identified as Aspergillus tamirii was obtained by optimizing operating and nutritional conditions, in liquid medium supplemented with mineral salts and coconut oil, as an inducer of the production of lipolytic enzymes. The authors reported that the addition of crude lipases in detergent improved by approximately 2.2 times the ability to remove oily stains and suggested their application in the formulation of detergents.

Sidra et al. (2016) showed that there was a significant increase (147.27%) in extracellular lipase activity by a mutant produced from Aspergillus niger (MBL-1511) in relation to the wild lineage of that microorganism. Optimal experimental conditions for submerged lipase production such as inoculum concentration, temperature, fermentation time, pH, carbon sources and inducer were studied, achieving an improvement of approximately 30% in relation to the maximum lipolytic activity presented by the mutant produced.

Niazet al. (2014) identified a coded microorganism such as Aspergillus nidulans MBL-S-6 and conducted a study to determine optimal conditions to produce extracellular lipases via FS. A gradual increase in enzymatic production and specific activity was observed when experiments included the presence of rice meal, increased fermentation time, variations in inoculum size and increased fermentation medium volume.

The analysis of the results of the research conducted indicates that research efforts in the production of fungal lipases by FS are concentrated in the screening of fungal strains, lipid-producing skills, and on the optimization of the cultivation medium and operational conditions, which is in accordance with the conclusions found by Singh & Mukhopadhyay (2012, p. 513). In addition, the use of vegetable oils from different sources, such as inducers of lipase production was observed in virtually all studies (see Table 2), indicating the strong dependence of a lipid inducer to provide lipase production.

Moreover, the versatility of industrial application of fungal lipases is evident, since its potentiality was pointed out for use in varied applications such as biosurfactants formulation, in the treatment of oily or greasy effluents

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and in the biofuels industry, as well as scored in the studies by Joshie&Kuila (2018, p.243), Geoffry&Achur (2018, p.250) and Singh & Mukhopadhyay (2012, p.513).

The reduction in production costs proved to be a recurring topic in the research conducted, since the high cost of lipases is an obstacle to their large-scale commercial employment. According to Kumar, Sharma & Kanwar (2012), "future developments in low-cost production and purification technologies would reduce the cost of these enzymes and allow increased commercial applications." In this sense, the use of agro-industrial waste as unique sources of carbon and effluents rich in organic matter as means of cultivation are established as viable alternatives, the reuse of immobilized lipases and also the use of intact cells, which do not require complex purification processes, as highlighted by Salihu et al.(2012), Shelatkarm&Padalia (2016) and Wachtmeister (2016). The presence of few studies in the sample of studies analyzed (1 study in 10 results) on the use of whole cells of fungi as biocatalysts indicates a possible gap in the clipping of the research area considered here, which is believed to be a potential area of research for the future.

The advantages of the use of lipases as industrial biocatalysts are widely explored in the analyzed work. Simultaneously, some disadvantages were also listed, with long reaction times and low yields mentioned more frequently, demonstrating that these are the main challenges to be faced in this context.

The strengths, weaknesses, threats and opportunities found after the analysis of the search results were listed in the SWOT matrix (Table 3).

*Table 3: SWOT analysis of the sample of selected articles*

| **Forces** | **Weaknesses** |
|---|---|
| -High catalytic efficiency, high selectivity, great versatility and environmental advantages. | -High cost of lipases makes bio catalyzed processes impossible on a large scale. |
| **Threats** | **Opportunities** |
| -Low reaction yields and long reaction times are verified in lipase-catalyzed reactions. | -Application of immobilized cells in biofuel catalysis reactions and effluent treatment; |

*Source: Prepared by the authors (2019)*

## IV. CONCLUSION

Based on the quantitative and qualitative analyses carried out from recent publications it was possible to satisfactorily identify the main topics treated, trends and possible gaps in research on fungal lipase production by submerged fermentation. In general, lipases are versatile enzymes that have numerous industrial applications. Regarding the production of lipases, it was observed that microbial lipases are essential sources for obtaining these enzymes and studies that used filamentous fungi are very promising. The scope of the analyses performed allows us to observe that the interest of the scientific community is concentrated in the optimization of liquid cultivation media and screening by lipase-producing fungi, identified as trends for the future of research in the production of fungal lipases via submerged fermentation. In addition, it is believed that there is a gap in research on the use of intact cells of fungi, as a way of reducing costs by eliminating purification steps of the enzymes produced, which has the potential to make the processes bio catalyzed by lipases more competitive.

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| Conditions/ Authors | Niaz et al. (2014) | Sidra et al. (2016) | Das et al. (2017) | Colla et al. (2010) | Roveda et al (2010) | Ferrarezi et al. (2014) | Colla et al. (2015) | Colla et al (2016) | Basheer et al. (2011) |
|---|---|---|---|---|---|---|---|---|---|
| F | Aspergillus nidulans | Aspergillus niger | Aspergillus tamarii | Penicillium E-3 | Aspergillus and Penicillium | Thermomucor*indicaeseudaticae*N31 | Aspergillus. | Aspergillus flavus | Aspergillus awamori |
| I | --- | Sunflower oil | Coconut oil | Olive oil | Olive oil | Soybean oil | Soybean oil | Soybean oil | Rice bran oil |
| Tl | Extracellular | Extracellular | Extracellular | Extracellular | Extracellular | Immobilized whole cells | Extracellular | Extracellular | Extracellular |
| T and pH | 40°C and 7.0 | 30°C and 6.0 | 25°C and 6.0 | 30°C and 6.0 | 30°C and 6.5 | 45°C and 6.0 | 30°C and 7.0 | 30°C and 5.0 | 35°C and 3.0 |
| A | 200 rpm | 200 rpm | 120 rpm | --- | 130 rpm | 150 rpm | 160 rpm | 160 rpm | 150 rpm |
| Tf | 3 days | 4 days | 7 days | 5 days | 7 days | 10 days | 4 days | 10 days | 5 days |
| Al | 33.33 U.mL$^{-1}$ | 22, 0 U.mL$^{-1}$ | 25.83 U.mL$^{-1}$ | 2.81 U | 2.25 U | 108 U.g$^{-1}$ | 4.30 U.mL$^{-1}$ | --- | 495, 0 U.mL$^{-1}$ |

*Fig. 2: Summary of the operating conditions studied in the production of lipases by FS found in the selected sample of articles, in which: F=Best lipase-producing fungi, I=Inducer, TL=Type of lipase, T and pH=crop temperature and optimum pH, A=agitation, TF=fermentation time, AL=Maximum Lipolytic Activity found*

*Source: Prepared by the authors (2019)*

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# Thermal requirements, life table and estimate of number of *Trichogramma galloi* in eggs of *Neoleucinodes elegantalis*

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***Abstract*— *The Neoleucinodes elegantalis is considered one of the main tomato pests, as it directly damages the fruit. The use of the parasitoid Trichogramma galloi in the management of N. elegantalis requires studies for knowledge of parasitoid behavior regarding the pest to be managed. The objective of this research was to evaluate the behavior of T. galloi for the management of N. elegantalis, through thermal requirements and of life table. According to the results, the fetal develop of T. galloi starts when the temperature remains above 8.02 ± 0.2°C and the heat buildup for complete development is of 159.74 ± 3.88°C degree days (DD). The number of generations of T. galloi was estimated to the five largest municipalities from the Espírito Santo state (Venda Nova do Imigrante, Domingos Martins, Conceição do Castelo, Vargem Alta and Santa Maria do Jetibá), checking that T. galloi may have 24.72 to 35.37 generations per year according to the temperatures reached in each region studied.***

***Keywords*— biological control, parasitoid, pest management, small fruit borer, tomato.**

## I. INTRODUCTION

The small fruit borer, *Neoleucinodes elegantalis* (Guenée) (Lepidoptera: Crambidae) is considered one of the main tomato pests, as it directly damages the fruit, making them unfit for consumption and industrial processing, with lossy that vary of 20 to 90% (Picanço *et al.,* 2007; Moraes & Foerster, 2015; Silva *et al.,* 2017). This species occurs, mainly, in the neotropical area, reaching the Central America and the South America (Querino, 2002; Moraes & Foerster, 2015; Silva *et al*., 2017).

In addition to causing serious damage to tomato fruit, this pest still has other host plants like solanaceae (scarlet eggplant, bell pepper and eggplant), besides weeds like joa and the jurubeba (Fornazier *et al.,* 2010; Pratissoli, 2015).

There are few studies to indicate alternative tactics for the management of *N. elegantalis*, because caterpillars penetrate the newly hatched fruit and remain inside the fruit until the pupal phase. This fact induces the producer to make constant pesticide applications (Plaza *et al*., 1992; Oliveira *et al*., 2017).

The Phytosanitary Pest Management is the establishment of control strategies that involve all the knowledge related to the biological cycle of culture, insect pest and of environmental factors. This kind of pest management involves pest control methods aimed at reducing producer costs over time, optimize production and reduce environmental impacts, mainly through lower use of chemical insecticides (Pratissoli *et al*., 2007; França *et al*., 2015).

Currently, the biological control assumes great importance in the pest management context, especially in the face of discussions for more sustainable agriculture, with less aggression to the environment and human health. A viable option, for the management of this pest, is the use of the egg parasitoid of the genre *Trichogramma* because the control of *N. elegantalis* is performed in the egg phase (Querino, 2002; Diaz & Brochero, 2012 Zucchi *et al*., 2015).

The use of this parasitoid in the management of *N. elegantalis* requires studies for knowledge of the parasitoid behavior regarding environmental conditions, the characteristic of culture, and the plague to be managed (Plaza *et al*., 1992; Milanez *et al*., 2018; Wang *et al*., 2018; Paes *et al*., 2018).

Therefore, the objective of this work was to evaluate the behavior of *Trichogramma galloi* for the management of *N. elegantalis*, through thermal requirements, fertility

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life table and the optimal number of parasitoids to be released in the field.

## II. MATERIAL AND METHODS

The laboratory creation of *Neoleucinodes elegantalis* occurred in air conditioned room (25 ± 2 ºC, 70 ± 10% of relative humidity (RH) and 12 h of photophase). The adults *N elegantalis* were kept in acrylic cages and fed with honey solution at 10%. The tomato fruits were packed in oviposition cages. Daily, the fruits of tomatoes were removed and the eggs of *N elegantalis* were distributed in fruits of Scarlet eggplant (on average five eggs/fruit) that remained in plastic trays, covered with non woven fabric, for pupation.

In the creation of *Trichogramma galloi*, eggs of *Anagasta kuehniella* Zeller (Lepidoptera: Pyralidae) were made unfeasible in germicidal lamp for 50 minutes and set in rectangles of blue cardstock (cartouches of 8.0 x 2.0 cm), with gum arabic at 20%. The cartouches were inserted in glass tubes (8.5 x 2.4 cm), with newly emerged adult parasitoids. Posteriorly, the tubes were sealed with plastic film of polyvinyl chloride, in order to prevent parasitoids from escaping. The cartouches were kept in the tubes for 24 h. Posteriorly, the cards were stored in clean glass tubes (9 x 3 cm) in air-conditioned room with temperature of 25 ± 1ºC, 70 ± 10% RH and 14h of photophase.

### 2.1 Thermal requirements and life table of *Trichogramma galloi* in eggs of *Neoleucinodes elegantalis*

The eggs of *N. elegantalis* were grouped into 10 eggs per female *Trichogramma galloi*. Three females *T. galloi* were used by repetition. The eggs of *N. elegantalis* were exposed to parasitism for 5 h, in order to prevent the occurrence of superparasitism. The eggs of *N. elegantalis* were transferred daily to blue cardstock (0.5 x 2.0 cm). These were inserted into eppendorf tubes (2 mL) along with the parasitoids (age 0 – 12 h) and a honey droplet for food. The tubes were sealed with the container lid, and packed in Climatic chamber at 25 ± 1°C, 70 ± 10% RH and 14 h of photophase. After 5 h, the female parasitoids were killed with the aid of a brush; and the parasitized eggs were transferred to climate chambers at temperatures of 18, 21, 24, 27 e 30 ºC ± 1 °C, 70 ± 10% RH and 14 h of photophase. These temperatures correspond to the optimal range (24°C and 27°C) and the extreme (18, 21 e 30 ºC) for parasitoid development (Melo *et al*., 2007).

From the emergence of the adult *T. galloi*, 15 females (age 0 - 6 h), from each temperature (18; 21; 24; 27 and 30 ± 1ºC), were individualized in Eppendorf tubes (2.0 mL) and returned to their respective temperatures. The cartouches of blue cardstock (0.5 x 2.0 cm) with 20 eggs of *N. elegantalis* (age 0 - 24 h) were offered daily, until the death of female *T. galloi.* The cartouches with parasitized eggs, from each treatment, were packed in plastic bags (23.0 x 4.0 cm) and kept under the same conditions.

For the assessment of thermal requirements, the calculation of base temperature (bT) and thermal constant (K), were obtained by the hyperbole method (Haddad *et al.,* 1999), in the SAS program, version 9.0 (SAS Institute 2001), based on cycle length (egg-adult) at temperatures tested.

The estimated number of annual generations of *T. galloi* was estimated based on monthly average temperature of the municipalities of the highland region from Espírito Santo state, which were: Venda Nova do Imigrante; Domingos Martins; Conceição do Castelo; Vargem Alta and Santa Maria do Jetibá. The data of monthly average temperature of municipalities were obtained by the National Institute of Meteorology.

For the elaboration of fertility life tables, the methodology proposed by Silveira Neto *et al*. (1976) was used. The fertility life table of the parasitoid was made based on age interval values ($x$), specific fertility ($m_x$), probability of survival ($l_x$) in estimating Jackknife (Maia; Luiz & Campanhola, 2000; Maia; Luiz, 2006). The parameters determined were: net reproduction rate ($Ro$), time interval between each generation ($T$), innate ability to increase in number ($r_m$) and finite rate of increase ($\lambda$).

The design used was the entirely randomized with five treatments (temperatures) being the quantitative data submitted to regression analysis. The choice of equation what se ajustou that fit to the data was based on the phenomenon under study and on the significance of regression coefficients ($\beta_i$) and regression by the test F at 5% probability level of error and in the coefficient of determination ($R^2$) (Pimentel-Gomes & Garcia, 2002; Souza, 1998; Gujarati & Porter, 2011).

### 2.2 Estimated number of *Trichogramma galloi* to be released

The experiment was conducted in a greenhouse. The tomato seedlings were transferred for 20 Kg plastic buckets with prepared substrate in proportion to 1:1:1 (soil: sand: tanned manure). After 60 days of transplanting, tomato fruits were offered to females *N. elegantalis*. Posteriorly, 200 eggs of *N.* elegantalis were accounted. The females *Trichogramma galloi* were released in the proportions of 1, 2, 4, 8, 16, 32, 64 and 128 per egg of the *N. elegantalis*, in a cage (60 x 60 x 150 m) made with anti-aphid screen and sealed at the base. The tomato infested with eggs of *N. elegantalis* was placed in the middle part of the tomato plant. Thus, according to the proportion,

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200, 400, 800, 1600, 3200, 6400, 12800 and 25600 females *T. galloi* were released. Parasitism occurred for 24 h. Posteriorly, the fruits were taken to the laboratory, arranged in a climate chamber (25 ± 2 ºC, 70 ± 10% RH and 14 h of photophase).

The experiment was repeated six times, in a completely randomized experimental design. The results were submitted to analysis of variance and regression in order to determine the optimal number of *T. galloi* to be released in the field. The percentage of parasitized eggs in each proportion was the evaluated parameter.

## III. RESULTS AND DISCUSSION

### 3.1 Thermal requirements and fertility life table

The embryonic development of *Trichogramma galloi* in eggs of *Neoleucinodes elegantalis* started from the temperature 8.02 ± 0.2 °C. The heat buildup for the complete development of *T. galloi* was of 159.74 ± 3.88 °C degree days (DD) (Figure 1).

The number of generations of *T. galloi* in eggs of *N. elegantalis* for the municipalities of Venda Nova do Imigrante, Domingos Martins, Conceição do Castelo, Vargem Alta and Santa Maria do Jetibá, tomato producing localities of the Mountain Region from the Espírito Santo state, were estimated through the thermal requirement with respectively 28.21, 24.72, 35.37, 30.96 and 28.72 generations per year (Table 1).

The highest number of generations per month of *T. galloi* in eggs of *N. elegantalis* occurred in the hottest periods of the year in all municipalities evaluated (Figure 2). The municipality of Domingos Martins presented the lowest number of generations in all months. The municipalities of Conceição do Castelo and Vargem Alta got bigger highlights with the most number of generations in every month, over three generations between the months of December and March.

In the life table, the average duration of one generation (T) of *T. galloi*, raised on eggs from *N. elegantalis*, demonstrated an inverse relationship with the increased temperature of 18 to 30 ºC with values of 16.06 and 8.11 days, respectively (Table 2). The net reproductive rate (Ro), which indicates the number of times that population multiplied by generation, ranged from 11.37 to 66.58 depending on temperature, with the maximum increase of the population in the temperature of 24 ºC and lowest net reproduction rate at temperatures of 30 and 27 ºC, with 11.37 and 28.28, respectively. The infinitesimal rate of increase ($r_m$) of *T. galloi* increased in the range of 18 to 24ºC (0.22 to 0.35). The finite ratio of increase (λ), which indicates the number of females *T. galloi* added to population by females parasitoid per day was greater at 24 ºC and smaller at 18 ºC, with 1.42 and 1.25 females / females / day, respectively.

### 3.2 Estimate Number of *T. galloi* per egg of *N. elegantalis*

In the analysis of the number of parasitized eggs, the behavior of *T. galloi* followed a quadratic function, which demonstrated a relationship between parasitism and the number of parasitoids released. The estimated 82 individuals of *T. galloi* per egg of *N. elegantalis* reached a parasitism peak of about 200 parasitized eggs (Figure 3).

The variables analyzed in the present study may present different values in other species of *Trichogramma*, since these are individual parameters related to adaptive capacities to various hosts and room temperature (Dias *et. al*., 2013; Arruda *et al*., 2014; Carvalho *et al*., 2017; Milanez *et al*., 2009; Zuim *et al.* 2013; Paes *et al*., 2018; Mansour, 2019).

The life table has been relevant for understanding the population dynamics of a species (Silveira Neto *et al.,* 1976; Melo *et al*., 2007; Pratissoli *et al*., 2007). In the present experiment, the temperature of 24 ºC was the most appropriate for the parameters evaluated on *T. galloi*.

The number of parasitoids to be released varies depending on several factors, such as plant phenology, the parasitoid species and with the host posture characteristic (Pratissoli *et al*., 2005; Bakthavatsalam, *et al*., 2013; Milanez *et al*., 2009; Wang *et al*., 2018; Paes *et al.,* 2018).

Therefore, the success in pest control, with the use of the parasitoid *Trichogramma*, is related to the correct choice of the species to be used. This because although it is classified as a generalist parasitoid, research results show that species may have affinity for certain hosts. This affinity can occur by stimulus-driven search behavior, of the nutritional and morphological characteristics of the egg. Abiotic factors, as weather conditions, also can affect other parameters as: the duration of development, sexual rate, parasitism and adult longevity (Pratissoli & Parra, 2001; Mansfield & Mills, 2004; Krishnamoorthy, 2013; Carvalho *et al.,* 2017; Hou *et al.,* 2018; Jalali, 2018, Paes *et al*., 2018).

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## IV. FIGURES AND TABLES

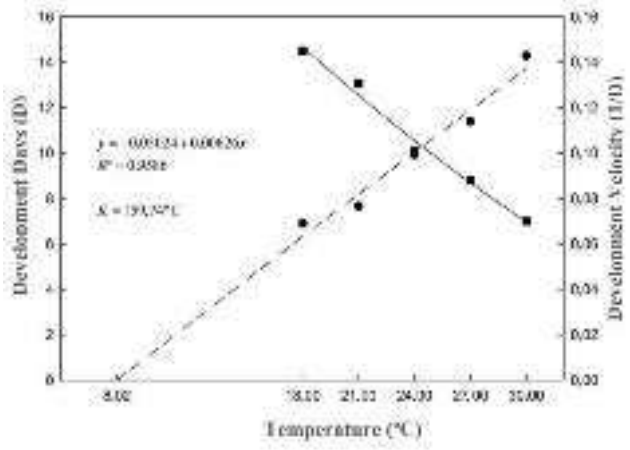


*Fig.1. Duration (days) and development velocity of Trichogramma galloi, in eggs of Neoleucinodes elegantalis, under to different temperatures. RH: 70 ± 10% and Photophase: 14 h.*

Table 1. Number of Generations of *Trichogramma galloi* in eggs of *Neoleucinodes elegantalis* in different municipalities of the Mountain Region from the Espírito Santo state, Brazil.

| Municipality | Number of Generations / year |
|---|---|
| Venda Nova do Imigrante | 28.21 |
| Domingos Martins | 24.72 |
| Conceição do Castelo | 35.37 |
| Vargem Alta | 30.96 |
| Santa Maria do Jetibá | 28.72 |

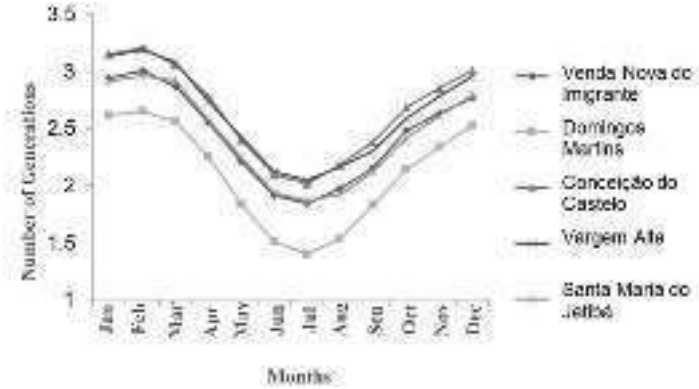


*Fig.2. Estimate of number of generations of T. galloi in eggs of n. elegantalis in the different months of the year, to four tomato producing municipalities on Espírito Santo state.*

*Table 2. Duration of a generation (T), net reproduction rate (Ro), infinitesimal rate of increase ($r_m$) and finite rate of increase ($\lambda$) of Trichogramma galloi (Hymenoptera: Trichogrammatidae) in eggs of Neoleucinodes elegantalis at different temperatures. RH: 70 ± 10% and Photophase: 14 h.*

| Temperatures | T (days) | Ro | $r_m$ | λ |
|---|---|---|---|---|
| 18 | 16.06 | 36.81 | 0.22 | 1.25 |
| 21 | 14.91 | 61.14 | 0.27 | 1.32 |
| 24 | 11.91 | 66.58 | 0.35 | 1.42 |
| 27 | 10.14 | 28.28 | 0.32 | 1.39 |
| 30 | 8.11 | 11.37 | 0.30 | 1.35 |

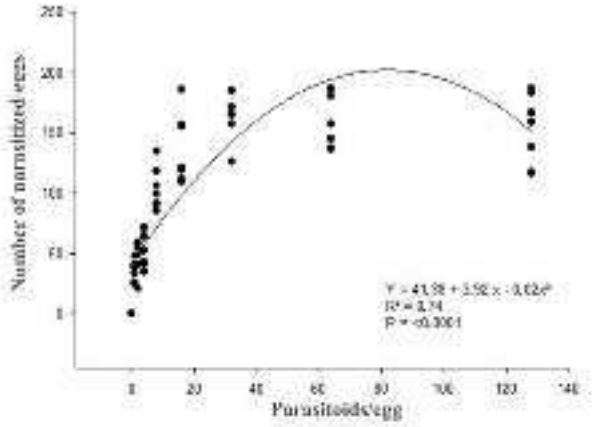


*Fig.3. Number of eggs of Neoleucinodes elegantalis parasitized by Trichogramma galloi in tomato plants.*

## V. CONCLUSION

It can be concluded that the estimated number of *T. galloi* generations in the five municipalities of Espírito Santo (Venda Nova do Imigrante, Domingos Martins, Conceição do Castelo, Vargem Alta and Santa Maria do Jetibá) can vary from 24.72 to 35, 37 generations per year, according to the temperatures reached in each region studied.

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# Development of a triple input musical instrument tuner using Yin algorithm

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***Abstract*** *— In music, it is important that the instruments sound harmonic and reproduce sound in a repeatable and universal manner. Humans have difficulty in distinguishing very similar sounds, therefore, a device capable of doing so is very useful. The tool used for this is called an instrument tuner. There is a huge variety of such devices in the market, usually capable of detecting sound and frequency from specific instruments, due to the way sound is produced. Musicians that play different instruments must own multiple tuners to suffice their needs. This article details the development of an optimized pitch detection device, running on an Android smartphone, capable of detecting and processing sound signals emitted by different kinds of instruments, with frequencies ranging from 27.5 Hz to 4186 Hz in a non-expensive manner.*

***Keywords*** *— **Android, Instrument Tuner, Java, Musical Instruments, Smartphone.***

## I. INTRODUCTION

One of the most important characteristics for the development of musical balance is pitch, which is a representation of the sound frequency. This is how musical notes were created, representing sounds in a universal and repeatable way.

Just as measuring instruments need calibration, musical instruments also need adjustments. The device responsible for assisting in this procedure is the tuner. According to [1], the tuning of musical instruments is as old as the musical scale. Nowadays, the tuning process is performed mostly through electronic tuners, which are small, light and have good accuracy.

Many of the electronic tuners available in the local market are limited to specific types of instruments. Some models are compatible with a wider range of instruments, but are very expensive.

According to [2], the human ear cannot detect frequency variations less than 0.5 Hz, and these variations influence how harmonic the final song will be. Due to the difficulty of the human ear to perceive slight frequency variations, there is a need to use specific tools for this.

The many ways in which instruments produce sound make it necessary to use different mechanisms to capture the played notes.

This article describes the development of a device that aims to unify in a single device the various ways of capturing acoustic signals emitted by instruments of different categories, helping musical groups to tune their instruments with a single tuner, instead of using specific tuners to each type of instrument, resulting in lower investment and greater portability.

## II. THEORETICAL FRAMEWORK

The sound produced by most musical instruments is the result of a sum of integer multiple frequencies of a fundamental frequency. It is the fundamental that defines the note played and, therefore, it has the most relevance to a tuning device.

2.1 Related Work

There are several ways to identify the fundamental frequency of a given signal. One is to apply the Fast Fourier Transform (FFT) and look for the frequency with the greatest magnitude. However, to get the resolution needed for a tuner, this technique may require a large FFT size, that is, a large number of bins. The relationship between the sample rate and the number of bins requires that to increase the frequency resolution, it is necessary to reduce the sampling rate or increase the number of bins. The sample rate cannot be reduced below the Nyquist theorem limit, so the solution is to increase the number of bins.

Santos [3] performed comparison tests of FFT calculations on several Arduino models: Arduino Mega with ATmega 1280, Arduino Duemilanove with ATmega 168 and Arduino Duemilanove with ATmega 328. He concluded that ATmega168 can store 128 points for the FFT calculation, compared to 512 points in ATmega1280. This condition is only obtained if no other variables need to be stored or processed by the microcontroller, which is unrealistic, since a platform like Arduino is rarely used to

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perform this type of calculation without any other input or variable. Thus, he concluded that depending on the desired application, it is more feasible to use Arduino as a data logger and process information on a computer.

Becchi [4] developed an automatic acoustic-electric guitar tuning system. It used the Arduino Due platform, equipped with a 32-bit ARM processor to perform input data processing and then control motors to adjust the instrument tuning. Due to limitations of the board used in FFT calculations, the author was unable to perform accurate readings and adjustments. According to him, the maximum desired inaccuracy value for the device was 0.5 Hz. The value obtained, nevertheless, was approximately 4 Hz, far above the ideal. As a solution, the author used Arduino as a data logger and a computer for processing. The results obtained using MATLAB were quite satisfactory, since the processing power of a computer is much higher than that of Arduino.

Using a computer to tune a musical instrument is not a portable solution. Modern smartphones have sufficient processing power, provided the right algorithm is used, to perform pitch detection.

Cheveigné and Kawahara [5] developed an algorithm to perform fundamental frequency estimation in speech and musical sounds, called YIN. The algorithm is based on the autocorrelation method and adds further steps to the process to reduce errors, as shown in Fig. 1. These 6 steps, performed in sequence, cause the gross error percentage to decrease from 10%, if only the autocorrelation method is used, to approximately 0.50%.

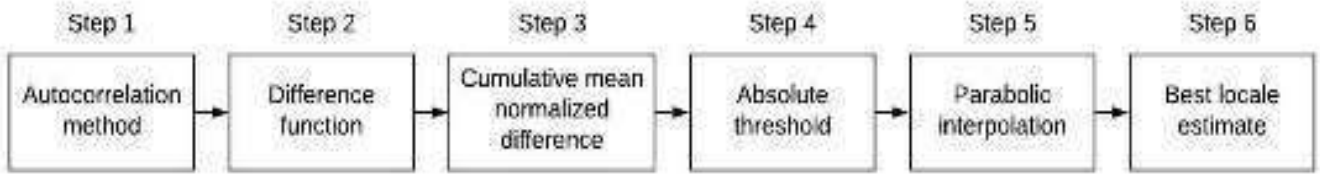


*Fig. 1: YIN algorithm steps*

Araujo and Trevisan [6] developed a system for acquiring and processing a signal from an electric guitar. Two different frequency detection algorithms were implemented and their results compared. The algorithms tested were YIN and McLeod. Four different tests were performed to evaluate which algorithm has the best accuracy and precision rate. The authors concluded that McLeod's method has a lower error rate in cases where only one note is played, slowly. On the other hand, the YIN algorithm performs better when several notes are played simultaneously or when the same note is played repeatedly over a short period of time. YIN was also more accurate, presenting a smaller deviation between readings than McLeod.

II.2 System Development

The developed device is a chromatic tuner that operates freely in the 12 semitones of each octave of the musical scale, ranging from A0 (27.5 Hz) to C8 (4186 Hz). It is intended to assist musicians in tuning various types of instruments through a single device, making the tuning process more compact and faster, as there will be no need to carry and handle different devices.

The system consists of two essential parts: the first is the hardware, that contains the electronic components responsible for capturing and converting the sound wave from the musical instrument to an electrical signal that can be read and processed by the smartphone. The second part is the application installed on a smartphone, which processes and compares the fundamental frequencies captured with the frequencies defined for each note, to identify which note is being played and, using the mobile phone screen, returns this information to the user. With this information, the user can make adjustments to the instrument until tuning is achieved.

There are three components responsible for capturing the sound, an electret microphone, a piezoelectric transducer and a line input. The user selects, in hardware, which of the three inputs to use, depending on the instrument to be tuned. This way, only one instrument can be tuned at a time, from one of the three inputs. The line input is basically a ¼ inch (6.35 mm) jack, which through a cable interconnects an instrument that has an integrated pickup to the tuner.

The piezoelectric transducer captures the sound wave through the mechanical vibration of the instrument. Since instruments tend to dissipate these string vibrations quickly, the signal duration are quite short. However, for instruments that do not have integrated pickups, tuning through mechanical contact is the best alternative, as the capture is not affected by background noise.

The electret microphone captures the sound without mechanical contact with the instrument. This form of sound capture is very prone to background noise. Therefore, it is necessary that the capture is performed in an environment with the least amount of noise possible.

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This alternative, despite external factors, returns satisfactory results if used in the recommended scenario.

The analog signal is inserted into the phone via the ⅛ inch (3.5 mm) headphone connector, on the microphone pin. The power supply comes from the cell phone USB, through USB On-The-Go (OTG), which provides a 5 V DC power [7].

In addition to the three capture devices, there is also a signal treatment step, as the three inputs have very different amplitude levels, with output voltages incompatible with what the smartphone can receive in its headphone connection. After the signal injection into this input, the phone is responsible for converting it from analog to digital. This way, the signal becomes data, ready for use in the software. The system overview can be seen in Fig. 2.

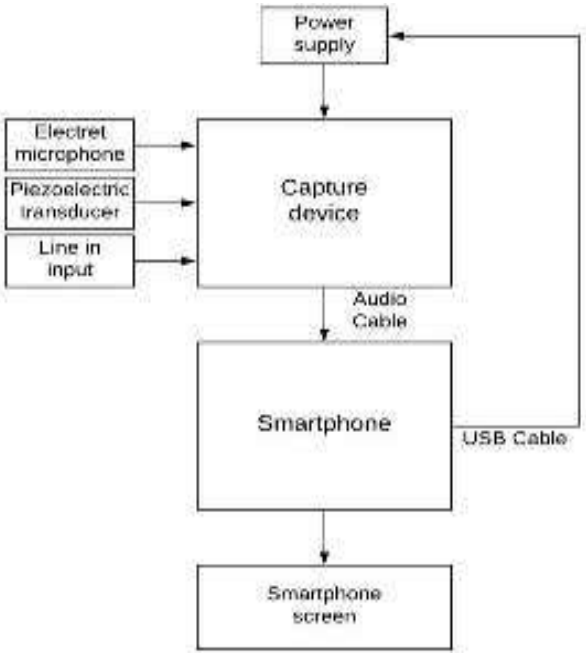


*Fig. 2: System overview*

The processing of the signal obtained through the hardware is done in an Android application. The first step of the software is responsible for identifying the fundamental frequency. This is accomplished through an implementation of the YIN algorithm by the TarsosDSP library [8]. In this step the sampling and buffer parameters are defined. For this system, a sample rate of 44.1 kHz and a buffer size of 22050 were quite sufficient.

After identifying the fundamental frequency, the algorithm compares this obtained data with the musical notes frequencies, which are calculated through (1) [2].

$$f = 440 \cdot 2^{n/12} \quad (1)$$

Where n is the number of semitones above or below A4 (La in the 4th octave), tuned to 440 Hz. This way, it is possible to calculate the fundamental frequency of any musical note. The purpose of this step is to recognize which note of the musical scale the identified fundamental frequency is. That is why it is necessary to calculate the frequencies of the musical notes.

In addition to the comparison, the deviation between the note being played and the correct pitch is also calculated. This deviation is given in *cents*, a logarithmic measure that divides one octave into 1200 cents. Since 12 semitones form one octave, there are 100 cents between adjacent semitones and 200 cents between adjacent tones. The deviation between two frequencies, one played and the other in perfect pitch, is given by (2) [9].

$$N = 1200 \cdot \log_2\left(\frac{f_2}{f_1}\right) \quad (2)$$

Where $f_1$ is the reference frequency (calculated through (1) and $f_2$ is the input frequency (identified by the YIN algorithm). The application flowchart can be seen in Fig. 3.

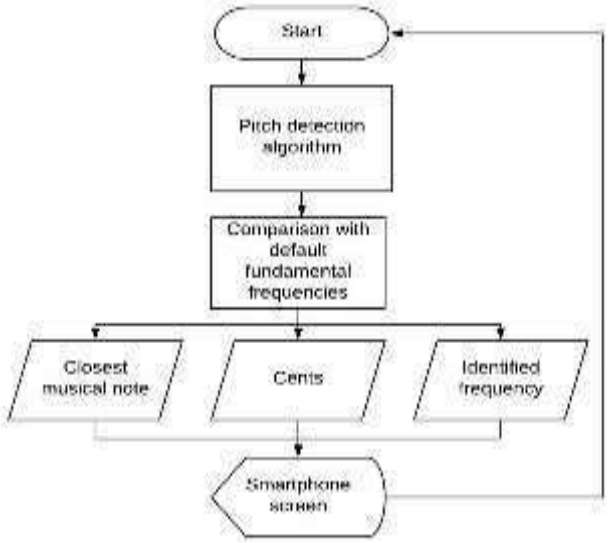


*Fig. 3: Application flowchart*

The software was developed in Java, through Android Studio. The minimum Android version required for this app is 6.0 Marshmallow. The graphical interface was developed in XML and includes the following information: identified musical note and octave, fundamental frequency of the captured signal, input signal level, adjacent musical notes and a chromatic wheel, that shows the deviation, in cents, graphically. The interface can be seen in Fig. 4.

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*Fig. 4: Graphical interface of the application*

## III. RESULTS

To validate the effectiveness of the device developed, it was compared to other similar commercial tuners. As it has three different inputs, three different instruments were used in the tests, one for each input.

The device developed can be seen in Fig. 5. The parts are identified by numbers {1} to {9}. {1} is the input signal peak meter LED. It is an indication that the signal level is saturating. LEDs {2} and {3} indicate which of the inputs is selected. If LED {2} is on, line or piezoelectric input is selected. If LED {3} is on, the electret microphone input is selected. {4} is the switch that selects the input. The electret microphone is identified by {5}. There is a potentiometer for system input gain adjustment, identified by {6}. {7} is the 6.35 mm connector, which serves the line and piezoelectric inputs. {8} is the USB connector that transfers power from the phone to the tuner device. Lastly, {9} is the 3.5 mm connector that transfers the analog signal into the smartphone.


*Fig. 5: Device developed in operation*

The prototype has low cost and easily obtainable components. The estimated cost in electronic components was $8. The case was built in a 3D printer and cost $10.

The test for validating the line input was performed using an electric bass. The results were compared with three other commercial devices: Zoom B3 [10], Korg CA-1 [11] and Mooer Baby Tuner [12]. The comparison was made by playing an instrument string while connected to all tuners simultaneously. As it is a direct connection to the instrument, there is no interference between the signal emission and capture. This tuning method is best suited for instruments with built-in pickups.

The piezoelectric input was tested using a cello. The device developed was compared to the Aroma AT-200D [13] tuner. For this test, the Korg CM-200 [14] transducer was used with the device. The test was performed by coupling both tuners to the instrument bridge simultaneously. Then, the instrument was played and both readings were recorded.

The electret microphone input was tested using a soprano recorder (fipple flute). The comparison was made with the Korg CA-1 [11] tuner. The test was performed by placing both tuners next to each other and playing a note on the recorder. The Table 1 summarizes the tests results.

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*Table 1: Tests results*

| Line input | | | | |
|---|---|---|---|---|
| Device | Tuner developed | Zoom B3 | Korg CA-1 | Mooer Baby Tuner |
| Fundamental frequency | 98.03 Hz | N/A | N/A | N/A |
| Musical note | G | G | G | G |
| Octave | 2 | N/A | N/A | N/A |
| Deviation | 0.6 cents | 0 | 0 | 0 |
| Piezoelectric transducer input | | | | |
| Device | Tuner developed | | Aroma AT-200D | |
| Fundamental frequency | 65.34 Hz | | N/A | |
| Musical note | C | | C | |
| Octave | 2 | | N/A | |
| Deviation | -1.8 cents | | Between 0 and -5 cents | |
| Electret microphone input | | | | |
| Device | Tuner developed | | Korg CA-1 | |
| Fundamental frequency | 782.97 Hz | | N/A | |
| Musical note | G | | G | |
| Octave | 5 | | N/A | |
| Deviation | -2.3 cents | | Between 0 and -5 cents | |

It is possible to notice that of all the tuners tested, the one described in this paper is the only one that informs the octave, fundamental frequency captured and the deviation in numerical format. Other devices report deviation graphically, with different scales. For this reason, when the deviation is close to zero, the result indicated is rounded. This is not a result of inaccuracy; it is just a feature of these devices.

## IV. CONCLUSION

This paper presented the development of a universal tuner. The results presented prove the functionality, comparable to commercial solutions. In some respects, it presents more information than other devices tested. Some of this information is very relevant to less experienced musicians, such as the octave. Other information is very relevant for experienced musicians who want perfect tuning, such as precise deviation in decimal scale.

For those who want as few cables as possible, the USB connection can be a downside. For future improvement, the implementation of an internal battery system is suggested.

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# Aussie Current and Myofascial Release in Muscular Power and Muscle: Controlled and Randomized Clinical Trial

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***Abstract-*** *Among the techniques identified as the possibility of accelerating and/or optimizing the process of muscle, strength gain is myofascial release and electrostimulation. Given this context, this study seeks to analyze and compare the effects of combined use of the Aussie current and myofascial release on muscle strengthening. This is a cross-sectional study, analytical and descriptive, experimental, comparative, controlled and randomized. The study sample is non-probabilistic composed of 16 volunteers who will be subdivided into four groups. The muscular strength gain of the quadriceps muscles will be evaluated bilaterally through the countermovement vertical jump. The interferential statistics used were through the paired Student t-test to verify the difference between the means before and after the treatments in each group, and it was also the Mannn-Whitney U test to verify the differences concerning the techniques. The significance level adopted will be 5% ($\alpha = 0.05$). Regarding the parameters of the evolution of muscular strength gain related to vertical jump distance, significant statistical differences were observed only for GL and GT in the initial-intermediate evaluation ($p = 0.025$ and $p = 0.035$, respectively). Regarding the evolution parameters of mean differences of 70% of the maximum load of 1RM, significant statistical differences were observed only for GA in the initial-intermediate and intermediate-final evaluations ($p = 0.035$ $p = 0.035$, respectively). It was not possible to identify a statistically significant advantage of the combined use of the techniques in the Todos Group over their isolated use.*

***Keywords***—*Electrical Stimulation, Physiotherapy, Muscle Strength.*

## I. INTRODUCTION

Muscle strengthening (FM) can be defined as the maximum capacity of a muscle or muscle group to exert a large force at a given speed and generate active tension, and the ability to produce strength depends on several determinants, including the muscular system, neural, biomechanical and psychological factor (BITTENCOURT, 2018; TRINITY, 2018). Several methods are used by physiotherapists for muscle strengthening, including active exercises, resistance actives, and also neuromuscular electrical stimulation (NMES) (ALVES et al., 2017).

Within this context of FM, there is a need, depending on the patient's objective and / or the worked muscles, to focus the training aiming at the gain of muscular power. Muscle power corresponds to the high intensity of contraction with the highest speed possible in the execution of the movement, generating recruitment of a large number of fibers, especially type II fibers that have

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high strength, power production and speed in anaerobic activities ( STRAIGHT et al., 2015).

Frequently, FM prescription is mainly the object of desire for injury prevention, aesthetic and sports/rehabilitation programs. Among the techniques used as a possibility to accelerate the process of muscle strength gain is myofascial release (LM), which consists of a passive and manual technique that can be performed with or without an instrument. It is a deep mobilization of connective tissue that prioritizes the fascia which is a flexible and strong membrane and involves muscles, bones, viscera and blood vessels protecting and assisting in the slides between them (SILVA; ALEXANDRE; SILVA, 2018).

According to Arguisuelas et al. (2017), the technique causes excessive pressure in the rigid areas to act on the muscle spindle cells by inhibiting them and stimulating the Golgi tendon organs that will alter muscle tone leading to relaxation. Several studies show the effectiveness of the LM technique. The LM aims to increase blood supply, muscle oxygenation, consequently decrease muscle contracture, pain and optimize movement, ie, make the tissue more flexible and functional (SILVA et al., 2017).

Another possibility mentioned in the literature for increased muscle strength is neuromuscular electrostimulation (NMES), which is a technique used as a therapeutic resource and muscle training through the application of electrical currents through transcutaneous pathways. For Agripino (2017) the effects of stimulation with medium frequency currents and high intensity lead to muscle fiber hypertrophy (type II - 50% and type I - 20%), type II fibers have a greater effect because the high current amplitude would be more oriented to power than to resistance.

For Franco et al. (2017) the use of electric currents for aesthetic and sports treatment has been very active, among them the Aussie current which is a medium frequency current 4000Hz presenting minimum discomfort using 1kHz in favor of a maximum torque production for strength gain. and tropism can use the modulation in short duration Burst, ie 2 ms making it more comfortable for both sensory and motor stimulation. Despite the literature, it is lacking controlled and randomized studies that prove the increase of muscular strength / muscular power due to the combination of Aussie current and myofascial release.

Therefore, it is essential to conduct studies in this segment since accelerating the increase in FM / Muscle Power would be beneficial for sports/rehabilitation. Thus this study seeks to analyze and compare the efficacy of the combined use of the Aussie current and myofascial release in strengthening and muscle power.

## II. MATERIALS AND METHODS

This is a cross-sectional study, analytical-descriptive, experimental, comparative, controlled and randomized, using quantitative data analysis. It is noteworthy that this research is a subproject of the study entitled "Physiotherapeutic performance in orthopedic and sports dysfunctions". Regarding the study site, it was developed in an Electrothermophototherapy and Kinesiotherapy Laboratory of the Physiotherapy course of a private college in the city of Vitoria da Conquista-BA, located in the southwest region of Bahia, occupying a territorial area of 3204,257 Km2, with an estimated population of 346,069 inhabitants (IBGE, 2016). The sample is non-probabilistic composed of 16 volunteers who will be subdivided into four (4) intervention groups: Control Group - CG (4); Strengthening and Aussie Group - GA (4); Myofascial Release and Strengthening Group -GL (4); Strengthening, Myofascial Release and Aussie Group - GLA (4).

The randomization of the groups was performed with the aid of MathWorks Inc's Matlab® software, using the rand function, which generates random numbers of equal probability between zero and one. Those who received numbers between 0 and 0.25 were allocated in the control group (CG), those who received numbers between 0.26 and 0.5 were allocated in GA, those who received numbers between 0.6 and 0.75 were allocated. Finally, those who received numbers between 0.76 and 1.0 were allocated to the GLA. Inclusion criteria were female individuals, aged between 18 and 40 years and not practicing physical activity with the objective of quadriceps muscle strengthening. The choice of single-sex individuals will be to prevent the study results from being influenced by the possible gender differences in muscle strengthening. For similar reasons, age will be limited to 40 years to also prevent results from being influenced by age on the ability to gain muscle strength. In addition, interference bias in treatment efficacy is avoided by including only individuals who do not perform other activities for the purpose of gaining quadriceps muscle strength.

Exclusion criteria were individuals who during the selection period for the study intervention refer to the use of food supplementation; who use anti-inflammatory drugs or pain relievers for continuous use; have altered skin sensitivity in the quadriceps region; have pacemakers; have phobia to electrostimulation; have deep vein thrombosis; being in gestational period; have recent lower limb musculoskeletal injuries (lower limbs); have

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neurological pathologies that lead to changes in sensory perception or motor control of the lower limbs; have severe lower limb arthroplasty that interferes with function and range of motion; as well as having lower limb amputations or severe heart disease.

The dependent variable muscle power was assessed through the countermovement vertical jump (SCM): from the standing position and without any shoes, with the right trunk and hands on the hips, and the lower limbs in extension, the individual performs a 90 ° knee flexion (countermovement), followed by a vertical jump touching the wall with the fingers of the right hand that were previously placed in contact with chalk dust (SILVA; OLIVEIRA, 2017). The highest point touched by the participant's fingers on the wall was recorded, and then the distance from this point to the ground was measured with an inelastic tape measure. Thus, participants in each group were evaluated before the first intervention, before the 7th intervention and after the 12th intervention (final intervention).

The variable dependent muscle strength was evaluated by the load offered in barbell with dumbbells supported on shoulders according to the 1 repetition maximum test which is characterized by the highest load to be exceeded in one maximum repetition. Gradually increase the weight to concentric failure. Subsequently, the calculation was made at 70% of perceived 1RM (MARTÍNEZ-CAVA et al., 2018).

For the independent variables we used the Aussie current that was applied with the protocol-based Neurodyn 10-channel Ibramed® device with the objective of muscle power gain (FRANCO et al., 2017), using the following parameters: carrier frequency: 1 kHz; modulated frequency: 110 Hz; Burst duration: 2 ms; time on: 3 s; time off: 9 s; Rise time: 2 s; Descent time: 2 s; Treatment time: 50 min. The patient's failure/fatigue limit was respected by interrupting the application of the current according to the patient's request. Will be used 3 channels/exits of the device (6 electrodes) longitudinally arranged using the technique of application on motor points in each of the quadriceps muscles (vastus medialis, vastus lateralis and quadriceps bilaterally).

It is noteworthy that before the application of the electrodes, the preservation of the patient's skin sensitivity was evaluated using the esthesiometer instrument (Semmes-Weinsten® Monofilaments).

Another independent variable is the use of myofascial release in the quadriceps muscle that was performed by manual technique for 2 minutes in each muscle, vastus lateralis, rectus femoris and vastus medialis (quadriceps) exerting moderate pressure and parallel to the direction of the muscle fibers. At the time of the technique, the volunteer was supine on the stretcher and with the bare quadriceps region and relaxed muscles to allow the application of the technique. Subsequently, the participants underwent a quadriceps muscle strengthening exercise session with the same protocol as the CG.

Regarding the procedure of collection in the first contact with patients who agreed to participate in the study and who met the inclusion and exclusion criteria, the Informed Consent Form (ICF) was presented, which is the first instrument to be used. used. After clarification and signing of the informed consent, the patients were submitted to the application of a sociodemographic and health conditions questionnaire

The sociodemographic questionnaire was built by the researcher himself and consists of questions related to the identification of participants such as name, age, gender, education, profession, marital status, physical activity practice, medication use, how long have you been in pain, among others.

After this initial evaluation, groups were randomly assigned to the volunteers. From this moment on, participants in each group were evaluated in the Vertical Jump Test with countermovement before the first intervention, before the 7th intervention and after the last intervention (12th).

Interventions in all groups occurred 3 times a week for 4 weeks. The members of the CG only performed muscle strengthening with squat exercise from 0º of knee flexion to the 90º limit of flexion and returning to degree 0. The load was offered in a barbell with dumbbells supported by shoulders according to the test. 1 The maximum repetition of each individual and the number of repetitions was according to the concentric failure of the individual's muscle. The participants in the GA group performed the squat exercise with the same protocol as the CG in conjunction with the use of the Aussie Chain as previously described in this study. It is noteworthy that in this case, the squat time in each repetition was according to the established contraction and relaxation times in the electrostimulation device. The GL volunteers have initially submitted to quadriceps muscle myofascial release (LM) session bilaterally according to the protocol already described in this study and later will be submitted to quadriceps muscle strengthening exercise session with the same protocol as the CG. The GLA volunteers, in addition to being initially submitted to the LM session for 2 minutes in each muscle of the quadriceps group, performed muscle strengthening together with the use of

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the Aussie Chain according to the protocol performed by the GA group. Data analysis was performed using descriptive statistics with a distribution of absolute frequencies, means, and standard deviation. Data normality was tested by the Kolmogorov - Smirnov test. The interferential statistics used were through the paired Student t-test to verify the difference between the means before and after the treatments in each group, and it was also the Mannn-Whitney U test to verify the differences in relation to the techniques. The adopted significance level was 5% (α = 0.05). Data were tabulated using The Statistical Package for Social for Windows program (SPSS 21.0, 2013, SPSS, Inc., Chicago, IL).

Regarding ethical aspects, this research will obey the ethical standards required by Resolution No. 466/2012 (National Health Council). The protocol of the main study was submitted to the Ethics Committee on Research with Human Beings of the Independent Faculty of the Northeast, and the collection was started only after approval and authorization by CEP-FAINOR (Opinion: 2.418.72). In the first contact with the patients, orientations and instructions about the research process were performed. Participants were informed about the theme, development, and objectives of the study, thus being free to agree to participate or not. Once I accepted the voluntary participation, I was asked to sign the consent form, making them make their decision fairly and without constraints about their participation in this study.

## III. RESULTS AND DISCUSSION

The sample composed of 16 individuals had a mean age of 21.31 ± 2.70 years, a height of 162.12 ± 6.31 cm and a weight of 57.46 ± 7.93 Kg. incomplete higher education 87.5% (14), standard race 62.5% (10), single marital status 100.0% (16) and do not practice physical activities 75.0% (12) of the situations, as outlined in table 1.

*Table 1 - Sociodemographic and anthropometric characteristics of the participants. Vitória da Conquista - BA, 2019.*

| Variables | Mean ± SD[1] | Response | n | % |
|---|---|---|---|---|
| | | 100 | | |
| Age, *yers* | 21,31 ± 2,70 | | 16 | — |
| Height, *cm* | 162,12 ± 6,31 | | 16 | — |
| Weight, *Kg* | 57,46 ± 7,93 | | 16 | — |
| **Schooling** | | 100 | | |
| Médio completo | | | 1 | 6,3 |
| Superior incompleto | | | 14 | 87,5 |
| Superior completo | | | 1 | 6,3 |
| **Race** | | 100 | | |
| White | | | 5 | 31,3 |
| Black | | | 1 | 6,2 |
| Brown | | | 10 | 62,5 |
| **Civil Status** | | 100 | | |
| Single | | | 16 | 100,0 |
| Maried | | | — | — |
| Divorced | | | — | — |
| Widowed | | | — | — |
| **Physical Activity** | | 100 | | |
| Yes | | | 4 | 25,0 |
| No | | | 12 | 75,0 |

[1] Sample standard deviation; cm (centimeters); Kg (kilograms); Source: Research Data.

Regarding the analysis of dependent variables, the sample presented a higher percentage gain in vertical jump distance for the intermediate assessment (6th session) for the Release group (2.89%), followed by the Everyone group (2.28%). From the intermediate evaluation to the final evaluation, the highest percentage gain was maintained for LG (1.30%) and reversed for the TG, with the smallest (-0.13%), as shown in table 2.

*Table 2 - Evaluation of average differences in vertical jump distance. Vitória da Conquista – BA, 2019.*

| Groups | Initial - Intermediate | | Intermediate – Final | |
|---|---|---|---|---|
| | Dif[1]. Avg | % gain | Dif[1]. Avg | % gain |
| **Control** | 1,00 | 0,43 | 2,30 | 0,98 |
| **Aussie** | 1,00 | 0,43 | 1,70 | 0,74 |
| **Release** | 6,50 | 2,89 | 3,00 | 1,30 |
| **All** | 5,30 | 2,28 | -0,30 | -0,13 |

[1] Average difference; Source: Research Data.

Regarding the parameters of the evolution of muscular strength gain related to vertical jump distance, significant statistical differences were observed only for GL and GT in the initial-intermediate evaluation (p = 0.025 and p = 0.035, respectively), as shown in table 3.

*Table 3 - Evaluation of average differences or vertical jump distance. Vitória da Conquista – BA, 2019.*

| Groups | AVG ± SD | | | *p*1* | *p*2* |
|---|---|---|---|---|---|
| | INITIAL | INTERMADIATE | FINAL | | |
| **Control** | 234,7 ± 9,70 | 235,7 ± 9,11 | 238,0 ± 10,55 | 0,252 | 0,078 |
| **Aussie** | 230,0 ± 13,83 | 231,0 ± 6,53 | 232,7 ± 7,04 | 0,810 | 0,069 |
| **Release** | 225,0 ± 8,44 | 231,5 ± 8,89 | 234,5 ± 11,81 | 0,025 | 0,190 |

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| | | | | | |
|---|---|---|---|---|---|
| **All** | 232,2 ± 9,5 | 237,5 ± 6,85 | 237,2 ± 7,13 | 0,035 | 0,836 |

Paired student t-test; Inicial Initial comparison - intermediate; ²Intermediate - final comparison; Source: Research Data.

The evolution analyzed for the percentage gain of the average differences of 70% of the maximum load of 1 RM revealed, in the intermediate evaluation (6th session) higher values for GL (30.77%) and GT (21.28%). However, it was observed in the final evaluation that GL and GT had lower percentage gains (5.0% and 3.51%, respectively), as shown in table 4

*Table 4 - Evaluation of average differences in vertical jump distance. Vitória da Conquista – BA, 2019.*

| **Groups** | **Initial - Intermediate** | | **Intermediate – Final** | |
|---|---|---|---|---|
| | Dif¹. Avg | % gain | Dif¹. Avg | % gain |
| **Control** | 1,20 | 4,29 | 6,30 | 21,58 |
| **Aussie** | 3,50 | 12,96 | 6,00 | 19,67 |
| **Release** | 8,00 | 30,77 | 1,70 | 5,00 |
| **All** | 5,00 | 21,28 | 1,00 | 3,51 |

¹Average difference; Source: Research Data.

Regarding the evolution parameters of mean differences of 70% of the maximum load of 1RM, significant statistical differences were observed only for GA in the initial-intermediate and intermediate-final evaluations (p = 0.035 and p = 0.035, respectively) as shown in table 4.

*Table 5 - Evaluation of average differences of 70% of maximum load of 1RM. Vitória da Conquista – BA, 2019.*

| **Groups** | **AVG ± SD** | | | *p*¹* | *p*²* |
|---|---|---|---|---|---|
| | INITIAL | INTERMADIATE | FINAL | | |
| **Control** | 28,0 ± 3,26 | 29,2 ± 9,42 | 35,5 ± 12,87 | 0,7 57 | 0,2 44 |
| **Aussie** | 27,0 ± 9,30 | 30,5 ± 8,85 | 36,5 ± 11,0 | 0,0 35 | 0,0 35 |
| **Release** | 26,0 ± 6,32 | 34,0 ± 11,54 | 35,7 ± 5,91 | 0,2 32 | 0,7 59 |
| **All** | 23,5 ± 6,61 | 28,5 ± 4,43 | 29,5 ± 9,0 | 0,0 96 | 0,7 18 |

* Paired student t-test; Inicial Initial comparison - intermediate; ²Intermediate - final comparison; Source: Research Data.

Based on the information collected in the results section, it was possible to observe that the vertical jump evaluation showed a significant increase in GL and GT, and this increase was only in the first 6 sessions. After the 6th session, the increment was not significant. According to Arguisuelas et al. (2017), the myofascial release technique treats soft tissue adhesions, reduces sensitivity, relieves pain and improves the performance of many modalities, being of great importance in sports. Several studies show the effectiveness of the myofascial release technique in gaining lower limb muscle power. Among these, we can mention Silva and Oliveira (2017), who states that during myofascial release, excessive pressure in the rigid areas acts on muscle spindle cells, inhibiting them, and stimulating Golgi tendon organs that will alter the tone. muscle generating relaxation, leading to muscle relaxation and fascia distension, which facilitates the sliding of muscles during movement.

Thus, for Silva and Oliveira (2017), if the fascia becomes more detached, consequently, it facilitates rapid muscle contraction generating an explosion. As the vertical jump is evaluating the fast contraction speed of the muscle fiber, it can be associated that the fast contraction capacity was facilitated by a "looser" fascia, being valid to emphasize that the study by Silva and Oliveira (2017) used self -liberation, differentiating one from the ML technique used in the present study. Studies such as Lima (2018) also show the effectiveness of the LM in the flexibility of the lower limbs that can be characterized as the ability of the muscle to distance itself from the origin and insertion promoting the greater articular range. Thus, as it decreases fascial restriction and adhesion, it consequently improves the performance of a set of movements or a specific movement by improving power performance.

Despite the positive result of muscle power with the LM, it is known that some techniques the window of gain is until a certain session, ie reach if the peak and later there will be no gain. Thus, the results of the present study suggest that only 6 LM sessions are required to obtain satisfactory results for muscle power. There are no further gains. The WG, as well as the WG, had gained to the muscular power, however, when observing that the isolated WG did not obtain gains, it is suggested that the gain obtained in the WG is due to the use of the LM, also observing that the % of the gain this group in these first 6 sessions was also slightly smaller than GL.

Concerning the strength gain evaluated by 1RM, it was possible to observe significant gain only in GA, with an increase of 9.5kg. Concerning GA, Franco et al. (2017) the Aussie current should be used to increase and accelerate muscle strength gain because through a mechanism that simulates the passage of the nerve impulse that propagates to the neuromuscular junction, releases acetylcholine and generates a muscle contraction.

Montenegro et al. (2019) have advantages in Aussie sensory and motor thresholds compared to other electrostimulation currents, stating that it can also reach muscle recruitment levels using lower current intensity,

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highlighting that one of the main limiting factors for increased force Muscle is discomfort. Dantas et al. (2014) note that the Aussie current generates faster hypertrophy because it recruits more fibers generating stress and increased mitochondria that result in higher volume, consequently hypertrophy.

In this context, an increase in torque capacity will occur. The results of the above studies support and support the results of the present study in which there was an increase in muscle strength throughout the use of Aussie in patients. Regarding the GT, it was noticed that there was no increase in strength gain. Oliveira and Pereira (2018), describe that the LM technique mainly reaches the superficial layer of the tissue receiving little or no stimulus to the muscle fibers. As the LM was used in the GT, the release may harm the strength gain, as the GL did not present load-bearing capacity gain, since the GL did not show significant force increase either.

## IV. CONCLUSION

From the results of the present study, it could be observed that there is no advantage in associating the Aussie current and myofascial release for the gain of muscle strength and power. It was also possible to register that Aussie is more effective for hypertrophy, obtaining gains throughout the treatment course, and that myofascial release generates benefits for muscle power. Thus, the isolated use in the clinical practice of Aussie for FM gain and LM for power gain is suggested, generating benefits for a faster recovery of the athlete or non-athlete individual in rehabilitation, as well as a greater increment of positive results. facing the goal desired by healthy high-performance athletes.

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# MBSE & SysML Applied to the Development of EGSE for Sattelites Assembly, Integration and Testing (AIT) - A Practical Case

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***Abstract*** *— This paper targets to present a proposal for the use of MBSE and SysML applied to a case study of the analysis in a component of a typical Electrical Ground Support Equipment (EGSE) used in Satellite Assembly, Integration and Testing (AIT).*
*The approach aims to describe the process flow used in the analysis, providing a methodological background for the practical application of SysML notation for EGSE's development.*
***Keywords*** *— **Systems Engineering; Model Based Systems Engineering; MBSE; SysML; Electrical ground Support Equipment; EGSE.***

## I. INTRODUCTION

Although SysML, in recent years, has become the *de facto* standard for MBSE, a supporting methodological basis is still needed, as SysML is just a graphical language and defines a set of diagrams, modeling elements, syntax and semantics. Like any language (formal or informal), it can be used in many different ways, including inappropriate ones. Most notably, it is possible to misuse the language for creating unrepresentative or even incorrect models.

The flow of the analysis processes used in this paper seeks to implement, as much as possible, the sequence presented in the GSE Integrated Development Guide proposed by Vintecinque (2017), respecting the limitations imposed by the SysML notation language and the modeling tool used. (Cameo Systems Modeller).

The added value of the methodology with the MBSE approach consists of:

- To select a suitable subset of SysML diagrams and artifacts to be generated conveniently and pragmatically;
- To define semantics to ensure meaningful diagrams and rules to check the model for consistency;
- To define an obvious sequence of diagrams that ensures modeling efficiency in relation to organizational processes, and is well understood by all stakeholders throughout the life cycle;

## II. METHODOLOGY - MBSE APPROACH TO THE GSE INTEGRATED DEVELOPMENT GUIDE

The process flow that will be used seeks to follow the major process phases of the Total Vision Framework proposed by Loureiro (2010), as shown below, as well as the SysML diagrams that will be used:

*Table 1 - Phases of Analysis Processes and Modeling Approach*

| Phase | Sub phase | SysML Diagrams | Modeling Approach |
|---|---|---|---|
| 1. Mission Analysis | 1.1 - Context / Concept of Operations | Block Definition Diagram (BDD) | Type Definitions (Parts Catalog) |
| | | Internal Block Diagram (IBD) | Description of Structures (blocks), internal components, relationships and interfaces between Structures. |
| | 1.2 - Life Cycle / Life Cycle Scenarios | Activity Diagram | Definition of the phasing of processes and subprocesses. |

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| Phase | Sub phase | SysML Diagrams | Modeling Approach |
|---|---|---|---|
| 2. Stakeholder analysis | 2.1 - Stakeholder Identificatio | Block Definition Diagram (BDD) | Actors (used in Use-Case Diagrams) Are created as "types" in a BDD |
| | 2.2 - Stakeholder Concerns | Use Case Diagrams | Description of stakeholder concerns in Use-Case diagrams, System or Interest Organization in various scenarios |
| | 2.3 - Stakeholder Requirements | Requirements Diagrams | Stakeholder requirements and their dependencies are represented in Requirements Diagrams. |
| | | Requirements Table | If there are no requirements dependencies, only SysML Requirements tables can be used. |
| | 2.4 - Measures of Effectiveness | Definition Diagram (BDD) / Parametric | MoE's are represented as value types in Block Definition diagrams and allow for simulation using external tools in Parametric Diagrams. |
| 3. Requirements Analysis | --- | Requirements Diagrams | System requirements and their dependencies are represented in SysML requirements diagrams or requirements tables. |
| 4. Functional Analysis | 4.1 - Boundaries identification, interfaces and | Internal Block Diagram (IBD) | Scenarios and circumstances for the product and organization of interest are described as blocks and their interfaces with the environment. |
| | 4.2 - Definition of functions | Generic Table | Tables with list of flows and events, MoEs and identified functions |
| 4. Functional Analysis (cont.) | 4.3 - Functional scope analysis | Internal Block Diagram (IBD) | Scenarios and circumstances for the product and organization of interest are described as blocks and their interfaces with the environment. |
| | 4.4 - Functional Interfaces | Internal Block Diagram (IBD) | $N^2$ chart generated from interfaces defined in functional scope analysis |
| | 4.5 - Definition of states and modes | Generic table | Tables with list of identified functions, modes, and states |
| | 4.6 - Analysis of functional behavior | State Machine Diagram | Refinement of states and modes identified for functions |
| | 4.7 - Establishment of the functional architecture | Use case diagram | Establishment of control, data and material flows between functions and functional elements of the system. (*1) |
| 5. Implementation Analysis | 5.1 - Establishment of physical | Block definition diagram (BDD and internal IBD) | Using both types of block diagrams for physical architecture proposals |
| | 5.2 - Function Allocation | Allocation Matrix | Through "Allocate" type relationships and automatic generation by modeling tool |
| | 5.3 - *Trade-Off* Analysis | TBD | TBD |

**NOTES *:**

1. The Guide proposes the establishment of functional architecture via Data Flow Diagrams (DFD's), which are not part of SysML. Using the Use-Case Diagram instead implies implementation limitations that need to be further evaluated throughout the application of the guide.

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## III. CASE STUDY - UMB SCOE ANALYSIS

As proposed by Vintecinque (2017) UMB SCOE is an element of EGSE proposed for future PMM platform satellite missions, which allows use during both the AIT and the Satellite launch phases, and aims to reduce the amount and volume of equipment to be transported to the launch base. The mission of UMB SCOE can be stated as:

***"To be the only satellite-connected element of EGSE that allows to power up, operate and monitor its vital signs during the AIT and launch phases" Vintecinque (2017)".***

The approach in the analysis and modeling to obtain UMB SCOE will be presented next.

### a. Mission Analysis

Starting from the mission statement, the possible concepts of operation, as exemplified in Fig. 1, are analyzed for one of the situations.

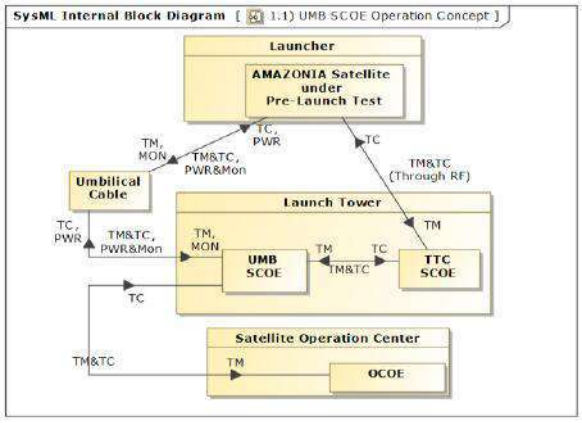


*Fig. 1 - Example of UMB SCOE operation concept for telemetry and telecommand data link in the launch tower (internal block diagram).*

Elements and their interactions are described textually through the appropriate fields of the model. Flows of energy, material or information from an early point of view are represented as "Information Item" stereotyped elements, denoting the directions of the flows. It does not matter at the moment the physical concept of interfaces.

### b. UMB SCOE Life-cycle

This analysis only states and establishes the sequence of expected life-cycle processes, as exemplified in Fig. 2.

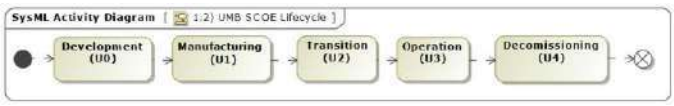


*Fig. 2 - UMB SCOE (activity diagram) life-cycle example.*

### c. UMB SCOE life-cycle scenarios

The UMB SCO life cycle scenarios are shown in *Fig. 3*. The activity diagram was used, with the inputs or controls of the old IDEF0 being replaced by SysML "Accept Event Action" or "Time Event" type elements.

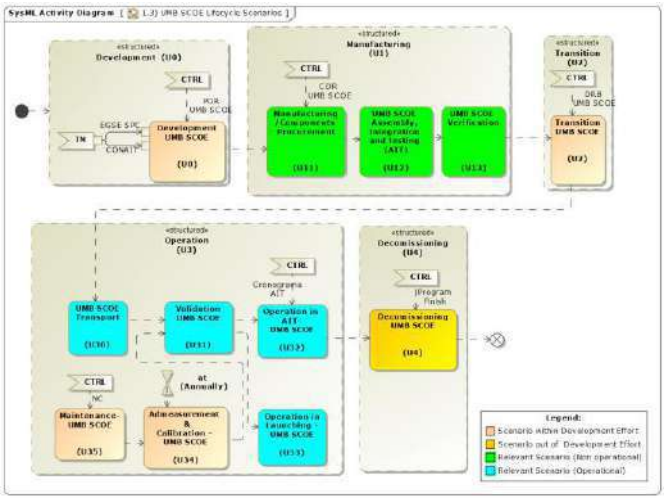


*Fig. 3 - UMB SCOE life-cycle scenarios example (activity diagram).*

Relevant scenarios within the development effort will be reviewed by the UMB SCOE developer organization.

### d. Stakeholder Analysis

#### i. Identification of UMB SCOE Stakeholders

For identification of product and process stakeholders, block definition diagrams (BDD) will be used with SysML stereotyped actors, as illustrated in Fig. 4.


*Fig. 4 - UMB SCOE stakeholder identification example (block definition diagram).*

#### ii. UMB SCOE stakeholders concerns

Product and process stakeholder concerns raised previously are analyzed together with the System or Organization of Interest in various scenarios.

The result is described through Use Case diagrams stereotyped as "Concern". Fig. 5 illustrates an example of how this will be done.

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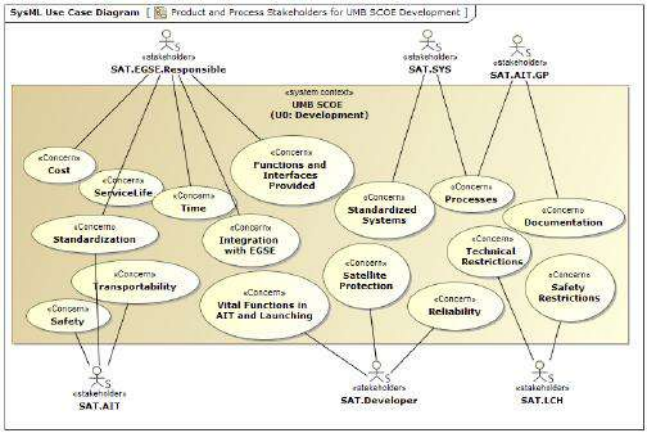


*Fig. 5 - UMB SCOE Stakeholder Concerns Example In the UMB SCOE scenario under development (Use Case Diagram).*

### iii. UMB SCOE stakeholder requirements

Stakeholder requirements derived from the concerns raised before are analyzed and the outcome is described through requirements diagrams or requirements table as exemplified in Fig. 6. Dependency or trace-ability relationships between requirements and stakeholder concerns can be made explicit in this kind of diagram. Additional attributes can be added to the requirements by the use of Tagged Values provided by the SysML notation.

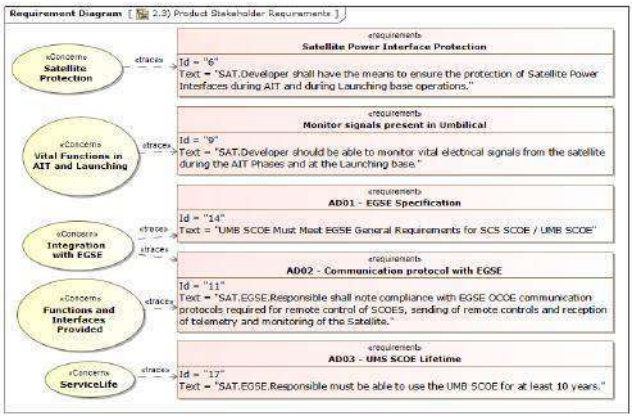


*Fig. 6 - UMB SCOE Product stakeholder requirements example (Requirements Diagram).*

### iv. UMB SCOE measures (MoE / MoP / TpM)

Measures of Effectiveness (MoE) are operational measures of success closely related to the achievement of the mission objective being evaluated and they are derived from the mission objectives related to the stakeholders concerns.

Measures of Performance (MoP) are measures that characterize physical or functional attributes relating to system operation, measured or estimated under specified testing and/or operational environment conditions.

Technical Performance Measures (TPM) measure attributes of a system element to determine how well that element is satisfying, or expected to satisfy, a technical requirement.

The SysML parametric diagrams will be used for the MoEs, MoPs and TpMs. It is desired that the measures could be quantitatively assessed, in a form that could be estimated or even simulated in supporting tools, integrated with the modeling tool. In order to allow this, the default SysML meta-model needs to be extended in order to allow then to be expressed in Value Types, but also in a textual description, which can be traced back to the Stakeholders Concerns and Requirements. This can be achieved by a Custom Profile which extends the SysML meta-model, with MoEs, MoPs and TpMs Specification elements, as shown in *Fig. 7*.

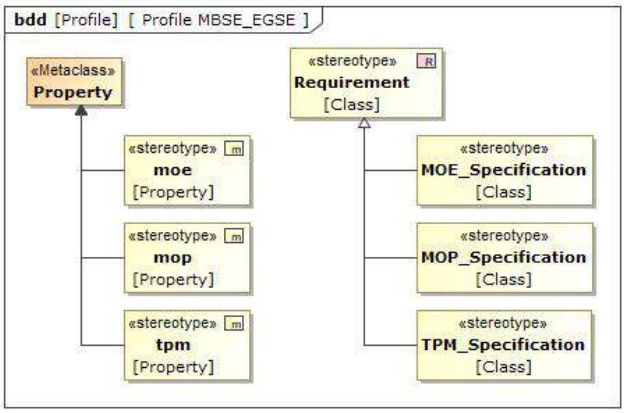


*Fig. 7 - MoEs, MoPs and TpMs Specification Meta-Model.*

The MoE, MoP and TpM specifications can be traced back to its source as the example shown in *Fig. 8*.

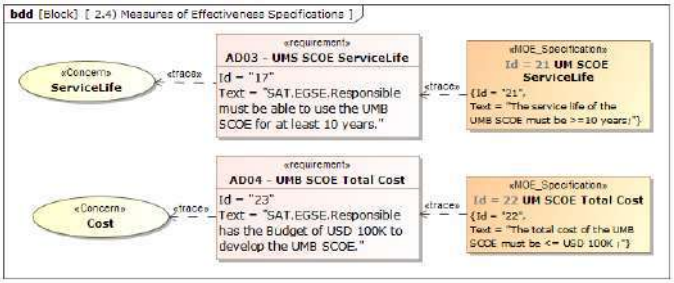


*Fig. 8 - Deriving Specification for MoEs Example.*

Finally, the Moe, MoP or TpM quantitative metrics can be expressed by Value Types (Properties), as shown in *Fig. 9*.

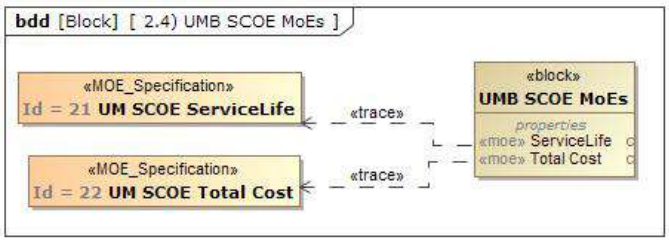

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*Fig. 9 - Parametric Diagram for MoEs of interest.*

### e. UMB SCOE Requirements Analysis

From the stakeholder requirements and MoEs defined before, as well as the assumptions that emerged during their analysis, the technical requirements (both for product and organization) are derived, but now from the UMB SCOE point of view. Similarly, requirements analysis is described through requirements diagrams or requirements table, as exemplified in Fig. 10.

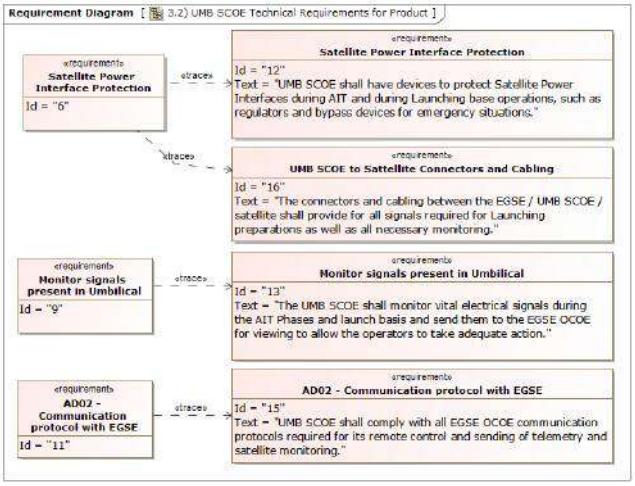


*Fig. 10 - UMB SCOE Product Technical Requirements Example (Requirements Diagram).*

### f. UMB SCOE Functional Analysis

#### i. UMB SCOE boundaries/interfaces identification and environment modeling

To identify system boundaries, relevant scenarios are chosen within the product and organization life cycle of interest (Vintecinque, 2018).

Scenarios and circumstances for the product and organization of interest will then be described as blocks and their interfaces with the environment by using internal block diagram (IBD), as illustrated in Fig. 11.

From the analysis of circumstances, it is possible to identify the events and expected responses of the system, as well as the associated measures of effectiveness.

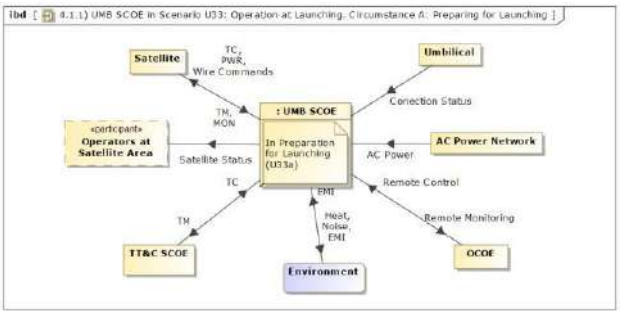


*Fig. 11 - UMB SCOE Environment Modeling Example during scenario U33: Launch Operation and its Circumstances (Requirements Diagram).*

#### ii. UMB SCOE functions definition

For each scenario and circumstance identified, all flows of energy, material and information are gathered and, from them, the system's external functions are identified, which can then be listed in a generic SysML table, as exemplified below:

*Table 2 - Example of definition list of functions identified for UMB SCOE (generic SysML table)*

| # | Name | Documentation |
|---|---|---|
| 1 | F1: Provide Satellite Umbilical Interface and EGSE | UMB SCOE must be EGSE interface with satellite umbilical connector during AIT and Launching |
| 2 | F2: Protect the Satellite | Minimize fault propagation and reduce the severity of failure effects on satellite and other EGSE elements |
| 3 | F3: Signals Monitoring | Monitor vital satellite signals present in the umbilical connector and important signals to Satellite Status including EGSE signals. |
| 4 | F4: Command | Generate on / off command pulse for satellite Through Umbilical Cable, or Through simulation devices (eg separation simulation |

#### iii. Scope analysis of UMB SCOE functions

Scope analysis of each function helps to identify inputs and outputs and scope limits for previously identified functions, as shown in Fig. 12.

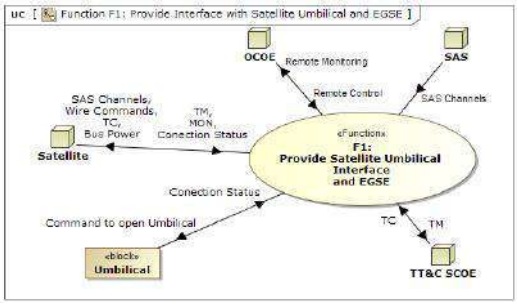


*Fig. 12 - F1 Function Scope Analysis Example for UMB SCOE (Use Case Diagram).*

#### iv. UMB SCOE functional interfaces identification

From the analysis of the inputs and outputs of each function it is possible to establish the interfaces between the functions.

Normally, this is represented through an $N^2$ chart (a.k.a $N^2$ diagram) which are not part of the SysML standard. But the main idea can be achieved through the use of internal block diagrams (IBD), in a matrix form, with te same rules of an N2 chart:

1. All Functions (or sub-functions) are on diagonal;
2. All Inputs are vertical (to down or to up)
3. All Outputs are Horizontal (to left or to right);
4. Inputs and outputs are items, not functions;

Fig. 13 Gives an example of this diagram used for some of the UMB SCOE functions.

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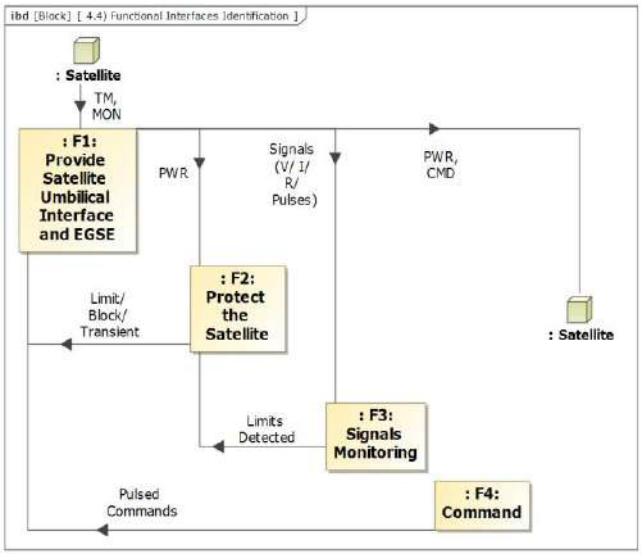


*Fig. 13 - UMB SCOE Functional Interfaces (Internal Block Diagram as N2 Chart).*

### v. UMB SCOE states and modes definition

From the functions identification, it is possible to identify states and modes of each function external to UMB SCOE. The definition is made by State Machine diagrams, for the purposes of tracing the states and modes to the functions defined before. The final representation is made by using a generic SysML table, as the example shown in *Table 3*.

*Table 3 - UMB SCOE Function State Analysis Example (Generic SysML Table)*

| # | Functions | Modes | Name | Documentation |
|---|---|---|---|---|
| 1 | F1: Provide Satellite Umbilical Interface and EGSE | REAL MODE<br>SIMULATED MODE | Connected | Cable connected to Sattelite |
| 2 | | | | |
| 3 | | | AIT Cable | AIT Cable of ~10m does not uses Umbilical Connector |
| 4 | | | Launch Cable | Launch Cable of ~70m does uses Umbilical Connector |
| 5 | F1: Provide Satellite Umbilical Interface and EGSE | REAL MODE<br>SIMULATED MODE | Disconnected | Cable is not connected to Sattelite |
| 6 | F2: Protect the Satellite | REAL MODE | Protection Active | Protection limit activated |
| 7 | F2: Protect the Satellite | REAL MODE | Protection Disabled | For each protection circuit |
| 8 | F2: Protect the Satellite | REAL MODE | Protection Enabled | Inicial Mode |
| 9 | F3: Signals Monitoring | REAL MODE | Monitoring Disabled | |
| 10 | F3: Signals Monitoring | REAL MODE | Monitoring Enabled | |
| 11 | F3: Signals Monitoring | REAL MODE | Monitoring Failed | |
| 12 | F3: Signals Monitoring | REAL MODE | Monitoring Runnning | |
| 13 | | | | |
| 14 | | | Acquiring | Acquiring signals |
| 15 | | | Waiting | Waiting for start of acquiring by command, automatic or reset |
| 16 | F4: Command | REAL MODE | Command Active | |
| 17 | | | | |
| 18 | | | Waiting | Waiting for Automatic or manual command or reset |
| 19 | | | Sending Command | Occupied, sending command |

### vi. UMB SCOE functional behavior analysis

After identifying the states and modes of operation, they are then refined using SysML state machine diagrams for each function external to the UMB SCOE. The Fig. 14 shows an example of that.

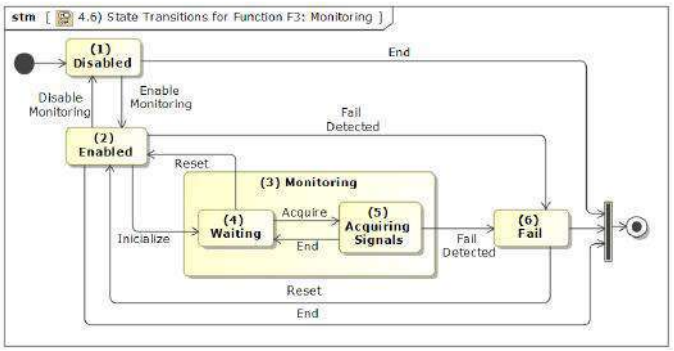


*Fig. 14 - UMB SCOE Function State Analysis Example (State Machine Diagram).*

### vii. UMB SCOE functional architecture establishment

During functional behavior analysis, it is possible to identify the possible failures in each of the flows and thereby identify preventive and protective functions for the failures. (Vintecinque, 2017). After that, it will be possible to map how functions interact, and perform functional partitioning that will provide an "allocable" generic functional architecture, allowing architectural decisions to be taken, for the product and organization of interest. In the guide proposed by Vintecinque (2017) DFD diagram is used. With SysML, the use case diagram will be used, with some restrictions, use of stereotypes and minor implementation differences, as illustrated in Fig. 15.

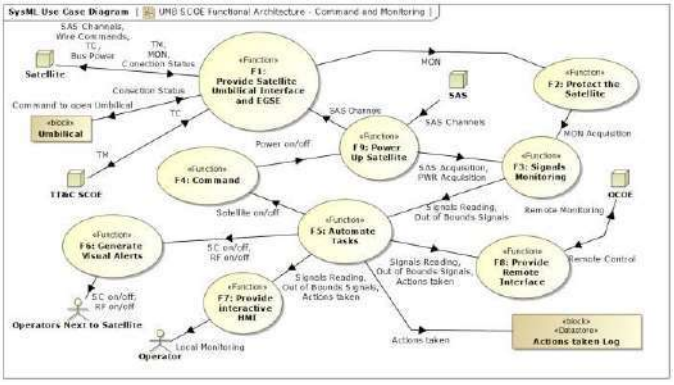


*Fig. 15 - UMB SCOE functional architecture example - Command and Monitoring (Use Case Diagram).*

## g. Implementation Analysis

### i. UMB SCOE physical architecture establishment

At this stage, from the functional architecture, through the two types of block diagrams from SysML (BDD and IBD), it is possible to propose a viable generic architecture that seeks to satisfy all that has been raised before, and Fig. 16 represents this step. In the Guide proposed by Vintecinque (2017), the physical architecture

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for UMB SCOE was not proposed, which will then be done from now on.

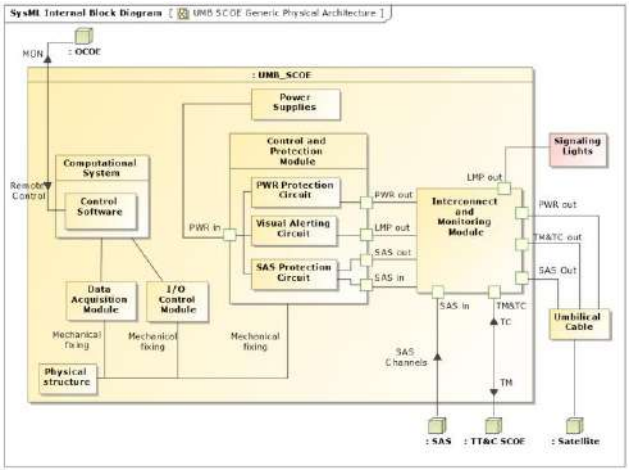


*Fig. 16 - UMB SCOE Generic Physical Architecture Example (Use Case Diagram).*

### ii. UMB SCOE physical architecture's functions allocation

Function allocation can be done through "allocate" SysML connectors, in block definition diagrams, which do not necessarily need to be documented (they can be temporary). From the relationships made between the functions and blocks of the physical architecture, the allocation matrix can be generated directly from the modeling tool, as illustrated by Table 4.

*Table 4 - UMB SCOE Function Allocation Example - (Allocation Matrix)*

| Legend: ↗ Allocate | Computational System | Control and Protection Module | Data Acquisition Module | I/O Control Module | Interconnect and Monitoring Module |
|---|---|---|---|---|---|
| F1: Provide Satellite Umbilical Interface and EGSE | | | | | ↗ |
| F2: Protect the Satellite | ↗ | ↗ | | | |
| F3: Signals Monitoring | | | ↗ | | ↗ |
| F4: Command | ↗ | | | ↗ | |
| F5: Automate Tasks | | | | | |
| F6: Generate Visual Alerts | | | | | |
| F7: Provide interactive HMI | | | | | |
| F8: Provide Remote Interface | | | | | |
| F9: Power Up Satellite | | | | | |

### iii. Trade-off analysis

This type of analysis is still open in the ongoing study. At first, the intention is to make the trade-off analyzes for "product" by using several block definition diagrams with different practical solutions (Product BreakDown Structures) for the same physical architecture, with estimates and simulations for different vendors / data acquisition solutions, protection systems, etc.

The approach most appropriate in this case seems to be taking advantage of the characteristics of SysML parametric diagrams, as well as external tools integration and simulation, in order to simulate various scenarios of cost, ease of implementation, material availability, technical performance, etc., besides of morphological charts with adequate criteria and weights for each component in order to achieve a balanced Product Specific Physical Architecture, but this issue is beyond the scope of this study effort.

## IV. CONCLUSION

The use of MBSE through the notation language SysML, supported by the use of appropriate modeling tools, allows to cover virtually the entire product and organization systems engineering life-cycle, obviously while respecting the limitations of the notation itself and maturity of its utilization, as well as the different methodological implementations that make use of it.

There are still difficulties in applying the notation fluidly with respect to the non MBSE approaches used in previous working frameworks, but future versions of the notation itself, such as SysML V2, as well as its future adoption by vendor modeling tools can simplify and better tailor their use more widely.

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# A Pick and Place Task with an KUKA Industrial Robot, Aided by an Arduino Board

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***Abstract*****—** *Work with industrial robots is a very challenge task. Those kinds of robots, usually, have an architecture very difficult to interact with and their programming language is not quite friendly. In the Robotics Laboratory of the Taubaté's University, we have an industrial robot KUKA KR 6 R900 Sixx. In order to develop some research with focus in the robotics field and the applications of robotics in the industry we propose the development of these work, which has the idea to interact an industrial robot with a low-cost board (Arduino) to perform a pick and place task. To do so, we assembled an experimental setup, where a two-finger shape claw mounted on the end effector of the robot and controlled by an Arduino board, was used to pick an object and place it in a known position. The robot and the Arduino board are linked by the Kuka control unit, using digital ports in the PWM mode. After few tests and analyzing the results, we consider the performance of the system quite good.*

***Keywords*****— KUKA, industrial manipulator, Arduino, robotics, pick and place,**

## I. INTRODUCTION

The pick and place task are very common, considering industrial robots. In Saut, J. et all (2010), the authors propose a planning framework to deal with the problem of computing the motion of a robot with dual arm/hand, during an object pick-and-place task. They considered the situation where the start and goal configurations of the object constrain the robot to grasp the object with one hand, to give it to the other hand, before placing it in its final configuration.

In H. Işıl Bozma, M.E. Kalalıoğlu, (2012), the authors consider the problem of multirobot coordination in pick-and-place tasks on a conveyor band. The robot team was composed of identical robots with mutually exclusive, but neighboring workspaces. The products were fed in at one end of the band, move through each workspace sequentially until being picked up and were collected at the other end—if not picked up interim.

In Rengerve, A. et all (2011), the authors present a bio-inspired neural network used in a robot to learn arm gestures demonstrated through passive manipulation. The neural network allowed the robot to plan arm movements according to activated goals. The model was applied to learning a pick-and-place task. The robot learned how-to pick-up objects at a specific location and dropped them in two different boxes depending on their color. As the system is continuously learning, the behavior of the robot can always be adapted by the human interacting with it.

The idea of moving a robot in an environment, with sensors, can allow the manipulator to develop tasks in closed loop, avoiding obstacles and changing its path at any time. Connecting a camera to a Kuka robot, for example, enables the robot to observe the environment and react responsively. The low-level information captured by the camera, namely the pixels, can be transformed into a certain meaningful signal that constantly informs the robot's motion. In Sanfilippo, F. et all (2015) the authors discuss a Java open-source cross-platform communication interface, JOpenShowVar, to Kuka industrial robots. The novel interface developed, allows to read and write, using the controlled manipulator, variables and data structures. JOpenShowVar, which is compatible with all the Kuka industrial robots that use KUKA Robot Controller version 4 (KR C4) and KUKA Robot Controller version 2 (KR C2), runs as a client on a remote computer connected with the Kuka controller via TCP/IP. Even though only soft real-time applications can be implemented, JOpenShowVar opens up to a variety of possible applications, making the use of various input devices and sensors as well as the development of alternative control methods possible.

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In Safeea, M. and Neto, P. (2019), the authors present a tutorial of the KUKA Sunrise Toolbox (KST), a MATLAB toolbox that interfaces with KUKA Sunrise.OS. KST contains functionalities for networking, soft control in real time, point-to-point motion, parameter setters/getters, general purpose, and physical interaction. The toolbox includes approximately 100 functions and runs on a remote computer connected with the KUKA Sunrise controller via Transmission Control Protocol/Internet Protocol (TCP/IP). The potentialities of the KST are demonstrated, by the authors, in nine application examples.

In this work, we propose a very simple way to control a pick and place task, performed by an industrial Kuka robot KR 6 R900 Sixx, aided by a low-cost board, in an attempt of to simplify the communication between industrial robots and its environment allowing the simplification of robot's operations.

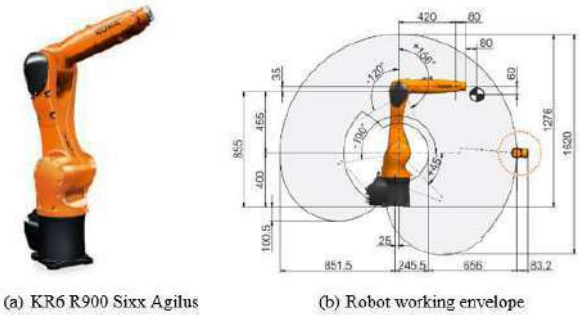
## II. THE ROBOT KUKA KR 6 R900 SIXX

The robot KUKA KR6 R900 SIXX AGILUS (Fig.1(a)) is a small industrial robot that features high work speed, with high precision in the activities performed. Can be used handling, loading and unloading activities, and many others. At the Robotics Laboratory of the University of Taubaté, this robot is being used in postgraduate research activities focused on robotic control. Table 1 summarizes the robot information and figure 1 presents the robot model referred to in this article.

*Table 1 – Robot information*

| Robot Specifications | | Robot Motion Speed | | Robot Motion Range | |
|---|---|---|---|---|---|
| Axes | 6 | J1 | 156 °/s (2.72 rad/s) | J1 | ±185° |
| Payload | 6.00kg | J2 | 156 °/s (2.72 rad/s) | J2 | +35° - 155° |
| H-Reach | 1570.00mm | J3 | 156 °/s (2.72 rad/s) | J3 | +154° - 130° |
| Robot. Mass | +0.050mm | J4 | 343 °/s (5.99 rad/s) | J4 | ±350° |
| Structure | Articulated | J5 | 362 °/s (6.32 rad/s) | J5 | ±130° |
| Mounting | Floor, inverted angle | J6 | 659 °/s (11.5 rad/s) | J6 | ±350° |

The robot working envelope is shown in Figure 1 (b) and clarifies the reach of the robot, during its operations. The dimensions are in mm.

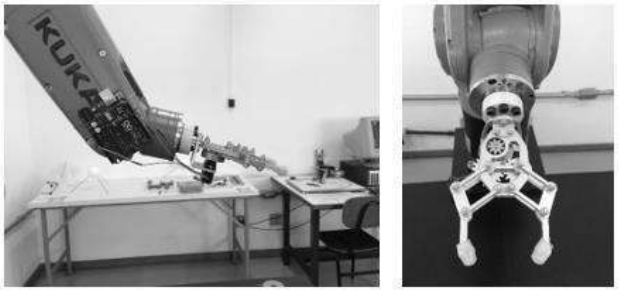



(a) KR6 R900 Sixx Agilus (b) Robot working envelope

*Fig.1 - KUKA robot*

## III. THE EXPERIMENTAL SETUP

To perform the pick and place task, we attach at the robot end effector a two-finger shape claw (Figure 3) which is controlled by an Arduino UNO R3 board. The claw has a servomotor which is wiring to an Arduino's PWM port.




(a) Side view (b) Top view

Figure 3 - Claw attached at the robot end effector

The Arduino board is programed to open and close que claw, depending on a command received by the Arduino, sending by the robot, through its KR C4 controller device. The KR C4 controller has about sixteen digital available ports, which can be accessed via the KSS (Kuka System Software).

## IV. DEVELOPMENT OF A SIMPLE COMMUNICATION PROTOCOL

The KSS (KUKA System Software) includes basic functions such as trajectory planning or input/output management. In addition, advanced features are already integrated in KSS. These features offer many possibilities in robot programming, including access to the controller KRC4 digital ports.

The Arduino board works with voltages from 0 to 5V, making it incompatible to use the direct signal from the robot's digital ports - which are from 0 to 24V with 0.5A of current. Thus, a conditioning and protection board was designed to receive the 24V signal from the robot and convert it to 5V, using an LM7805 IC, which is a tension regulator, that will be connected to one of the Arduino's digital input ports protected by a 4N35 opto-coupler (Fig. 4).

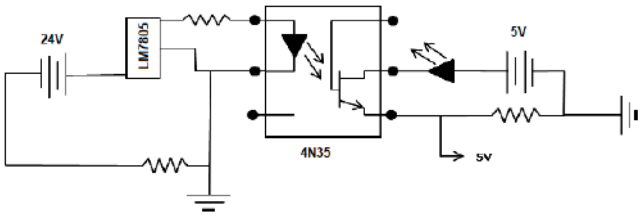



*Fig.4 – Input signal conditioner*

The figure 5, shows the scheme of the hardware used in this work. The robot, initially, moves to a known point in its work space, and stop in this point for a few seconds.

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After it stops, it sends a 24V signal to a digital port on the KR C4 controller. This port will be wired at the pin 1 of the voltage regulator, LM7805.


The voltage regulator, coupled to the opto-coupler 4N35, sends to the Arduino board, port 3, a 5V signal. When the Arduino board reads this signal, it will close the claw, acting in Arduino's PWM port 3. After that, the robot moves to another known position in its work space, stops for a few seconds, and sends a 0V signal to a digital port on the KR C4 controller. When the Arduino board reads this signal, it will open the claw, acting in Arduino's PWM port 3. Those steps will be repeatedly executed, putting the robot in a pick and place task.

Once the setup was assembled, we developed a simple program, off-line, which is shown in figure 6.


*Fig.6 – Program developed to perform the pick and place task*

## V. CONCLUSIONS AND FURTHER WORK

The integration proposed in this work, worked very well. After the installation of the two-finger shape claw mounted, on the robot's end-effector, we performed the robot calibration to include the end-effector in the robot kinematics. After that the industrial robot was able to interact quite fine with its work space. The robot was able to execute several pick and place tasks and the communication protocol shown no problems in exchange signals with the Arduino Uno board.

With this improvement, we can program the robot to execute more complicated tasks, obeying a control strategy executed by the Arduino board.

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# The Effect of whistleblowing Hotline, Surprise audit, and the independence of Audit Committee on internal Fraud: Facts of Banking Companies in Indonesia

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***Abstract*****—** *Banking and other of finance institutions was one of the sectorsthat has lots of fraud. Indonesian Financial Services Authority discover the most substantial fraud in the banking involves employ or customers. Therefore, banking needs a mechanism that can limit that actions. This study aims to analyze the effect of whistleblowing hotline on internal Fraud, the effect of surprise audits on internal fraud, and the effect of the independence of the audit committee on internal fraud. Furthermore, this research analyze the effect of whistleblowing hotline, surprise audits, and the independence of the audit committee against internal fraud simultaneously.*

*Paper is based on the data from annual reports and Good Corporate Governance (GCG) company banks report listed on the Indonesia Stock Exchange in the period of time throughout twelve years 2008-2018. Samples were tested by multivariate regression analysis. The Results showed that the whistleblowing hotline significantly affect negative against internal fraud. Surprise audit has a significant negative effect on internal fraud. The independence of the audit committee hotline has a significant negative effect on internal fraud. In simultaneous whistleblowing hotline, surprise audits, and the independence of the committee audit affect negatively against internal fraud.*

***Keywords*****— fraud; bank; whistleblowing; surprise audit.**

## I. INTRODUCTION

Fraud is a latent danger that threatens every organization. Based on survey results of the Association of Certified Fraud Examiners (ACFE) in 2018, banking and finance institutions was one of the sectors that has lots of fraud. Fraud in the banking industries can be interpreted as an act of intentionally violating of the internal provisions consist of policies, systems, and procedures which could potentially harm the bank both material and moral. The existence of fraud in the world of banking wouldly gave great impact on the trust of the customers level and harm it financially. Therefore, banking needs a mechanism that can limit that actions. The ACFE's surveyat 2016 and 2018 concluded that the most good and effective method to preventing the fraud is whistleblowing hotline mechanism. Whistleblowing hotline is a service that allows employees and the third suppliers to report malpractice, behaviour that violates the law, or unethical behaviour at the work place.

Surprise audits can prevent fraud because employees and managers are not given out before the random verification and therefore did not have time to hide the fraud by cover up their traces (Peltier-Rivest et al., 2015). In fact, the random audit and without notice can increase the perception of fraud perpetrators on the detection and fear them to be caught (Wells, 2011).

The results of the survey ACFE (2016) shows that the audit of external and internal audits also can be a medium for detecting the occurrence of fraud. However, the percentage that little thing that shows that the audit of external and internal not contribute to find fraud. Therefore, audit committees had necessary roles in their function which can reduce the chance of the irregularity occurrence in the management of the company and

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improve the effectiveness of internal audit and external audit function and ensure the audit findings followed up well. Collier's Research (1993) on the audit committee in the UK indicates that the independence of the audit committee on management was the second most important factor, after the judgment which affects the effectiveness of the committee. Various studies show that the independence of the committee audit has effect against fraud (Bryan et al. (2004), Pamudji and Trihartati (2007), and Kosasih and Widayati (2013). Therefore, the aim of this research is to analyse the effect of hotline whistleblowing against internal fraud, the effect of surprise audits on internal fraud, the effect of the independence of the audit committee on internal fraud, and analyzing the effect of hotline whistleblowing, surprise audits, and the independence of the committee audit against internal fraud simultaneously.

**Fraud**

According to the Association of Certified Fraud Examiner (ACFE) in the Fraud Examiners Manual 2006: Fraud was the profits were obtained by someone with existing something which not in accordance with real conditions. Including unexpected elements, hokey pokey, cunning, and unhonest way that can harm someone else (Karyono, 2013:3).

**Fraud Triangle Theory**

Cressey's Research (1973) with 200 prisoners that were convicted of fraud, conclude the end hypotheses of that time it was known as the triangle of fraud. The hypothesis is assumed that: "Trusted People become violators when they consider themselves they have not to be shared problem finances and realize that problem can be resolved secretly with breaking the trust finances positions, and could apply to their behaviour in that situations. Verbalization that allows them to adjust their own concept as users of funds and entrusted property."

Research concluded that fraud consists of three elements, namely the existence of pressure, opportunity, and justification that by the time is better known as fraud triangle theory.

**Fraud on banking**

Fraud in banking industries can be interpreted as an act of intentional violating the internal provisions consist of policies, systems, and procedures which could potentially harm the bank either material or morale. Bank Indonesia (2011) through Circular Letter of Bank Indonesia (SEBI) 13/28/DPNP issued regulations related to fraud, where fraud is defined as the act of irregularities were deliberately made to deceive, cheat, or manipulate the bank or the customer who performed at the neighborhood bank and/or use the bank's means that resulted suffer losses in the customer or the other and fraud perpetrators earn a profit finance directly or not directly.

The actions which classified as fraud is cheat, deceive, misappropriation of assets, the leaking of information, banking criminal acts, and the other actions that can be equated with it (Bank Indonesia, 2011). Based on the data Indonesian Financial Services Authority,the types of acts in criminal banking that occurred in 2014 up to quarter III-2016 include : the case of credit (55%), engineering registration (21%), embezzlement of funds (15%), transfers of funds (5% ) and asset procurement (4%) (Sukmana, 2016 ).

**Whistleblowing Hotline**

Komite Nasional Kebijakan Governance(2008:3)defines whistleblowing as: "Disclosure act violations or disclosure of acts that against the law , the unethical act or immoral act or other that can be harm the organization or stakeholder, which is done by employees or organization leaders to otherorganization leader or other institution which can take actfor that violation. This disclosure is generally carried out in secret."

The fraud reporting mechanism is an important component of an effective fraud prevention and detection system. Organizations must implement a hotline to receive reports from internal and external sources. The ability to report the fraud in anonymous is very important because many employees and others stakeholders may be afraid to report suspicious behaviour because of the threat of retaliation from superiors and negative ratings of co- worker (ACFE, 2010).

Whistleblowing hotline is a service that allows employees and the third suppliers to report malpractice, behaviour that violates the law, or unethical act at the work place. Wells (2011) stated that in the war against fraud, hotline serves as a detection method and prevention act by improves the perception of detection and fear of caught between individual who plans a crime. Priantara (2013) mentions that one of the systems that are used to prevent the occurrence of fraud is to implement a reporting system of fraud allegations (whistleblowing hotlines). Peltier-Rivest and Lanoue's research (2015) found that the hotline had a significant negative effect on fraud, so the hypothesis in this study is as follows. H1: whistleblowing hotlines affect negatively against internal fraud.

**Surprise Audit**

Based on BI Circular Letter No.13/28/DPNP Regarding Anti-Fraud Strategy for Commercial Banks, there are three techniques for detecting fraud, namely the Whistleblowing System mechanism, surprise audit, and surveillance system. Surprise audits can prevent fraud because employees and managers are not given out before the

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random verification (eg, the amount of money in cash, review documents, the buyer secret) and therefore they did not have time to hide the fraud to cover their tracks (Peltier-Rivest and Lanoue, 2015). In fact, the random audit and without notice increase the perception of fraud perpetrators about the possibility of being detected and their fear to be caught (Wells, 2011).

According to Sam Bowercraft and David Hammarberg (2013), the purpose of surprise audit is to evaluate without giving notice of the review/inspection so that the preparation cannot be done by the auditee (audit target), to confirm the readiness of actual operational of the process area, as a detection strategy, and as a prevention strategy. The benefits of the surprise audit implementation are to improve employees caution in carrying out their duties. Every part that related to the operational companies will be cautious because of concerns at any time can be carried out by surprise audits, so that things can decrease the motivation to commit fraud. Peltier-Rivest and Lanoue's research (2015) found that Surprise Audit has a significant negative effect on fraud. Therefore, the hypothesis in the research of this is as follows. H2: surprise audit has a negative effect on internal fraud.

**Independence of Audit Committee**

Audit Committee is one of the media to improve the effectiveness of the control system of company. Definition audit committee by Komite Nasional Kebijakan Governance(KNKG, 2006) is a group of people chosen by the bigger group to do specific job or to perform special tasks or a number of members of the commissioner board of client company which responsible to assist the auditor in maintaining its independence from management. In the execution of its duties, the committee audit has functions as follows: (1) Assist the board of commissioners to increase the quality of financial report; (2) Creating a climate of discipline and control that can reduce opportunities for irregularities in company management; (3) Increasing the effectiveness of internal audit functions and external audits; (4) Identifying matters that require the attention of the board of commissioners/supervisory board.

Audit Committee has a role which is quite vital in the implementation process of a governance mechanism of companies. Surely that committee audit can carry out their duties with properly and effectively, it is necessary specific qualifications that adequate so that the duties and responsibilities running maximally (Wardhani and Joseph, 2010).

Independence is a major factor in what an examiner must have especially an audit committee. The importance of independence on the audit committee is emphasized by Regulation No.IX.I.5 Appendix Decisionof Chairman of Badan Pengawas Pasar Modal (BAPEPAM) No. KEP-29/ PM/2004 date September 24, 2004 concerning the Formation and Guidelines for the Implementation of Audit Committee Work (BAPEPAM, 2004). Various studies show that the independence of the committee audit effect against fraud (Bryan et al. (2004), Pamudji and Trihartati (2007), and Kosasih and Widayati (2013)), sothe hypothesis in this study is as follows. H3: The independence of the audit committee has a negative effect on internal fraud.

In addition to testing in partial, testing is simultaneously also conducted to see the effect of the three variables that whistleblowing hotline, surprise audits, and the independence of audit committee internal fraud, therefore the hypothesis, H4: whistleblowing hotline, surprise audits, and the independence of audit committee affect internal fraud simultaneously.

## II. RESEARCH METHODOLOGY

**Location and Research Design**

The aims of this research to test the hypothesis. The type of relationship between variables studied is correlational relationship. Location conducted on Stock Exchange Indonesia by using the secondary data from 2008 up to 2018. The analysis unit is the company level, namely companies banking listed in Indonesia Stock Exchange (IDX). The time horizon in this study is the time series. The variables in this study consisted of the dependent variable and the independent variable. The dependent variable used is Internal Fraud while the independent variable is the whistleblowing hotline, surprise audit, and independence of the audit committee.

**Population and Research Samples**

This research will look at the effect of whistleblowing hotline, surprise audit, and independence of the audit committee on internal fraud. The Population of this research is the whole enterprise banking which listed on the Stock Exchange Indonesia in 2008-2018. The selection of samples is done with purposive sampling method. Companies that meet the requirements to be used as a sample in this study about 25 companies.

**Data Analysis Method**

The data in this study is processed by using the software Statistical Package for the Social Sciences (SPSS) version 23.

**Classical Assumption Test**

The classical Assumption Test is conducted to provide assurance that the regression equation was obtained has accuracy in estimation, not biased, and consistent. The classical Assumption Test is done by normality test, a

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multicollinearity test, heteroskedastisitastest, and autocorrelation test.

**Multiple Linear Regression Analysis**

Multiple linear regression analysis is used to analyze the effect of the whistleblowing hotline, surprise audit, and independence of the audit committee on internal fraud. Regression model in this research shown in the equation below:

$$IF = \beta0 + \beta1\ WH + \beta2\ SA + \beta3\ IKA + e$$

Description:

| | | |
|---|---|---|
| IF | = | Internal fraud is measured by the a |
| $\beta_0$ | = | constants; |
| $\beta_1, \beta_2, \beta_3$ | = | regression coefficient; |
| WH | = | whistleblowing hotline is measured by a dummy variable. A value of 1 if there is a hotline that can be contacted when fraud occurs, and a value of 0 if it does not exist; |
| SA | = | surprise audit is measured by the surprise audit frequency every year; |
| IKA | = | the independence of the committee audit measured by the percentage of audit committee comes from the outside to the number of members of the audit committee; |
| *E* | = | *error terms* |

## III. RESULTS AND DISCUSSION

**Classical Assumption Test**

The test results of normality after the data transformation shows the value of the Kolmogorov-Smirnov about 0.642 with a significance 0.805 located in the upper α = 0.05 so it can be concluded that the distribution data is normal. The test results of heteroskedastisity show that there is not a clear pattern and dots spread on top and at the bottom of the numbers 0 on the axis Y, so it can be concluded that heteroskedastisitas did not happen. The autocorrelation test results showed a number of significant lags less than two so it can be concluded that there is autocorrelation occurred.

**Hypothesis Test**

*Table 1 Test results for the coefficient of determination*

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .443[a] | .295 | .286 | .79303 |

a. Predictors: (Constant), IKA, WH, SA

The testing results indicate the amount of adjusted $R^2$ is 0.286, it means 28.6% variation of internal fraud can be explained by the other three independent variables,hotline whistleblowing, surprise audits, and the independence of the audit committee, while the rest is explained by other causes outside the model.

*Table 2 Results of the testing are partial (test statistic t)*

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | T | Sig. |
|---|---|---|---|---|---|---|
| 1 | (Constant) | 4.731 | .162 | | 29.191 | .000 |
| | WH | -.100 | .027 | -.225 | -3.752 | .000 |
| | SA | -.100 | .034 | -.177 | -2.911 | .004 |
| | IKA | -.114 | .033 | -.217 | -3.437 | .001 |

a. Dependent Variable: IF

Hypothesis test results indicate that the whistleblowing hotline variable has a negative effect on internal fraud. Constant of 4.731 shows without the influence of the whistleblowing hotline variable, the company will increase internal fraud action about 4.731 %. The regression coefficient of whistleblowing hotline variable has a value of -0.100 that shows if the whistleblowing hotline increases by 1%, it will reduce the internal fraud action by 0.100 %. It means whistleblowing hotline affect negatively against internal fraud. The level of significance about 0.000 or smaller than 0:05 indicates that whistleblowing hotline is partially have the effect against internal fraud significantly, so the first hypothesis which states that whistleblowing hotline affect negatively against internal fraud is received.

The test of second hypothesis shows regression coefficient of internal fraud variable about -0.100 indicates when the surprise audits increased by 1% then it will reduce the action of internal fraud about 0.100 %. It means surprise audits affect negatively against internal fraud. The level of significance about 0.004 or smaller than 0.05 indicates that surprise audit is partially have the significant effect against internal fraud, so the second hypothesis that states surprise audits affect negatively against internal fraud is received.

The test of third hypothesis shows that the independence of the audit committee has a coefficient about -0.114. It means if the independence of the audit committee increased by 1% then it will reduce the action of internal fraud about-0.114 %. The level of significance about 0.001 or smaller than 0.05 indicates that the independence of the audit committee influences significantly against internal fraud, so the third hypothesis that stated the independence of the audit committee affect negatively against internal fraud is received.

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*Table 3 Results of the testing are simultaneous (test statistic F)*

**ANOVA[a]**

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 37.688 | 3 | 12.563 | 19.975 | .000[b] |
| | Residual | 154.710 | 272 | .629 | | |
| | Total | 192.397 | 275 | | | |

a. Dependent Variable: IF

b. Predictors: (Constant), IKA, WH, SA

The test of fourth hypothesis shows whistleblowing hotline variable, surprise audits, and the independence of the audit committee effect against internal fraud simultaneously. The value of F arithmetic amounted to 19.975 with a 0.000 probability is muchsmaller than 0.05 so it can be concluded that the fourth hypothesis that states whistleblowing hotline variable, surprise audits, and the independence of the audit committee effect against internal fraud simultaneously is received.

**The influence of whistleblowing hotlines on internal fraud**

The testing results of first hypothesis shows that the whistleblowing hotline variable affect negatively against internal fraud, things are seen from the value of the coefficient whistleblowing hotline variable about -0.100 with a significance level 0.000. It means the higher level of whistleblowing hotline, it will reduce the action of internal fraud. This research result increasingly supports the study results that were conducted by Wells (2011), Priantara (2013), and Peltier-Rivest and Lanoue (2015) who find that whistleblowing hotline is influenced negative significantly against fraud. Whistleblowing hotline will build a healthy neighborhood business, integrity, and reliable so banking companies can provide quality service. Whistleblowing hotline will provide an opportunity for every person to report fraud allegations were carried out by internal company so the company will be supervised every time and opportunity to conduct fraud will be getting smaller.

**The effect of surprise audit on internal fraud**

The testing results of second hypothesis shows that the surprise audits variables affect negatively against internal fraud, things are seen from the value of the coefficient of surprise audit variables about -0.100 with a significance level about 0.004. It means the higher level of surprise audit,it will reduce the action of internal fraud. This research result increasingly supports the study results that were conducted by Wells (2011) and Peltier- Rivest and Lanoue (2015) who find that a surprise audit is influenced negative significantly against fraud. Bank Indonesia make serious effort to optimize the detection of fraud by making a surprise audit as one of the efforts to detect fraud at the banking institution. Surprise audits can directly detect fraud at the time while audit process was underway because the fraud perpetrators have no time to eliminate his fraud evidence. Implementation of the sudden audit make the parties that are involved in the company will try to carry out the duties and functions as best as possible and be able to suppress the desire to do cheat because feel worried any time for surprise audit, so with the surprise audit, controlling process in the company will be getting better and reduce the risk of internal fraud.

**The effect of the independence of the audit committee on internal fraud**

The testing results of third hypothesis shows that the independence of audit committee variable affect negatively against internal fraud, things are seen from the value of the coefficient of independence of audit committee variable about -0.114 with a significance level about 0.001. It means the higher level of independence of audit committee it will reduce the action of internal fraud. This research result increasingly supports the study results that were conducted by (Bryan et al. (2004), Pamudji and Trihartati (2007), as well as Kosasih and Widayati (2013) who find that the independence of the audit committee is influenced negative significantly against fraud. The audit committee was one of media to improve the effectiveness of the control system at the company. The independent audit committee can carry out the functions of effective controlling and monitoring because of its duties was not affected and depended on the other. In addition, the independent audit committee will be objective in carrying out duties and obligations so they can put forward the professionalism of the work and skepticism that are not affected with pressure or interests of others who can minimize internal fraud that occurred at the company.

**The effect of the whistleblowing hotline, surprise audit, and independence of the audit committee on internal fraud**

The testing results of fourth hypothesis shows that the whistleblowing hotline variables, surprise audits, and the independence of the audit committee affect negatively against internal fraud, things are seen from the significance level of whistleblowing hotline variables, surprise audits, and the independence of the audit committee about 0.000. It means the higher levels of whistleblowing hotline, surprise audits, and the independence of the audit committee it will reduce the action of internal fraud. This research result increasingly supports the study results that

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were conducted by (Bryan et al. (2004), Pamudji and Trihartati (2007), as well as Kosasih and Widayati (2013).

## IV. CONCLUSIONS

Whistleblowing hotline has a negative effect on internal fraud. Surprise audit has influenced negative significantly against internal fraud. The independence of the audit committee has a negative effect on internal fraud. In simultaneous, whistleblowing hotline, surprise audits, and the independence of the audit committee affect negatively against internal fraud. Based on these conclusions, as advice for the next study can use the latest theory as an extension of the theory of fraud triangle (Cressey, 1953) i.e. Fraud pentagon theory that proposed by CrowenHowart (2011) to look at the deciding factors of fraud. The next research can investigate fraud by using the five elements of fraud that is pressure, opportunity, rationalization, capability, and arrogance.

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# Comparative Study of Steel Economy on fck-25 MPa and fck-50 MPa Reinforced Concrete Pillars in a 4-Story Building

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***Abstract*** *— Reinforced concrete is the most widely used building typology in the world, with steel as its most expensive component. The use of high strength concrete tends to enable the making of slender pieces, its use directly implies the monetary cost of the work, thus generating savings or increasing the cost. The present work aims to show the steel consumption for a dimensioned building using 25 MPa and 50 MPa concrete, as well as to provide results regarding the utilization rates of concrete and steel sections and to draw conclusions about the mechanical tests performed to obtain the strengths. mentioned above. With the mechanical tests satisfactory results were obtained for the concrete consistency indexes measured by the slump test and by the axial compression and tensile compression tests it was possible to demonstrate the expected results. With the use of C50 concrete, a reduction in steel consumption was achieved mainly for the columns, when compared to the design made using C25 concrete.*

***Keywords*** *— **Concrete, Software, Cost.***

## I. INTRODUCTION

In the civil construction market, we have several types of construction and various materials that are used, such as steel and wood. But in the present scenario concrete is still the most used material in construction. Due to its low cost compared to steel, for example. In addition, it is a fluid material which is easily moldable, allowing the creation of pieces in irregular shapes geometrically. It has a good compressive strength and not so much considerable tensile strength, in this reasoning that reinforced concrete was invented. Previously we worked with casual strength concrete, 25, 30 and 40 MPa. ABNT NBR 6118 (2007) (1) itself did not include in its text the high strength concretes, from the update of the standard in 2014 that was inserted in its text the considerations regarding the high strength concretes (C50 to C90). High-strength concrete has become increasingly common, whether to build taller buildings, tunnels or to reach slender pieces.

Today we have several integrated calculation software for reinforced concrete structures, the best known are: TQS, EBERICK and CYPECAD. Software has come to increase the productivity of structural engineers. With them it is possible to model, analyze, dimension and detail the structures. For this work we chose to use Multiplus' CYPECAD software.

The software allows us to make fast simulations that would not be so agile manually, for this article we will establish cost analysis results for structures sized using 25 MPa and 50 MPa concrete, and demonstrate the strengths obtained through mechanical tests of axial compression and traction. by diametrical compression. With the purpose of showing the differences between the utilization rates of the concrete and steel sections, and exposing the real economy according to the SINAPI-BRA table of the state of Amazonas.

## II. BIBLIOGRAPHIC REFERENCES

The use of high strength concrete makes it possible to produce increasingly slender parts and other economic advantages, depending on the use. This paper aims to demonstrate the consumption of steel for a dimensioned building using 25 MPa and 50 MPa concrete, and then the cost comparison according to the SINAPI-BRA table. Demonstrate the traces for the resistances mentioned above through mechanical tests, in addition to the utilization rates of the concrete and steel sections.

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Sometimes the builder wonders if it is possible to reduce the steel consumption for the works, because it is one of the most expensive materials in construction.

### 2.1 Concrete

Concrete is a properly obtained mixture of cement, coarse fine aggregate and water. The various characteristics that it must present in order to be used depends fundamentally on the planning and care in its execution (2), (3).

It is a product or mass produced from the use of a cementing medium, which is the product of the reaction between a hydraulic cement and water, with aggregates fulfilling the cheapest filling paper. Its strength is influenced essentially by the components of this mixture and its degree of density, being considered the most important property especially for conventional concretes (4). It is noteworthy that they are very used concretes, since there are many applications in which the concrete with high water/binder ratio, but with a not so high compressive strength are still perfectly adequate and economical to the present times.

By definition Portland cement conventional concrete is a material composed of two distinct phases where the first and the cement paste, consisting of Portland cement and water, and the second the aggregates. The binder, which is cement, upon contact with water, develops binder properties as a result of hydration, which is the chemical reaction between cement minerals and water and, after some time, the combination hardens into a sturdy cluster (5), (6).

*Table 1. Strength classes of structural concretes*

| Resistance class Group I | Characteristic compressive strength (MPa) | Resistance class Group II | Characteristic compressive strength (MPa) |
|---|---|---|---|
| C20 | 20 | C55 | 55 |
| C25 | 25 | C60 | 60 |
| C30 | 30 | C70 | 70 |
| C35 | 35 | C80 | 80 |
| C40 | 40 | C90 | 90 |
| C45 | 45 | C100 | 100 |
| C50 | 50 | | |

*Source: NBR 8953: 2015*

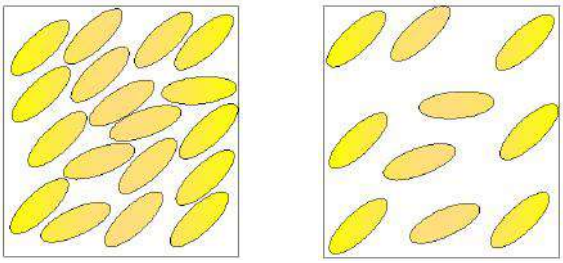
Conventional concrete is defined as that mixture that is produced using only cement, coarse aggregates and mints and water (3). In general, they are those produced on site, but can be manufactured in batching plants or concrete mixers. Their resistances are generally low, less than 30 MPa. In Brazil, most of the concretes used in construction are conventional or usual concretes.

ABNT NBR 8953 (2015) (7) classifies concrete in two groups, being group I conventional concrete, with resistances ranging from 20 MPa to 50 MPa, and group II categorized as high strength ranging from 55 MPa to 100 MPa, as shown. Table 1.

#### 2.1.1 High Strength Concrete

What makes a concrete very high-strength is its very low water / cement ratio, always below 0.35 and often around 0.25, up to 0.20, and that due to low factor a / c the compressive strengths easily reach values above 50 MPa. High strength concretes present in their compositions common aggregates, although of good quality; Common Portland cement, although initial high strength cement may be used when initial strength is a requirement, in high consumptions, between 450 and 550 kg / m³, generally between 5% and 15% of the total mass of cementitious material; possibly other cementitious materials such as microsilica, ash or granular blast furnace slag, and always a superplasticizer additive. The dosage of superplasticizer is high, between 5 and 15 liters per cubic meter of concrete, depending on the solids content of the additive as well as its nature. This dosage enables reductions in the amount of water in the order of 45 to 75 liters per m³ of concrete. Other additions may also be used, epoxy polymers, artificial aggregates such as calcined bauxite sand and steel fibers. High strength concrete should be able to be cast into the structure by conventional methods and cured in a normal manner, although a well-performed wet cure is required (2), (8).

For Barros (2016) (9) superplasticizers are high-effect water reducers, when carefully matched to cement make it possible to reduce the water / cement ratio in high-strength concretes to approximately 0.23 and still achieve an excellent initial level of rebounding between 100 mm and 200 mm. Polycarboxylic ether polymers have long side chains that deposit on the surface of cement particles, causing dispersion by electrostatic repulsion. Figure 1 presents the phenomenon of cement grain deflocculating.



(a) (b)

*Fig.1 - Effect of cement grain dispersion (a) flocculated (agglutinated) system (b) dispersed system*
*Source: AÏTICIN, JOLICOEUR and MACGREGOR (1994) (10)*

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High strength concrete has a high modulus of elasticity, as these two properties are related. The high modulus of elasticity is necessary to increase the stiffness of the building, reducing oscillation in the most intense winds. The construction of the Water Tower Place building in 1960 resulted in a shrinking of the lower floor pillar sections. It also significantly decreased the building's own weight by increasing its useful spaces. There was also a reduction in costs with prefabricated metal forms, as with the progressive reduction of the compressive strength of concrete on the upper floors, the forms could be used on all floors of buildings. Where the compressive strength of concrete has progressively decreased from 60 MPa at ground level to 30 MPa at the top of the building (11).

**2.1.2 Computational Programs in the Aid of Structure Calculation**

In the decades before the 1960s, structural designs were done manually, from conception to final detailing drawings. With the advancement of technology, several computational packages emerged, which streamlines and facilitates the elaboration of projects. Today in the market we have software capable of analyzing, dimensioning and detailing structures automatically. It is worth remembering that the software does not replace the engineer, the technology is here to add, increase production with regard to design. According to Kimura (2010) (12), there is no magic behind the computer screen, all output information is based on formulations drawn from consistent theoretical methods. There is several software for structural engineering in the market, in Brazil 3 integrated system software (calculates, scales and details) stand out from the others, they are: TQS, EBERICK and CYPECAD.

CYPECAD software is a Spanish program that is broadcast worldwide. Although not a Brazilian program, it has in its system the Brazilian standards (NBR 6118: 2014 - Design of concrete structures - procedures) (13), foundations (NBR 6122 - Design and execution of foundations) (14) , loading (NBR 6120 - Loads for calculating foundation structures) (15), bars (NBR 7480 - Steel for reinforcement for reinforced concrete structures - Specification) (16), winds (NBR 6123 - Forces due to wind in buildings) (17), actions and combinations (NBR 8681 - Actions and safety in structures - Procedure) (18), thus enabling its use.

The software uses to calculate the structure or the matrix method of stiffness, through a space hole consisting of pillars, beams and plates. Unlike TQS and EBERICK, or CYPECAD, it is used to determine the requirements of finite element methods (19), (20).

**2.1.3 Structural Analysis**

According to ABNT NBR 6118 (2014) (13) the principles of structural analysis are divided into determining the effects of actions based on the ultimate limit state (ULS) and the service limit state (SLS) and also establishing internal efforts and displacements. For Kimura (2010) (12), this is certainly the most important step in the elaboration of a structural project, because based on the results obtained by the structural analysis, the structural elements are dimensioned. ABNT NBR 6118 (2014) (13) lists five different types of structural analysis, which are: Linear Analysis, Linear Analysis with Redistribution, Plastic Analysis, Nonlinear Analysis and Analysis through Physical Models.

Structural analysis can be performed in separate elements, where we obtain stress and displacement values. When we talk about structural analysis of a building, it is necessary to adopt a certain structural model (numerical model). The structural model is nothing more than a prototype that simulates the real structure and important features such as boundary conditions, forces and connections between the structural elements. There are several types of structural models, among the best known are: continuous beam model, flat gantries, space gantries, grid model and finite element methods (FEM) (21), (22).

## III. MATERIALS AND METHODS

The building under study was a four storey building with a specific multifamily residential use, consisting of a ground floor, 3 floors with a ceiling height of 3.00 m, a four-roof ridge with a 1.80 m ridge, totaling a useful height. of the 13.80 m building, the total area of each floor is 290.07 m² in each floor, making a total built area of 1160.28 m². The structure is of the conventional type with slabs, beams, pillars, and reinforced concrete foundations, adopted as closing elements ceramic bricks and light frames. The project follows a simple architectural conception, since the objective is analysis of the structural design. Figures 2 and 3 below show the details of floor plans of the type floor and structural design of the building.

In possession of the Architecture projects and structural design conception, the launch and sizing were made in the CYPECAD 2017 software, which is a program for reinforced concrete structure design, precast structures, prestressed and mixed concrete and steel structures that covers the project launch phases, structural analysis and calculation, sizing and final detailing of the elements. Resources for detailing and dimensioning are in accordance with Brazilian Reinforced Concrete Standards (NBR 6118: 2014 - Concrete Structures Design -

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Procedures) (13), Foundations (NBR 6122 - Foundations Design and Execution) (14), Loading (NBR 6120 - Loads to calculation of foundation structures) (15), bars (NBR 7480 - Reinforced steel for reinforced concrete structures - Specification) (16), winds (NBR 6123 - Wind forces in buildings) (17), actions and combinations (NBR 8681 - Structural actions and safety - Procedure) (18).

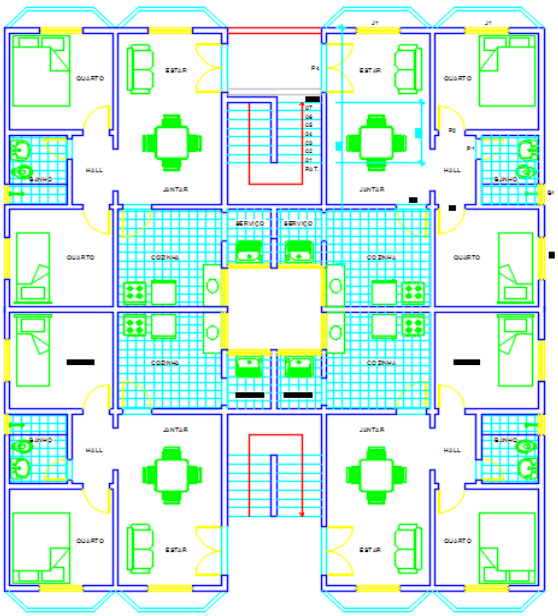

*Fig.2 - Detail of the floor plan of the building under study*
*Source: Data produced by the authors (2019).*

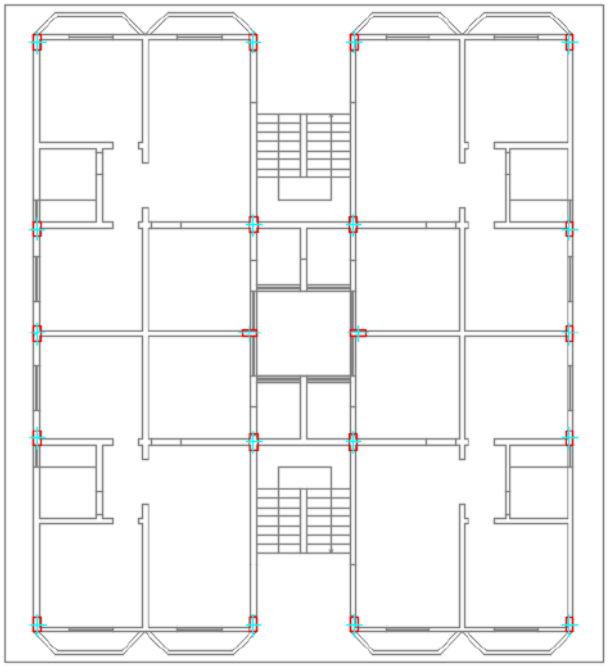

*Fig.3 - Detail of the structural design of the building under study.*
*Source: Data produced by the author (2019).*

The research methodology was divided into three phases:

**Phase one:** Mechanical tests of axial compression and traction by diametral compression were performed, which aimed the characterization of the materials, such as maximum diameter of coarse aggregate, compatibility of additives and additions involved in dosages of high strength concrete, greater than 50 MPa and strength. 25 MPa for later release in CYPECAD software.

The tests were performed according to ABNT NBR 5739 (2018) (23), and ABNT NBR 7222 (2011) (24) at the Construction Materials and Materials Resistance Laboratory of the Federal Institute of Education, Science and Technology of Amazonas - IFAM. Cylindrical specimens of 10x20 cm were molded, sulfur capped and tested on a universal electromechanical machine UMC 60T and 200T with the aid of global pavitest-UMC software, as shown in Figure 4.


*(a)* *(b)*

*Fig.4: Mechanical tests: (a) axial compression, (b) diametral compression traction.*
*Source: Source: Data produced by the authors (2019)*

**Second phase:** In this phase the launch and configurations of the commercial version CYPECAD 2017 program of fck 25 MPa were made for all the superstructure slabs, beams and pillars. Wind actions were considered in accordance with ABNT NBR 6123 of 2013 (17), where the characteristic wind speed adopted was 30 m / s, topographic factor for flat or slightly rough terrain of S1 = 1.0, factor S2 = 0,93 category IV and class A, while for S3 the factor considered was 1.00 for group 2. For the slabs was adopted thickness of 11cm (ABNT NBR 6118, 2014) (13), coating loads of 100kgf/m² and accidental 150kgf / m². The 16x50 cm section beams and 500 kff / m wall loads and disregard of the window and door spans had their dimensions compatible with the 20 x 40 cm pillars. The structural sizing scheme was calculated by the program considering the beams and columns as spatial frames using the finite element method. According to (ABNT NBR 6118, 2014) (13), 25 mm coverings were adopted for the slabs and 30mm for beams and columns, environmental aggressiveness class II. The CYPECAD software considers buildings as spatial frames, verifying

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their stability through the linkages of structural elements in their different considerations, as well as the analysis of second order effects is performed through the P-Delta process.

**Third phase:** In this phase the same launching considerations and program configurations as in the second phase of the research were maintained, changing to fck the concrete to 50 MPa, the 16x50cm beam sections compatible with the original Architecture and Design project. pillars in the dimensions of 20x40cm. With the results of concrete and steel obtained in the launches of the first and second phases, a cost survey was carried out comparing the two steps, through the unit costs table of the National Costs and Indexes Research System. of Civil Construction - SINAPI-BRA Amazonas 2019, issued by Caixa Econômica Federal in March.

## IV. RESULTS AND DISCUSSIONS

### 4.1 Mechanical Tests

Figure 5 presents the results of the consistency tests, which is the property of freshly mixed concrete, which indicates the viability with which it can be properly worked and cast without separation, and is measured using the conventional drop test. The fall cone slump test was the instrument used for the test that presented 100 mm and 85 mm for the concrete with strengths of 25 MPa and 50MPa respectively shown in Figure 4. It can be observed that the values of the slump for the resistances of 25 MPa and 50 Mpa were different, but were within the acceptable range for the projected (100 ± 20) .mm The decrease in slump observed in high strength concrete is related to the lower hydration of the mixture, as they contain lower water / binder ratio, 0.32 for high strength concrete and 0.58 for conventional concrete. The abatement was adjusted with the fluidizing additive for concrete at a ratio of 0.80% by mass of binder, Portland CP IV-32 cement and microsilica, which resulted in lower flowability for the mixture.

The compressive strength of each mixture was evaluated as a function of cure time at ages 7, 14, 21, 28 and 90 days. The average compressive stress results are listed in Figure 6, which shows the variation of compressive stresses for the different ages of disruption.

Figure 6 shows a progressive increase in resistance with increasing age, as expected, and a significant difference between them. When comparing the resistances for the ages of 7 and 90 days, we had a percentage increase of 291% and 257% respectively, demonstrating that they remained practically constant throughout all rupture ages.

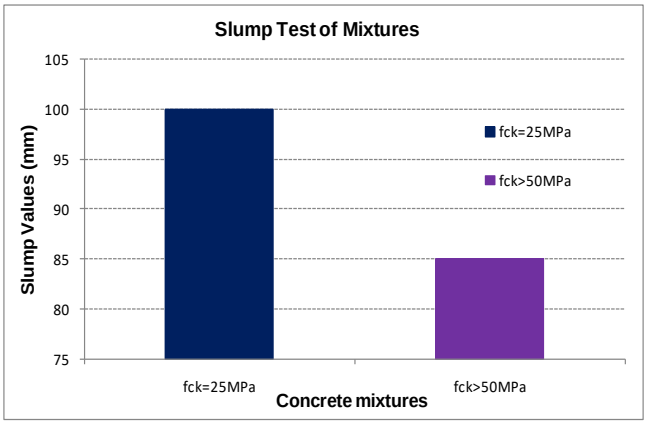


*Fig.5 - Result of consistency tests: fck-25MPa and fck>50MPa respectively.*
*Source: Data produced by the authors (2019).*

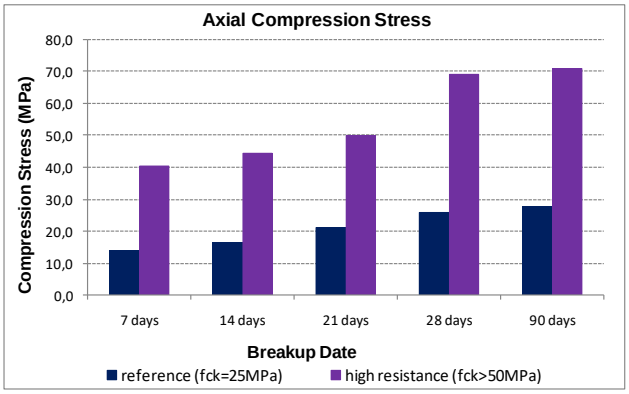


*Fig.6. Comparison of axial rupture compressive stresses of conventional and high strength concrete.*
*Source: Data produced by the authors (2019).*

### 4.2 Analysis of column performance

After the structural modeling of the building and the release of its permanent and accidental loads, we could reach the results of Table 2. It is worth mentioning that the structure was calculated using 25 Mpa and 50 Mpa Fck concrete for all structural elements except the foundations. in addition, we have narrowed the analysis of results of use only in columns, since they are structural elements that are mainly requested for compression, where they will have greater use with the use of a concrete with greater strength. Not least, the beams and slabs are structural elements that are subject to bending, among other efforts. Due to knowledge of Material Resistance and normative calculation procedures, these elements would not undergo significant changes with the increase of concrete strength, since they work mainly in traction regime.

The software calculates the elements and provides us with a utilization table (%), the closer to 100%, the greater the utilization of the section, that is, the element that has a low utilization rate is left with resistance. optimized for a

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smaller section of concrete and steel. For this research, the concrete sections of the structural elements were not optimized, so we could see the results from the utilization rates and the ratio of concrete area to steel area (Ac / As).

The following is a summary table showing the average of the abutment performance with the respective concrete classes, C25 and C50.

*Table 2: Analysis of all pillars*

| PILLARS | DIMENSION (cm) | CONCRETE (Fck) | Ac/As (%) | EFFICIENCY | | |
|---|---|---|---|---|---|---|
| | | | | Q(%) | N,M(%) | ADVANTAGE (%) |
| All | 20x40 | 25 Mpa | 1,08 | 32,23 | 69,61 | 70,54 |
| All | 20x40 | 50 Mpa | 0,77 | 19,56 | 48,3 | 48,8 |

*Source: Data produced by the authors (2019.*

According to Table 2, we can conclude that the pillars dimensioned with 50 MPa concrete resulted in a reduction of 21.74% regarding the utilization of the section, and consequently the Ac/As ratio fell from 1.08% to 0.77. % which translates to a certain steel economy.

**4.2.1 Specific analysis of use of pillar P1**

Table 3 shows the analysis of the 25 MPa and 50 MPa concrete verification rates for the P1 pillar, the results of shear stress analysis, normal stress and overall utilization, respectively. It has results in each element's bid, having different values for the top and bottom of the pillars.

As can be seen from Table 2, the overall utilization of the pillar at bid 2 was very close for both concrete classes. In this section the software dimensioned the abutment obtaining 8 steel bars of 12.5 mm for 25 MPa concrete, for 50 MPa concrete the software sized the abutment with a 25% reduction in reinforcement, i.e. 8 bars dropped to 6 12.5 mm bars. It can be stated that in the Type 2 pavement pillar throw the maximum utilization of the pillar was achieved for both the concrete section and the steel area. It is worth remembering that the P1 pillar is located in the corner of the building, being thus subjected to oblique compound flexion, where the utilization rate is not so significant, since the increase of resistance only presents considerable results in elements where its greatest demand is. the compression. Based on this information it is justifiable to approximate the utilization values.

*Table 3: Efficiency check for P1 pillar*

| CHECKING THE EFFICIENCY FOR THE PILLAR - P1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Concrete section | | | | | | | | |
| Part | Dimension (cm) | Position | Verifications 25 MPa | | | Verifications 50 MPa | | |
| | | | Q (%) | N, M (%) | Effec. (%) | Q (%) | N, M (%) | Effec. (%) |
| TYPE 3 (9 - 12 m) | 20x40 | Outer Superior | 23.3 | 26.6 | 26.6 | 37.0 | 34.1 | 37.0 |
| | | Lower External | 23.3 | 74.7 | 74.7 | 37.0 | 84.7 | 84.7 |
| TYPE 2 (6 - 9 m) | 20x40 | Outer Superior | 41.3 | 98.9 | 98.9 | 68.4 | 96.9 | 96.9 |
| | | Lower External | 41.3 | 93.1 | 93.1 | 68.4 | 92.8 | 92.8 |
| TYPE 1 (3 - 6 m) | 20x40 | 6 m | 6.5 | 93.1 | 93.1 | 12.1 | 92.8 | 92.8 |
| | | Outer Superior | 36.0 | 66.3 | 66.3 | 59.8 | 83.4 | 83.4 |
| | | Lower External | 34.7 | 62.3 | 62.3 | 57.8 | 79.7 | 79.7 |
| PILOTIS (0 - 3 m) | 20x40 | 3 m | 5.8 | 62.3 | 62.3 | 10.8 | 79.7 | 79.7 |
| | | Outer Superior | 19.0 | 44.5 | 44.5 | 30.5 | 67.5 | 67.5 |
| | | Lower External | 19.0 | 34.6 | 34.6 | 30.5 | 55.5 | 55.5 |
| LOWER BEAMS (-0.6 - 0 m) | 20x40 | 0 m | 3.6 | 34.6 | 34.6 | 6.7 | 55.5 | 55.5 |
| | | Outer Superior | 6.8 | 22.7 | 22.7 | 11.6 | 38.4 | 38.4 |
| | | Lower External | 6.8 | 22.7 | 22.7 | 11.6 | 38.4 | 38.4 |
| Foundation | 20x40 | Foundation | 2.1 | 22.7 | 22.7 | 4.1 | 38.4 | 38.4 |

*Source: Data produced by the authors (2019).*

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**4.2.2 Analysis of the most requested and least requested pillar**

Tables 4 and 5 show the utilization rates of the most requested and least requested pillars. This finding was obtained through the calculation memorial provided by the software. The most requested pillar was pillar P14, it is an intermediate pillar that is subjected to a normal force of 88.22 kN. The difference between the utilization rates for the two concrete classes was 30.59%.

*Table 4: Most requested pillar analysis*

| REQUESTED PILLAR ANALYSIS | | | |
|---|---|---|---|
| PILLAR | DIMENSION (cm) | CONCRETE (Fck) | EFFICIENCY (%) |
| P14 | 20x40 | 25 Mpa | 79,65 |
| P14 | 20x40 | 50 Mpa | 49,06 |
| EFFICIENCY RATE DIFFERENCE | | | 30,59 |

*Source: Data produced by the authors (2019)*

As shown in Table 5, the least requested abutment is P12 abutment; it is an end abutment subjected to a normal force of 38.95 kN. The difference between efficiency rates was 13.98%, we noticed that it was much smaller than the difference shown in Table 4.

*Table 5: Most requested pillar analysis*

| REQUESTED PILLAR ANALYSIS | | | |
|---|---|---|---|
| PILLAR | DIMENSION (cm) | CONCRETE (Fck) | EFFICIENCY (%) |
| P12 | 20x40 | 25 MPa | 53,26 |
| P12 | 20x40 | 50 MPa | 39,28 |
| EFFICIENCY RATE DIFFERENCE | | | 13,98 |

*Source: Data produced by the authors (2019).*

This difference is due to the location of the abutments in the plant, the most requested abutment (P14) is an intermediate abutment, therefore it is subjected to simple compression. much higher resistance to compression than to tensile strength. The least requested pillar (P12) is an end pillar, which is subjected to normal composite flexion due to eccentricity due to its location in the plant. It is subject to bending moment efforts which generates flexion. Thus, the use of the section proved to be much lower than that of the P12 pillar.

**4.3 Cost Analysis (Steel)**

Due to the increase of the concrete strength, a reduction in the amount of steel was obtained mainly for the columns, as we can see in tables 6 and 7.

*Table 6: 25 MPa Concrete Steel Value*

| VALUE 25 MPa | | | | |
|---|---|---|---|---|
| DESCRIPTION | UNITY | AMOUNT | UNIT PRICE (US$) | TOTAL PRICE (US$) |
| Slab Steel | Kg | 5817,00 | 1.55 | 9016.35 |
| Beams steel | Kg | 3928,00 | 1.55 | 6088.40 |
| Pillars steel | Kg | 2818,00 | 1.55 | 4367.90 |
| Stair steel | Kg | 585,00 | 1.55 | 906.75 |
| SUM OF ITEM | | | | (US$) 20379.40 |

*Source: Data produced by the authors (2019).*

As shown in Tables 6 and 7, the columns had a reduction of 811 kg of steel due to the increase in section. To compare these costs, we use the values available in the table SINAPI-BRA (National System of Costs Survey and Indexes of Construction) for the state of Amazonas in May. Concrete consumption was not compared because we did not choose to optimize the concrete sections of the columns, only the comparison of steel reduction. Comparing the data in tables 6 and 7, we arrive at savings of around US$ 1432.20 for 50 MPa concrete.

*Table 7: 50 MPa Concrete Steel Value*

| VALUE 50 MPa | | | | |
|---|---|---|---|---|
| DESCRIPTION | UNITY | AMOUNT | UNIT PRICE (US$) | TOTAL PRICE (US$) |
| Slab Steel | Kg | 5740,00 | 1.55 | 8897,00 |
| Beams steel | Kg | 3892,00 | 1.55 | 6032.60 |
| Pillars steel | Kg | 2007,00 | 1.55 | 3110.85 |
| Stair steel | Kg | 585,00 | 1.55 | 906.75 |
| SUM OF ITEM | | | | (US$) 18947.20 |

*Source: Data produced by the authors (2019).*

## V. CONCLUSION

With the dosages adopted for the concrete we obtained satisfactory indexes for the concrete consistency and its characteristic resistances. A consistency value of (100 ± 20) mm was projected, and the slump test reached a value of 100 mm and 85 mm for the 25 MPa and 50 MPa concretes respectively, concluding that it is within of the acceptable range that was designed. Compressive strength showed a progressive increase concomitantly with increasing ages. The dosages for 25 MPa were satisfactory reaching the expected resistance, for the high strength concrete it exceeded 70 MPa at 90 days.

Regarding steel consumption, a reduction of 811 Kg was achieved when using 50 MPa concrete. Referring to the values with the SINAPI-BRA table, considerable savings were achieved. The results are significant when comparing values related to columns, elements subjected to flexion and traction do not undergo major changes. It is worth noting that the savings are even greater when choosing to optimize concrete sections.

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# Experimental Study on Bio-Self Cured Marble Powder Based with M-25 Grade Concrete

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***Abstract*****—** *Water is most widely used in construction activity for first phase to mix material and final phase to curing. In first phase, we mix water in concrete to achieve workability. Without workability concrete cannot be used for construction. Curing is the most important phase for achieving strength. But now-a-days more problems for water because water is falling in its quantity in environment, so in place of water there an urgent requirement to find substitute to make concrete and for construction works. However, it is not possible to provide sufficient curing because of many causes like different environment, availability of water, fluorides and inattentiveness of human. In this way, it is necessary to invent the self-curing agents prepared by different method like using Biomaterials (Calatropis gigantea, Spinacea oleracea) and chemical admixture (polyethylene glycol) along with waste environmental material i.e. marble powder or dust. Hence, to reduce consumption of water, some admixtures i.e. marble powder, PEG-400, calotropis gigantea and spinacea oleracea were used in such manner so that there was no bad effect on workability, compressibility, split tensile strength, flexural strength of concrete. Marble powder is a by-product of stone industries and affects the environment badly, when thrown in an open area. In this way, 10% of marble powder used in place of cement was appropriate quantity in concrete. It is observed that concrete of M25 grade, mixing with 10% of marble powder and 1% of polyethylene glycol - 400 gives optimum result when compressibility, split tensile strength and flexural strength tests were performed and examined for 7 and 28 days.*

***Keywords*****— Bio-Self Cured Marble, M-25 Grade Concrete, PEG-400.**

## I. INTRODUCTION

Concrete plays a vital role in construction field because it can be found every region. Concrete is high rated construction material as it has high compressive strength and durability. Conventional concrete is a mixture of cement, fine aggregate, coarse aggregate and water required for workability and curing to achieve strength. The objective of internal curing is to provide water in the proper amount with a proper distribution so that the hydrating cementations paste remained moisturized and spontaneously stress free in its entire three-dimensional microstructure. In this study, it is recommended to use the marble powder in concrete construction as fractional replacement of cement. When water is added to cement, hydration occurs that is required for hardening of concrete. Since the ancient time, marble or marble stone are commonly used as a building material. Marble powder (very fine powder) make from the marble industries and disposed in environment that becoming hazardous materials. Marble powder is obtained by marble sawing and shaping. Concrete is prepared with marble powder by replacing some amount of cement. Practically virtuous curing of concrete is not possible in various cases due to absence of proper quality of water and various practical problems. In last two decades, concrete technology has been improving and implemented by some new techniques and methodology. By using admixtures, it is possible to prepare practically good concrete mixed with conventional constituents. Adding Some Self Curing agents, the internally cured concrete will be achieved.

**Advantages of Self Curing Concrete**

- Reduces autogenously cracking.
- self-curing
- Reduce the permeability.
- Increases mortar strength and early age strength enough to withstand strain.
- Greater utilization of cement.
- Lower Maintenances.

**Advantages of water reducing admixture:**

- Advantage of addition the admixture is to reduce water –cement ratio and obtained higher compressive strength by concrete with some workability.

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- When the admixture is mixed without reducing water-cement ratio, concrete can obtain higher workability at the same compressive strength.
- When admixture is added at lower cement content, compressive strength and workability remain same.

**Objective of Study**

- To Study of concrete mixes with conventional concrete with M-25 Grade.
- To study of concrete mixes with 10% marble powder-based concrete.
- To study of compressive strength of internal curing agent with spanicea oleracea, Calotropis Gigantea and Polyethylene Glycol-400 with marble powder-based M-25 grade concrete.
- To study of Split tensile strength of internal curing agent with spanicea oleracea, Calotropis Gigantea and Polyethylene Glycol-400 with marble powder-based M-25 grade concrete.
- To study of flexural strength of internal curing agent with spanicea oleracea, Calotropis Gigantea and Polyethylene Glycol-400 with marble powder-based M-25 grade concrete.
- To study about the property of natural bio self-cured gent effects on the concrete strengths.

## II. LITERATURE REVIEW

**General**

In this chapter we will discussed about the previous research and their results which were concluded by the researchers on the base of the material used in their experimental study.

### I. Spinacea oleracea and Calotropis gigantean (Self-curing agents)

R. Malathy[1] (2017) studied that Self-curing concrete is concrete that cured by itself with enough workability, strength and durability. A comparison is made between the dealing and settlement property of self-curing concrete by adding bio material named Spinacea oleracea and Calotropis gigantea and performance of self-curing concrete by using chemical is polyethylene glycol. 30% of fly ash is replaced by cement and check the workability, strength and durability of M20, M30 and M40 grade concrete. The most appropriate quantity of Spinacea oleracea, Calotropis Gigantea and PEG was taken respectively as 0.6%, 0.24%, and 0.3% of cement weight. Performing slump test, a minimum variation is determined between the self-cured concrete and conventional concrete. Observing strength activity index of conventional cured concrete, it is found more than 1 and 1.15 after 28 days and 56 days respectively due reaction of fly ash. However, the durability of concretes results positive in aggressive environment like chloride, sea water and acid attack as well as encouraging bio self-cured concrete, eco-friendly, economical and high-performance materials.

## III. POLYETHYLENE GLYCOL-400 (SELF-CURING AGENTS)

Kumar[2] et al. (2012) investigate that now-a-days concrete is the most usable material for construction because of its good compressive strength and durability. Considering type of work, plain concrete is prepared by mixing, coarse aggregate, fine aggregate, cement and water in a specific ratio. It is necessary to remain favorable atmosphere for plain concrete to acquire desired strength by providing water content or minimum duration of 28 days so that a good hydration can take place. Strength and durability of concrete can be affected by indolence in curing procedure. In this way, self-curing concrete is the most favorable concrete in term of enhancing hydration that is affected by inadequate curing because of inattentiveness of human towards curing, poor availability of water in dry areas, unreachable. Construction site or terrains and existence of fluorides in water which have a bad impact on concrete properties. In this study an admixture named polyethylene glycol (PEG-400) was used in concrete. This is a shrinkage reducing material that helps to obtain desired strength because of good hydration. The study consisting of PEG-400 at different percentage i.e. 0% to 2% by weight of cement and effect of this admixture on compressive strength, modulus o rapture and split tensile strength were investigated or M20and M40 grade concrete. As a result, it was got to know that PEG-400 is a good self-curing compound that helps concrete to acquire good strength by conventional curing. It was also investigated that 1% o PEG-400 by weight of cement was the best quantity forM20, whereas 0-5% was the best quantity or M40 grade concrete. Using optimum proportions o PEG- 400 helps to achieve highest strength without affecting workability of concrete.

**Heiza[3] et al. (2019)** experiment that self-curing of concrete is important in construction activity in term of lack of water. Purpose of this study was to consider the application of concrete with new admixture to obtain self-curing concrete. In this study polyethylene glycol-400 was used as a shrinkage reducing admixture that performed good as a self-curing compound by providing good hydration and to obtain good strength. The study was depending on compressive strength, split tensile strength, water retention and modulus of rapture effected by changing percentage i.e. 0% - 1% of compound (PEG-400)

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by the weight of cement in M1 and M2 mixes. It was observed by study that PEG-400 could be a good option as a self – curing agent for acquiring good strength. It was also got to know that the optimum percentage of PEG – 400 by the weight of cement was 0.5%. It was suitable for both type of mixes M1 and M2.

Marble Powder (Replacement of Cement)

**Aruntas[4] et al. (2010**) study is based on utilization of waste marble dust (WMD) while mixed in cement as on additive material and results were investigated waste marble dust (WMD) was crumbled (grinded) with Portland cement clinker to obtain waste marble dust cement (WMDc). The proportion of WMD and Portland cement clinker were different i.e. 2.5%, 5.0%, 7.5% and 10% by weight. Obtained cement produce mortar prisms of 40 40- and 160-mm. Strength of mortar specimen was tested a different duration i.e. 7, 28 and 90 days. Considering physical, mechanical and chemical properties of CEM I and CEM II, WMDCs have been compared with one another. It was clarified with recorded results that WMDCs follow toEN-197-1 standard. In this way, 10% WMD is optimum quantity to be utilized in cement production in the form of an additive material.

**Bhanushali[5]** et al. (2018) utilized that marble industry produces large amount of marble waste during mining and processing phases. This waste is dumped onto open huge land which creates a lot of environmental problems Industrial wastes like fly ash, rice husk, marble dust, etc. are found to be an efficient alternative for cement as their composition are identical as that of cement & in particular, they produce less heat of hydration. This review will deploy the use of marble waste powder against cement and sand at many proportions along with material like silica fume in mix.

## IV. METHODOLOGY & RESULTS DISCUSSION

### General

In this study, we discussed about the physical properties of material used. We are using marble powder as a replacement in cement concrete. Vegetation Calotropis Gigantea, spinacia oleracea and a compound named PEG-400 are used as self - curing agents in concrete. We are going to conduct workability test, compressive strength test, split tensile strength test and flexural strength test for checking all above experiment related properties of concrete.

### Cement

*Physical Properties of Ordinary Portland Cement -43 Grade*

| S.No. | PROPERTIES | RESULTS |
|---|---|---|
| 1 | Fineness | 6% |
| 2 | Specific Gravity | 3.10 |
| 3 | Standard Consistency | 37% |
| 4 | Initial Setting Time (In Minutes) | 28 |
| 5 | Final Setting Time (In Minutes) | 285 |

### Marble Powder

*Physical Properties of Marble Powder*

| S.No. | Properties | Marble powder |
|---|---|---|
| 1 | Specific Gravity | 2.98 |
| 2 | Bulk density (kg/m$^3$) | 1300-1500 |
| 3 | Fineness modulus (cm$^2$/g) | 5100-5250 |
| 4 | Water absorption % | 22-24 |

*Slump Test for Workability*

| Mix Design | Slump Value |
|---|---|
| $M_O$ | 85 |
| $M_1$ | 87 |
| $M_2$ | 100 |
| $M_3$ | 90 |
| $M_4$ | 95 |
| $M_5$ | 110 |

*Result of Compressive Strength on Cubes*

| Mix | Description | Compressive Strength(N/mm$^2$) for M-25Grade (7 Days) | Compressive Strength(N/mm$^2$) for M-25 Grade (28 Days) |
|---|---|---|---|
| M0 | Conventional | 36.29 | 38.51 |
| M1 | 10% Marble Powder | 30.51 | 31.55 |
| M2 | 10% Marble Powder + 1% Polyethylene glycol-400 | 40.44 | 41.47 |
| M3 | 10% Marble Powder + 0.6% Spinacea Oleracea | 37.69 | 42.22 |
| M4 | 10% Marble Powder + 0.25% Calotropis Gigantea | 38.81 | 41.48 |
| M5 | Mix-up | 29.55 | 32.29 |

*Result of Split Tensile Strength on Cylinder*

| Mix | DESCRIPTION | Split Tensile Strength(N/mm$^2$) for M- | Split Tensile Strength(N/mm$^2$) for M-25 |
|---|---|---|---|

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| | | 25Grade (7 Days) | Grade (28 Days) |
|---|---|---|---|
| M0 | Conventional | 3.62 | 4.06 |
| M1 | 10% Marble Powder | 3.53 | 4.31 |
| M2 | 10% Marble Powder + 1% Polyethylene glycol-400 | 3.65 | 4.33 |
| M3 | 10% Marble Powder + 0.6% Spinacea Oleracea | 3.91 | 3.96 |
| M4 | 10% Marble Powder + 0.25% Calotropis Gigantea | 3.48 | 3.53 |
| M5 | Mix-up | 2.83 | 3.13 |

*Result of Flexural Strength on Beams*

| Mix | DESCRIPTION | Flexural Strength( N/mm$^2$) for M-25Grade (7 Days) | Flexural Strength(N/mm$^2$) for M-25 Grade (28 Days) |
|---|---|---|---|
| M0 | Conventional | 19.06 | 25.86 |
| M1 | 10% Marble Powder | 18.42 | 19.76 |
| M2 | 10% Marble Powder + 1% Polyethylene glycol-400 | 20.28 | 25.33 |
| M3 | 10% Marble Powder + 0.6% Spinacea Oleracea | 17.14 | 27.10 |
| M4 | 10% Marble Powder + 0.25% Calotropis Gigantea | 21.22 | 24.46 |
| M5 | Mix-up | 17.7 | 22.65 |

## V. CONCLUSION

**General**

As a conclusion of this study it is cleared that bio-materials give better results in workability and strength when mixed as self-curing agents in concrete of M25 grade along with marble powder. These agents (Spanicea oleracea, Calotropis gigantean and polyethylene glycol) can be mixed in different construction works like pre-stressed, highway construction, RCC works, water tanks etc. to reduce curing and enhance workability and strength.

**Compressive strength test**

Usage of marble powder in concrete improved the compressive strength and the value of compressive strength was found different for different curing duration. It was evaluated 30.51 N/mm$^2$ for 7 days curing and 31.55 N/mm$^2$ for 28 days. When PEG-400, spinacea oleracea and calotropis gigantea were used as self-curing agents, they provided better compressive strength to the concrete. Computation of compressive strength was found 40.44, 37.69 and 38.81 N/mm$^2$ for PEG-400, spinacea oleracea and calotropis gigantea respectively. This value was determined after 7 days curing. Determined compressive strength value after 28 days curing was 41.47, 42.22 and 41.48 N/mm$^2$ for PEG-400, spinacea oleracea and calotropis gigantea respectively.

When all the self-curing agents were mixed together in marble powder-based concrete, the strength of conventional concrete.

**Split Tensile Strength**

When marble powder is mixed in concrete as additional material, split tensile strength of concrete was found good. It was obtained 3.53 N/mm2 for 7 days curing and 4.31N/mm2 for 28 days curing. Spinacea oleracea and calotropis gigantea were used as self-curing agents and they both have a good impact on split tensile strength. While using spinacea oleracea, split tensile strength of concrete was found 3.91 N/mm2 and 3.96 N/mm2 respectively for 7 days and 28 days curing. When calotropis gigantea was mixed in concrete, the result of split tensile strength was obtained 3.48 N/mm2 and 3.53 N/mm2. That was according to 7 days curing and 28 days curing respectively. Additionally, PEG-400 was also used as an admixture, then split tensile strength was found 3.65 N/mm2 and 4.33 N/mm2 for 7 days curing and 28 days curing respectively.

The result of split tensile strength of concrete was not good when all the admixture was mixed together in concrete. That showed less split tensile strength than that of conventional concrete.

**Flexural Strength**

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In concrete, marble powder was used as a replacing agent of cement while PEG-400, spinacea oleracea and calotropis gigantea were used as self-curing agents. Flexural strength for all the admixtures was found good and different for different curing duration. Flexural strength on concrete with marble powder was 18.42 N/mm2 and 19.76 N/mm2 respectively for 7 days and 28 days curing. When PEG-400, spinacea oleracea and calotropis gigantea were mixed in concrete, flexural strength was obtained 20.28 N/mm2, 17.14 N/mm2 and 21.22 N/mm2 respectively for 7 days, while 25.33 N/mm2, 27.10 N/mm2 and 24.46 N/mm2 respectively for 28 days curing. Though, flexural strength was found less than that of conventional concrete when all the additional agents were mixed together in the concrete.

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# Scientific evidence and technocracy as a public policy for the increase in the availability of ICU beds in Brazil: A systematic review

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***Abstract*—Objective:** *To identify studies and collect data from the studies that resulted from the analysis of variables that generated quality indicators in intensive care, with the increase in length of stay, care costs and mortality rate, aiming to explain scientific and technocracy criteria as a public policy for patient admission, sedation protocols and infection control as a direct or indirect way, to ensure greater supply of ICU beds.* **Method:** *This is a Systematic Literature Review that sought scientific articles, in Portuguese and English, in the Medline, Cochrane, Capes Journal Portal, Latin American and Caribbean Center for Information in Health Sciences - Bireme, Latin American and Caribbean Literature in Health Sciences - Lilacs and Scientific Electronic Library Online - Scielo. It was set out of the following steps: location of the studies by reading the titles and abstracts, careful reading of the abstracts of the pre-selected articles, selection of articles consistent with the objective of the present study, application of the Jadad scale [1], to evaluate the methodological quality and exclusion of randomized articles with a score of less than three points in it, interpretation and discussion of the results.* **Results:** *Eliminated duplicity of the search resulted in 269 scientific articles. The inclusion criteria remained 33 references, of these 10 were evaluated for theoretical basis and 23 that met the above recommendations and evaluations. The data from these studies show a close relationship between the adoption of criteria for patient admission, sedation protocols and infection control.* **Conclusions:** *Evidence found in the studies shows that the application of evidence-based medicine in the management of public health policies, especially in intensive care units, can corroborate better quality indicators, with higher bed supply and, consequently shorter waiting time, lower mortality rate and lower costs.*

***Keywords*—Intensive Care Unit, Admission of patients, Sedation Protocols, Infection control, Length of stay, Welfare costs, Mortality rate.**

## I. INTRODUCTION

Tertiary health care refers to high complexity care systems for the user whose monitoring is done at the expense of high technological density [2]. At this level of care, according to the computer department of the Unified Health System of Brazil [3], were spent R$ 24.165.927.467,87 (twenty-four billion, one hundred and sixty-five million, nine hundred and twenty-seven thousand, four hundred and sixty-seven and eighty-seven cents) from May 2011 to April 2016 in Brazil. According to Ribeiro (2009) [4], in tertiary care, the intensive care unit (ICU) is currently one of the most complex scenarios in care.

Evidence-based management began in the health area around the 19th century when it came to the conclusion that doctors should be guided based on coherent research [5].

In recent times it has been constantly reported, in newspapers of great circulation the lack of vacancies available in this sector. This is due to the constant increase in the life expectancy of Brazilians [6] which proportionally concerns an increase in the incidence of chronic diseases, especially cardiovascular and metabolic diseases [7]. According to Rufino (2012) [8], age is directly proportional to the length of hospitalization, which indirectly reduces the availability of beds.

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In 2008, the Federal District Government reported an average of up to 30.9 days of staying in the ICUs of its public hospitals. Oliveira (2010) [9] in a study conducted in Campinas (São Paulo) with 401 patients, highlighted that 97.3% have a prolonged stay rate in ICUs, that is, a time longer than or equal to 7 days.

Adding to the current crisis in the availability of vacancies in tertiary care and problems related to prolonged stay in ICUs as a higher incidence of infection rate [10, 11] and high costs [12], public policies based on scientific evidence focused on reducing length of stay and reducing costs in this sector can bring greater supply of beds to the population without investment in the construction of new units and ensure better allocation of financial resources. According to data from the CNES (National Council of Health Establishments), an agency linked to the Ministry of Health, in 2015 [13] Brazil accounted for a total of 40,960 (forty thousand nine hundred and sixty) ICU beds (Table 1) and had a total population, of according to data from IBGE (Brazilian Institute of Geography and Statistics) [6], 204,450,649 (two hundred and four million, four hundred and fifty thousand and forty-nine) inhabitants, reaching a proportion of 1.86 beds per 10,000 inhabitants, or, 18.6 beds per 100,000 inhabitants.

*Table 1– Number of ICU beds in Brazil in 2015*
*Source: CNES/MS, prepared by the Federal Council of Medicine. [13]*

| Region / UF | Population[1] | ICUs beds | Total Beds Ratio (%) | Beds / 10,000 Inhabitants |
|---|---|---|---|---|
| **Northern Region** | **17.472.636** | **2058** | **5,0%** | **1,18** |
| Rondônia | 1.768.204 | 270 | 0,7% | 1,53 |
| Acre | 803.513 | 73 | 0,2% | 0,91 |
| Amazonas | 3.938.336 | 463 | 1,1% | 1,18 |
| Roraima | 505.665 | 48 | 0,1% | 0,95 |
| Pará | 8.175.113 | 964 | 2,4% | 1,18 |
| Amapá | 766.679 | 50 | 0,1% | 0,65 |
| Tocantins | 1.515.126 | 190 | 0,5% | 1,25 |
| **Northeast Region** | **56.560.081** | **7332** | **17,9%** | **1,30** |
| Maranhão | 6.904.241 | 632 | 1,5% | 0,92 |
| Piauí | 3.204.208 | 323 | 0,8% | 1,01 |
| Ceará | 8.904.459 | 1035 | 2,5% | 1,16 |
| Rio Grande do Norte | 3.442.175 | 570 | 1,4% | 1,66 |
| Paraíba | 3.972.202 | 506 | 1,2% | 1,27 |
| Pernanbuco | 9.345.173 | 1726 | 4,2% | 1,85 |
| Alagoas | 3.340.932 | 487 | 1,2% | 1,46 |
| Sergipe | 2.242.937 | 363 | 0,9% | 1,62 |
| Bahia | 15.203.934 | 1690 | 4,1% | 1,11 |
| **Southeast region** | **85.745.520** | **22200** | **54,2%** | **2,59** |
| Minas Gerais | 20.869.101 | 3976 | 9,7% | 1,91 |
| Espírito Santos | 3.929.911 | 970 | 2,4% | 2,47 |
| Rio de Janeiro | 16.50.024 | 5985 | 14,6% | 3,62 |
| São Paulo | 44.396.484 | 11269 | 27,5% | 2,54 |
| **Southern Region** | **29.230.180** | **5995** | **14,6%** | **2,05** |
| Paraná | 11.163.018 | 2619 | 6,4% | 2,35 |
| Santa Catarina | 6.819.190 | 1046 | 2,6% | 1,53 |
| Rio Grande do Sul | 11.247.972 | 2330 | 5,7% | 2,07 |
| **Central-west Region** | **15.442.232** | **3375** | **8,2%** | **2,19** |
| Mato Grosso do Sul | 2.651.235 | 363 | 0,9% | 1,37 |
| Mato Grosso | 3.265.486 | 668 | 1,6% | 2,05 |
| Goiás | 6.610.681 | 1273 | 3,1% | 1,93 |
| Distrito Federal* | 2.914.830 | 1071 | 2,6% | 3,67 |

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| | | | | |
|---|---|---|---|---|
| **Total** | **204.450.649** | **40.960** | **100%** | **1,86** |

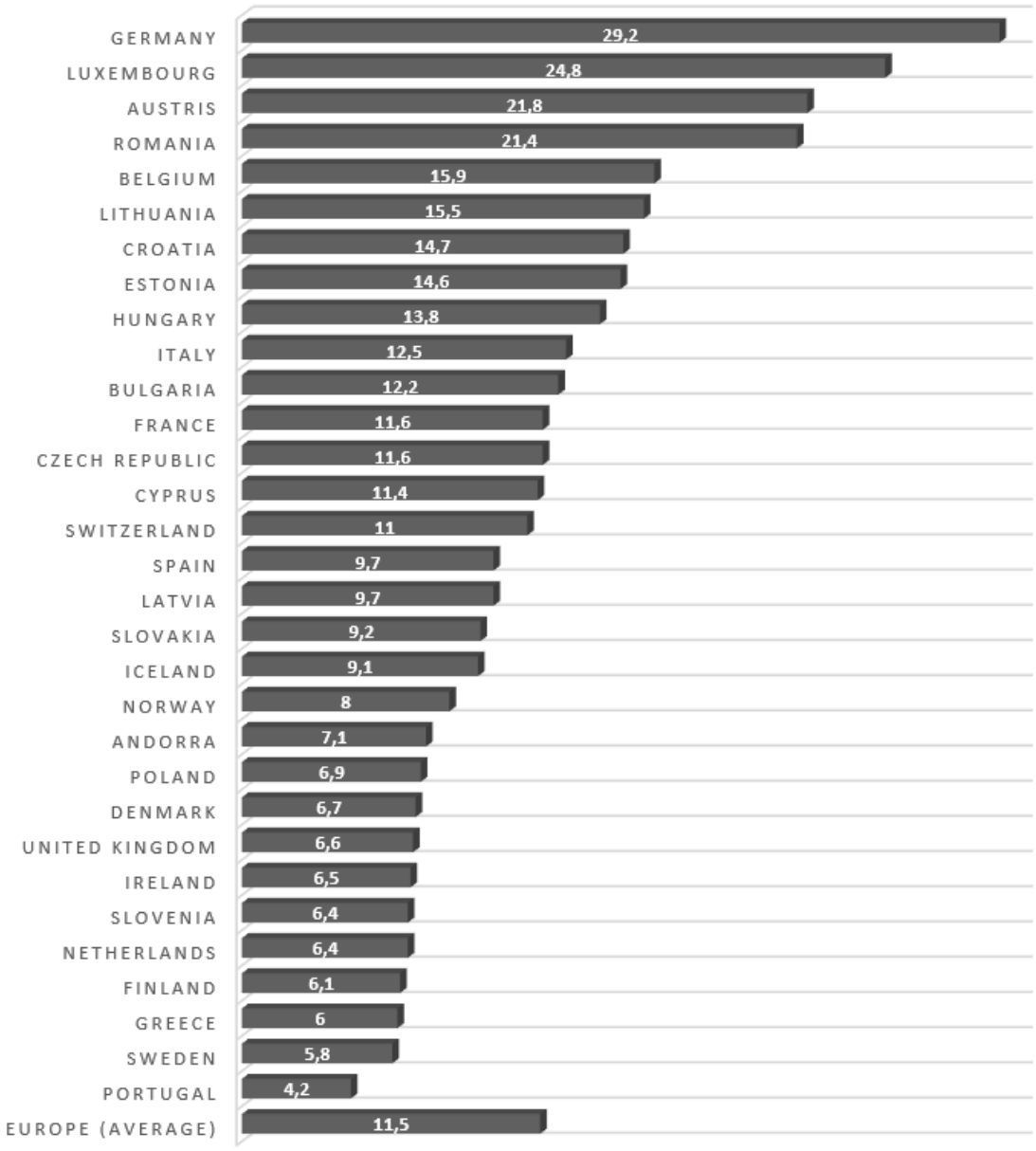


*Fig.1 - Proportion of ICU beds in Europe to 100,000 inhabitants in 2012*
Source: Rhodes et al., Rev. Intensive Care Medicine [14]

In this plane, comparatively, in 2012, Rhodes et al. [14] published a study entitled The variability of critical care bed numbers in Europe, where results showed that in economically developed countries such as France, Switzerland, Norway, and Sweden, the number of beds per 100,000 inhabitants is lower than Brazil (Figure 1), as well as the average and proportional number of ICU beds throughout Europe, which has accounted for a ratio of 11.5 beds/100,000 inhabitants, against 18.6 in Brazil, which reinforces, in addition to the quality of primary care, the context of primary care, the context of efficiency of the services offered in the current scenario of tertiary care.

Based on these data, we can infer that evidence-based management and a technocratic model, which was one of the supposed widespread in the 19th century that, "thanks to science, humanity could get rid of politics" [15], where science was considered the mastery of logic and reason, while politics was the orbit of emotion and passion.

It is possible that a change in the profile of current management of public health policies is necessary, especially in tertiary
care, since the 1970s, when British teacher Archibald Cochrane published the book “Effectiveness and

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efficiency: Random reflections on health services", medical interventions and diagnostic models have stopped based on personal experiences and began to rely on evidence, or rigorous scientific evidence, with the commitment to explicit and honest search to guide decision making [16]. Perhaps, a change in the current scenario of political health management is necessary, seeking for public administration the concepts of science and technocracy, in order to detail the ills of the Brazilian unified health system. Therefore, this systematic review aims to collect data from studies that resulted in the analysis of variables that generated worse indicators of quality in intensive care, with the increase in length of stay, care costs and mortality rate, the that, directly or indirectly, when prevented, can generate greater efficiency of services and increase the supply of vacancies in Brazilian ICUs.

## II. MATERIALS AND METHODS

This is a systematic review of the literature. The scientific articles for the elaboration of the same were selected in the Medline, Cochrane, portal of capes journals, Latin American and Caribbean Center for Information in Health Sciences - Bireme, Latin American and Caribbean Literature in Health Sciences - Lilacs and Scientific Electronic Library Online - Scielo, in Portuguese and English, using Portuguese-language descriptors: *Unidades de Terapia intensiva*, *Tempo de permanência*, *Infecção Hospitalar*, *Sedação profunda*, *mortalidade*, *Avaliação da Qualidade dos Cuidados de Saúde e Análise Custo-Eficiência*, contained in the DeCS (Descriptors in Health Sciences) and English-language descriptors: Intensive Care Unit, Lenght of stay, Hospital infection, Deep sedation, mortality, Quality Assessment of Health Care e Cost Efficiency Analysis, all contained in MeSH (Medical Subject Headings).

The inclusion criteria defined were randomized, epidemiological and/or clinical trial that had as inclusion criteria the data approach of patients who remained in ICU, free or paid who address technical data that can increase the number of vacancies and/or that decrease the length of stay of patients and be written in English or Portuguese. Articles that did not obtain statistical significance in the results by theoretical saturation were excluded. Articles were not deleted based on the publication date.

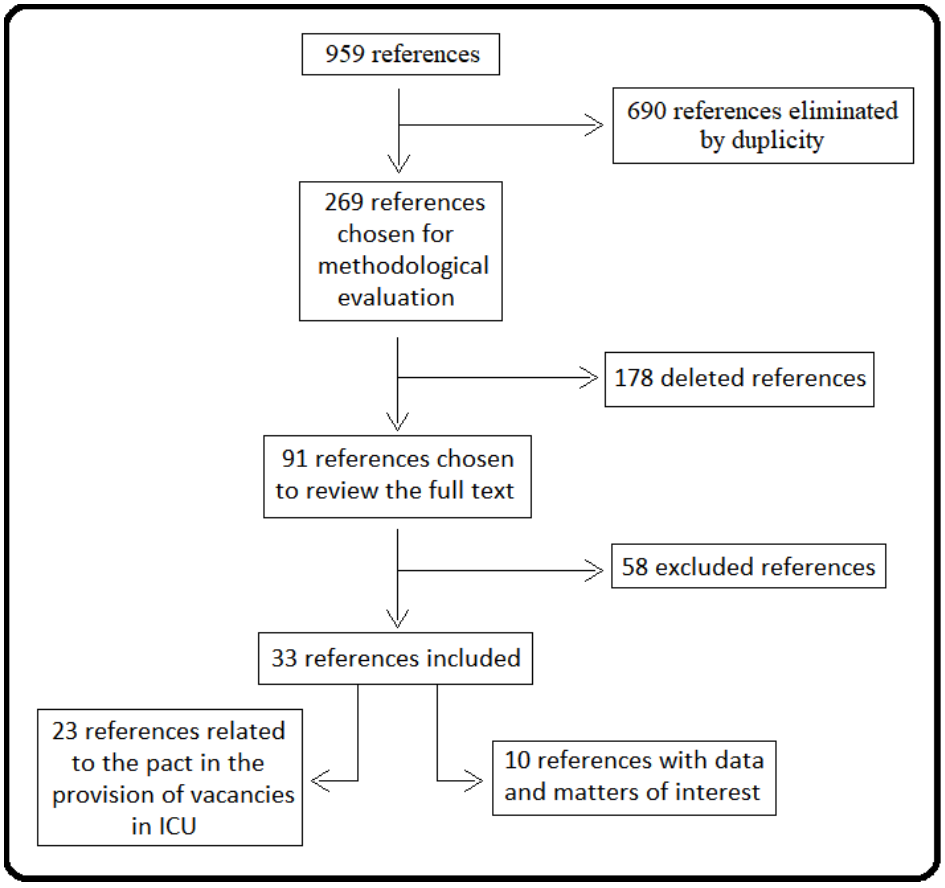


*Fig.2 - Diagram of the selection flow of articles*

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The research was developed through the PRISMA recommendation [17] and consisted of the following steps: location of studies by reading the title and abstract, careful reading of the abstract of the pre-selected articles, selection of articles consistent with the objective of the present study, application of the *Jadad* scale [1] to evaluate the methodological quality and exclusion of randomized articles with a score of less than three points in it, interpretation and discussion of the results.

Initially, 959 articles were found that met the descriptors used, however, only 33 references were selected, where 10 were evaluated for theoretical basis and 23 met the above recommendations and evaluations, as Figure 2.

The present work did not need to be submitted to the ethics committee in research, according to resolution 466/12, because it does not have as its participant the human being, in its entirety or in parts, and does not involve it directly or indirectly, including the management of its data, information or biological materials.

## III. RESULTS AND DISCUSSION

### ADMISSION OF ICUS PATIENTS

In 1999, the Society of critical care medicine [18] published guidelines for admission of ICU patients, dividing them into four criteria-based priorities, where patients with priority 1 (top priority) are those without any limits for therapeutic intervention and who usually require vasoactive drugs and/or ventilatory support, priority 2 patients are those who need continuous monitoring, also without any limitation to therapy and may require immediate interventions. Patients with priority 3 are those with a low probability of recovery and with limits on therapeutic intervention as patients without indication for orotracheal intubation or cardiopulmonary resuscitation. Patients 4 were allocated into 2 groups: 4A - those who may have little or no benefit of being admitted to the ICU as hemodynamically stable with ketoacidosis congenital heart failure, overdose or undergo peripheral surgeries. 4B - Patients with a terminal disease such as irreversible brain injury, multiple organ failure, metastatic cancer without response to chemotherapy, and/or radiotherapy, patients in a vegetative state who are in a permanent state of unconsciousness.

Based on these priorities, the Federal Council of Medicine published resolution No. 2,156 on November 17, 2016, in the Official Gazette, which establishes the criteria for admission and discharge in intensive care.

According to a survey by Caldeira *et al.* (2010) [19] held in a tertiary hospital where the outcome of 359 patients admitted to ICU and related to their priority level, based on the guidelines of the American Society of Intensive Care, it was observed that the average permanence of patients with priority 4 was 28.8 days, against only 7.6 and 4.4 of the patients with priorities 1 and 2, respectively. Furthermore, the mortality rate among patients with priorities 3 and 4 was higher than 80%.

The lack of criteria for admission of patients in ICU can lead to reduced bed supply for patients who can potentially benefit from intensive care for life support, and reduce bed waiting in this population.

In 2016, Garcia-Gigorro [20] analyzed the impact of patients waiting in the emergency sectors by ICU beds, where 269 patients were included in the study for a period of 18 (eighteen) months. It was verified that 48% of patients remained in the emergency room waiting for an ICU vacancy for more than 5 hours and that they had a chance of death increased by 2.5 times due to time-dependent complications.

A cohort study conducted by Cardoso in 2011 [21] with 401 patients concluded that for each hour of waiting for an ICU vacancy, the risk of death increases by 1.5%.

Regarding the length of stay related to the level of priority for admission, Sinott et al. (2014) [22] in a retrospective study evaluating 8,973 (eight thousand, nine hundred and seventy-three) patients admitted to the ICU, found significant differences that correlated these factors.

### ICU STAY TIME

Another important factor in this reduction of vacancies in ICU is the length of stay of patients admitted to this sector, in a randomized study conducted by Strom *et al.* in 1999 [23], where patients under mechanical ventilation who remained sedated were divided and compared with those who remained without sedation, it was observed that the ICU stay of those who remained under sedation was 22.8 days, against 13.1 days of those who remained without sedation.

In a meta-analysis developed by Junior & Park (2016) [24] where they analyzed the results of studies that compared the length of stay of patients in mechanical ventilation who underwent a sedation protocol against those undergoing only daily interruption of the same was observed a shorter duration of the days in mechanical ventilation of the groups submitted to the sedation protocol in relation to those who had only sedation interrupted once a day.

One of the causes of longer stay-related sedation is the diaphragmatic dysfunction that the same cause in patients under ventilatory support, Demoule *et al.* (2016)

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[25] in a prospective cohort study noted that 79% of patients under mechanical ventilation developed diaphragmatic dysfunction, which potentially increased the time required for ventilator weaning due to muscle inefficiency for the development of spontaneous breathing.

In addition to diaphragmatic dysfunction, prolonged sedation may also develop delirium in intensive care patients. In 2001, Ely et al. [26] evaluated 48 patients who received midazolam, and evaluated (through diagnostic statistical manual IV - DSM-IV) than of these, 39 (81.3%) developed delirium, and that it was a strong determinant for the increase in their length of stay in relation to the group that did not develop delirium.

Another important factor that prolongs the length of stay of patients in ICU (in addition to increasing costs) are hospital infections. Dal Forno et al. (2012) [27] compared the length of stay and costs of ICU patients who had hospital infection with those who did not develop, and the results showed that the group with hospital infection remained about 10.5 days longer in the ICU, and their costs were about $65,993 (sixty-five thousand and nine hundred and ninety-three) dollars higher than the group that had no infection during the stay in the unit.

According to the survey by Chacko *et al.* (2017) [28], where it evaluated the incidence of ICU-acquired infection of 499 patients, the presence of infection doubles the hospital costs of these patients, in addition to increasing the average length of stay from 12.4 to 21.8 days.

The analysis of this review about the presence of hospital infection with the length of stay can be observed in Figure 3.

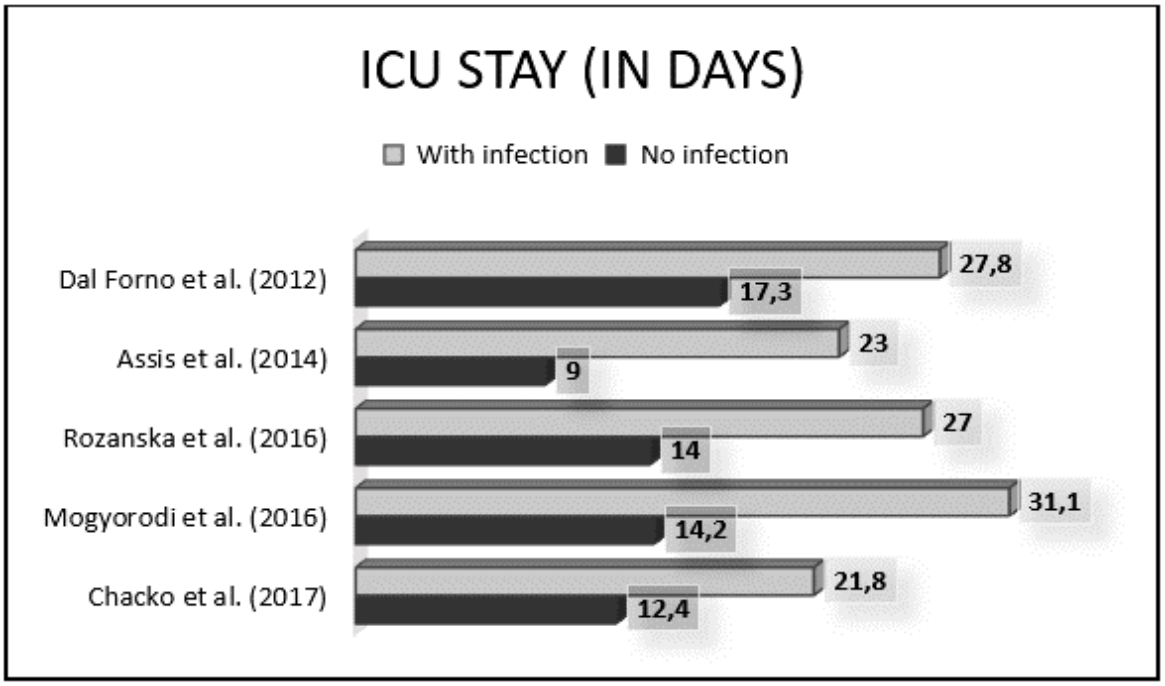


*Fig.3 - Comparison of the average length of stay in the main studies collected*

With databases in these data, the adoption of criteria for the admission of patients, sedation protocols and infection control can, directly and indirectly, ensure a greater supply of ICU beds.

## IV. DISCUSSION

The last date of the National Register of Health Establishments (CNES-DATASUS) [13,3] describes that Brazil has almost 41,000 tertiary care beds, but only 25.2% are maintained directly by public management. In any case, based on Articles 5 and 196 of the Federal Constitution and also provided for in federal law 8,080/90, in the absence of a vacancy in a public hospital, it is the duty of the State to adopt measures to ensure care and the right to life, either through hospitalization and the cost in the private network.

Even with all the investment in ICU beds, most Brazilian regions lack vacancies in this type of health care, even though studies denote that the proportional number of beds in Brazil exceeds that of many developed countries.

This lack of ICU vacancies, which today is a major public health problem that spreads throughout the national territory, considerably increases the rate of

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morbidity and mortality due to slowness in the transfer and regulation of severe patients for tertiary care.

Also, According to Lemos de Sá (2015) [12] in a paper presented in the annans of the IV International Symposium on Project Management, Innovation and Sustainability, the costs of a daily ICU, accounting for exams, medicines and direct labor, reaches the amount of R$ 3,864,86. Therefore, it becomes a determining value within the current concept of decentralization of the SUS (Single System of Health) (SPEDO, 2009) [29] and in the face of the current financial crisis of the Brazilian states.

It is observed in the studies analyzed that priority criteria for admission of patients to the ICU may lead to the lower occupation of them since there is still a large percentage of patients admitted without life prognosis (criterion 4B) and/or without the need for intensive care or severity (criterion 4A).

Another important point of this research was that variables related to ICU-acquired infection and deep sedation directly increase the length of stay of patients in these units, which obviously drastically reduces the number in the availability of ICU beds for the population.

## V. FINAL CONSIDERATIONS

Evidence shows that the adoption of management measures based on technical knowledge, or technocracy, and the application of evidence-based medicine in the management of public health policies, especially in intensive care units, can corroborate better quality indicators, with higher bed supply and, consequently lower waiting time, lower mortality rate and lower costs, without large investments in new units and/or opening new beds.

Incisive studies on the efficiency in the management of tertiary health care are still scarce, especially with regard to the criteria of admission and control of sedation, however, due to the methodological quality of the articles used in this review, it is possible to conclude that there is still a lack of efficiency in this sector in our country and that political-administrative reform can infer in better conditions assistance to society.

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# Implementation of Freeness advanced control in a carton board machine

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***Abstract***— *Special cartonboards requires restricted raw materials specifications. Klabin's Paper Machine 09 produces some of the best cartonboards of the world, and the requirements for this are quite narrow. Freeness is the most important variable for pulp stock preparation. Thinking at this, a MPC control was developed to refining control.*

***Keywords*— carton board machine, Klabin, Paper Machine.**

## I. INTRODUCTION

Klabin unit Monte Alegre is based in a small countryside city in Brazil, this unit produces some of the best cartonboards of the world. These prime papers requires that specific variables to be under narrow control. Freeness is one of the most important variables for papermaking, having this on mind the company has developed a MPC (Model Predictive Control) for Freeness control at Paper Machine 09.

This controller should be capable to delivery freeness with the desired specification, to produce prime paper. Before of this implementation, this site tried to use a PID control, without success, and an expert system from Valmet to control this variable. This expert system works good in several paper machines, but because of the narrow specification of this paper machine, this control wasn't enough to delivery desired specification.

So Monte Alegre unit was looking for a way to achieve the specifications, and as described at this paper, MPC was a good solution.

**Descriptive Information**

The constant modernization of Packaging conversion machines using cartonboard as a fundamental raw material and the increasing competitiveness of the market requires constant manufacturers' innovation and optimization of its processes, so that you can meet the high performance product requirements, with tolerances increasingly smaller, variability specifications and the new quality requirements which arise each year.

For better results, companies are investing in training its staff, new equipment and manufacturing processes, excellence can only be achieved with the use of advanced control tools, which are able to maintain the streamlined process 24 hours a day, reducing the dependence of the level of operators' training, their level of attention and their attitude to intervene on process variations.

Within a paper machine, maintenance of physical properties of paper is strongly influenced by the stability of physical properties of pulp and the stability achieved in the process before leads to an efficient dewatering control of the pulp in different process steps. The physical properties of the pulp and the dewatering on the paper machine are strongly influenced by a characteristic of pulp called "drainability". This characteristic is measured using a test known as: Freeness, established through Tappi T227 om-94 method.

The Freeness analysis provides a measure of the drainage rate of a dilute pulp suspension 3 g / L and the result obtained is the volume in ml of filtrate drained through the side orifice standard equipment specifically designed for this assay.

The equipment used for this work Freeness measurements was KajaaniMAP analyzer, which allows one Freeness analysis every four minutes, thus providing sufficient information to allow the use of an advanced control tool.

The stage of paper machine process which is responsible for ensuring compliance with Freeness specifications is called refining. Refining takes place in a device known as refiner, which is responsible for the mechanical treatment of fiber suspension in order to improve the bonding requirements between them and ensure an adequate level of drainability for the production of paper with the desired features.

Due to the strong correlations between the physical properties of the paper and the degree of drainability Freeness is the most important variable to be controlled in the pulp feeding for paper machine.

## II. METHODS AND MATERIALS

There are four common ways to control refining systems:

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- Manual Control – means that the gap between the refiner plates is controlled by hand, or by an automated gap system operated manually to adjust the gap. Flown and consistence has a direct impact on the refining load, hence the freeness. So, when gap is kept constant, changes in flow or consistence will change the thickness of the fiber flow between the plates, affecting directly the Freeness. For this control strategy, consistency and flow should be narrow controlled.
- Power Control – the load of the refiners is kept constant, so the gap adjustment works to maintain a constant load, but variations on fiber flow or consistency has direct impact on Freeness.
- Specific Refining Energy Control – flow and consistency are measured and controlled before the refining. The objective of this control strategy is to apply the same amount of energy for each unit weight of solids on the stock. This controller uses flow, consistency and power measurement to calculate the amount of load to be applied, keeping the specific energy constant. This control works pretty good if the raw material has no changes at its properties; difficult at most of industries.
- Freeness Control – probably the best way to assure physical properties of fiber. This strategy needs a Freeness measurement after the refiner, Fig.1 [1], and will manipulate the load as needed to keep the Freeness constant, or at the desired setpoint. Hopefully with some time, a new technology will measure freeness continuously, and then a simple PID control will handle Freeness control.

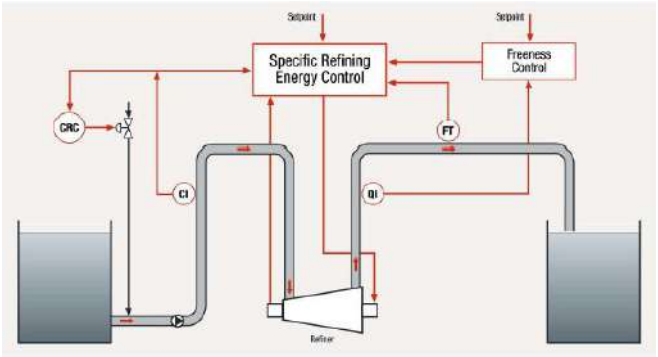


*Fig.1: Freeness Control.*

The main challenge for Freeness control is the dead time, this sampled analysis took more than 7 minutes for each sample, and the system has a rise time lower than 2 minutes. Conventional PID controller can´t control system with this behavior, the sampling by itself is already a big issue for PID control, together with the ratio between dead time and rise time, makes this system real hard to have an effective PID control.

So, a model predictive control was selected for this challenge, it should be capable to handle the sampling, and the dead time caused by the sampling. This controller should be capable to take a control action and predicts what will happen until the next sample, which takes 7 to 9 minutes.

The advanced control tool used was the Profit Suite controller by Honneywell Inc, which is an APC (Advanced Process Control) that follows the steps below using MPC (Model Predictive Controller), until you reach your final product:

1) Modeling - Fig.2: some steps or bumps were made in the process and the responses were observed on the major refining variables;

2) Controller configuration for process;

3) Development of Human Machine Interface, Fig.3;

4) Deployment and assisted operation of the controller, Fig.4.

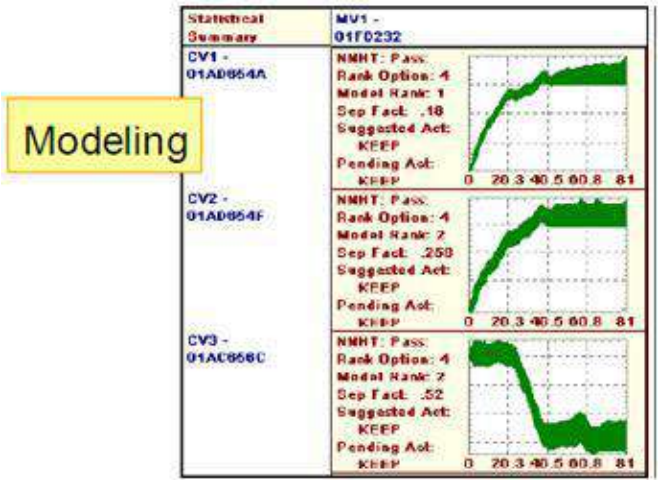


*Fig.2: Controller Modeling.*

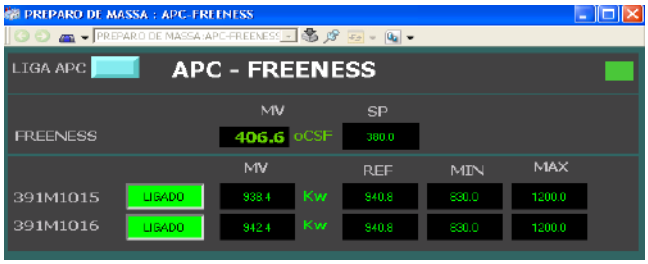


*Fig.3: Human Machine Interface.*

Briefly speaking, the controller action happens as follows: At each sampling, the controller and optimizer read the main operational process parameters (power, flow, consistency and Freeness), calculates the optimum value of the movements to be implemented in the manipulated variables (refiner drive motor power), taking into account

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the limits of each parameter and the prediction of future behavior (future Freeness).

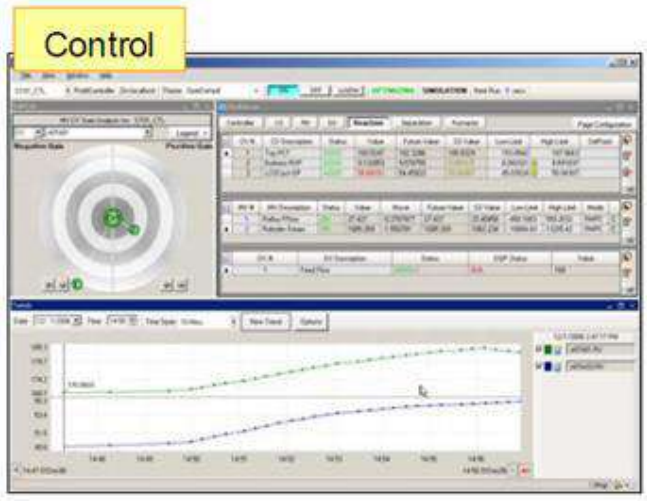


*Fig.4: Controlling the Process.*

These changes are then written in the power setpoint of the refiners and the cycle is restarted.

The advanced controller used for this work, has it core based on multivariable predictive technology, called in industry of model predictive control (MPC). The main goals of this technology are:

- Increase process stability;
- Better operational efficiency;
- Lead the process to an optimal operational target;
- Assure process specifications.

The target desired at Klabin's Paper Machine 09 (PM09) was stable freeness, despite of energy saving. The reason for this is the prime cartonboard produced at this paper machine, in this case, quality is everything.

## III. RESULTS

As showed in Fig.5, the freeness control excepted the expectations, the figure has just a few points out of control range. The control range has a 20 °CSF of amplitude, and the site specification are 350 to 420 °CSF, what means that in eight hours of operation, not even one point was out of specification.

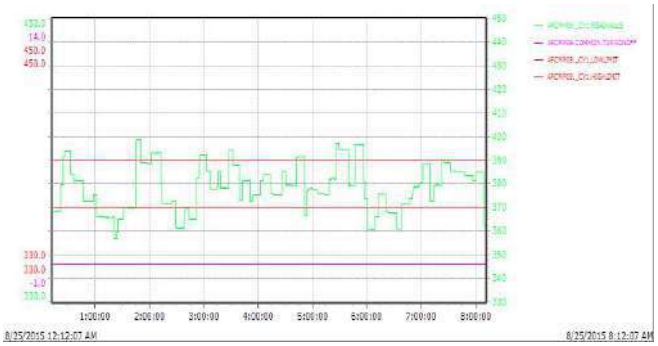

*Fig.5: Eight Hours of Operation.*

The standard deviation for freeness was reduced by 47%, delivering a stable freeness for the process. Fig.6 contains some statistical analysis for freeness.

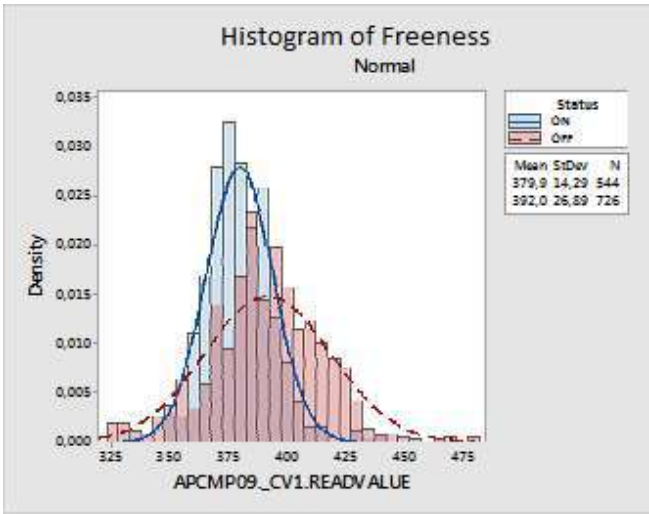


*Fig.6: Reduction of 47% for Freeness Standard Deviation.*

Fig.7 says that only 16% of the data are outside of control limits, which has an amplitude of 20 °CSF, a way below of 40 ºCSF from the specification. This means that we have no more freeness out of specification for this paper machine.

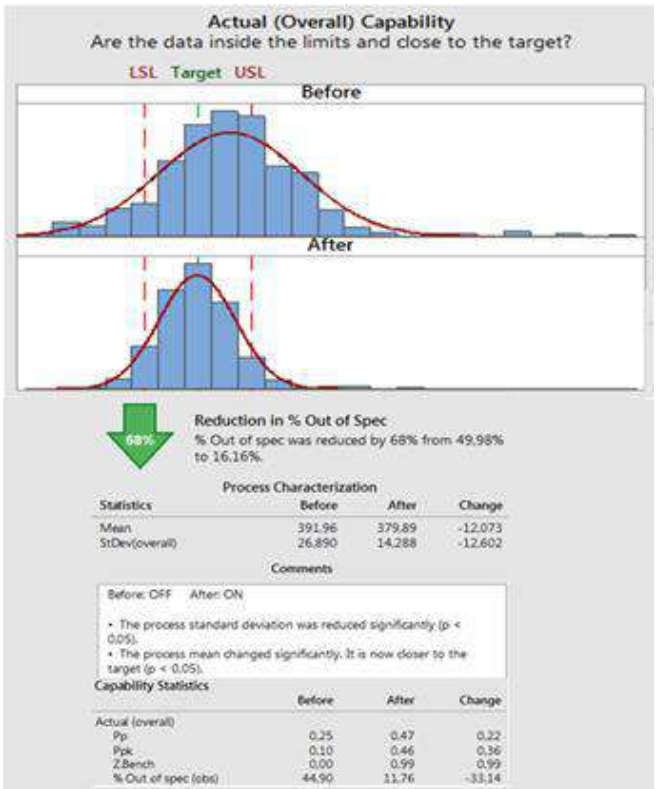


*Fig.7: Capability Analysis for Freeness.*

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# Nursing Care in Severe Traumatic Brain Injury

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***Abstract***— *Objective: To report the experience experienced by trainees of the 9th semester of Nursing, in assisting a patient victim of a car accident with severe traumatic brain injury (Subdural Hematoma), through the systematization of the care of Nursing. Method: A descriptive study, with a qualitative approach, of the type of experience report, performed at a referral Hospital in Trauma of Belém-PA, Brazil, in the period of November and December of 2018, during the supervised internship. Applying the systematization of Nursing Care (SAE) in a patient with severe traumatic brain injury, following the six steps of the nursing process. Results:We evidenced the priority nursing diagnoses: ineffective Cerebral tissue perfusion; Risk of electrolyte imbalance; Risk of aspiration. Related to Orotracheal tube; Hypothermia Risk of infection; Impaired physical mobility; Self-care deficit. The nursing interventions were performed for each diagnosis. Conclusion: Nursing care through the use of NCS allows care based on scientific evidence, guaranteeing quality of service that affects patient safety. In critically ill patients, nurses need specific knowledge, with the objective of restoring damage and avoiding new complications.*

***Keywords***— ***Nursing Care; Craniocerebral Trauma; Nursing Process; Standardized Nursing Terminology; Hematoma, Subdural.***

## I. INTRODUCTION

The external causes of morbidity and mortality are among the main agents of death in the world, especially in the young, economically active and male population, resulting in millions of deaths annually, thousands of Hospitalizations and high cost to health services(Preis, Lessa, Tourinho, & Santos, 2018).

Accidents involving automobiles and motorcycles have been instituted as a serious public health problem in today's society, and are included as Morbi-mortalities by external causes. The complications are countless to the survivor of an automobile accident, the most important and the most serious is the traumatic brain injury (TBI), having its international classification of diseases by CID-10. The TBI is characterized by any traumatic injury that affects and compromises anatomically and functionally, the Encephalon, meninges, cranial cap and scalp, and this type of trauma is responsible for large numbers of deaths caused by accidents Automobile. In Brazil, traumatic injuries caused by traffic accidents represent the major

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cause of death in the age group of 10 and 29 years of age. In this way it is an important agent of morbidity and mortality in Brazil(P. F. Silva, Silva, Olegário, & Furtado, 2018).

This type of lesion can be classified as mild, moderate and severe. Among the indicators of severity are the depth and permanence of the coma evaluated by the Glasgow scale. According to this scale, patients with scores between 13 and 15 points in the scale set a mild TBI, from 9 to 12 moderate and between 3 to 8 severe(J. A. da Silva, Souza, Feitosa, & Cavalcante, 2017).

Different lesions may appear from the primary lesion, especially the intracranial hematomas that divide into: I) extradural (blood collection between the skull and dura mater by laceration of a meningeal vessel, a venous sinus or bleeding from the bone table ); II) Subdurals, characterized by a blood collection between the dura mater and the brain, where the most common cause is the traumatic rupture of the cortico-meningeal veins (from the cortex to the dural sinuses); III) Intraparenchymal, where there is a dense collection of blood installed within the cerebral parenchyma. The location of this last type of hematoma is preferential in the temporal and frontal lobes(Rodrigues, Dias, Hohl, & Mazzuco, 2008).

On Subdural Hematoma (SH), it is characterized as a primary traumatic injury. It is located between the Duramaph meninges and arachnoid. They are commonly larger than the Extradural Hematoma in extension. It can overcome sutures, but not the dura mater inserts. In 85% of the cases is unilateral, with the most affected sites being fronto-parietal convexity and the middle fossa. The SH inter-hemisféricos isolated and Parafalcinos can happen, also in cases of mild traumas(Badke, Perdonssini, Dalmolin, & Sassi, 2011).

In this context, the professional nurse, is involved in the assistance from the first care to the patient with TBI, to the intensive care unit, surgical center and etc. Thus, it is noteworthy the importance of nursing team care in the specificity and complexity of the service provided to these victims, which characterize differentiated clinical conditions resulting from the severity of traumatic injuries. In neurological intensive care units, one of the main attributions of nursing routinely effected to the victims of TBI is the hemodynamic monitoring of the patient, with emphasis on the control of intracranial pressure and cerebral perfusion(Oliveira, Soares, Fontinele, Galvão, & Souza, 2018).

Nursing care is sustained as a science based on nursing theories, which allow evidence of problems related to some basic human need. Thus, an instrument was elaborated, the systematization of Nursing Care (SNC), which is nothing more than a scientific method that has five stages, with the objective of identifying the nursing problems and tracing the nursing diagnoses (ND) for each One, with the aid of the North American Nursing Diagnosis Association (NANDA). After the ND defined, the expected results and interventions are elaborated. The evaluation should soon be carried out and if necessary to amend the(Alvim, 2013).

Thus, the aim of this study is to report the experience of trainees in the 9th semester of Nursing, in assisting a patient victim of a car accident with severe traumatic brain injury (Subdural Hematoma), through the systematization of Nursing care.

## II. METHOD

This is a descriptive study, with a qualitative approach, of the type of experience report, developed from the description of the experience of academics in the care of a victim of automobile accident, with severe TBI of the Subdural Hematoma type, through SNC application. This study corresponds to the experience of the hospital internship, in the urgency and emergency module, which occurred in the period from November 12th to December 10th, 2018, under the preceptorship of a nurse specializing in patient care critical residency modality Multiprofessional.

The study site was in a large Hospital in the metropolitan area of Belém, a reference in trauma and burns. The students performed in the emergency Service (yellow Room) in this period, where the patients care in urgency and emergency are attended and referenced to other sectors, consisting of 12 beds, 6 have support for treatment Intensive.

Data collection for the SNC, occurred in two stages, 1) information in the medical records, on admission, health history, mechanism of trauma and etc. 2) through the nursing evaluation, performed by anamnesis and complete physical examination. After these steps it was possible to identify the nursing problems based on the theories, and to trace the nursing diagnoses, thus elaborating the care plan.

## III. RESULTS AND DISCUSSION

The victim was admitted the night before, in the Yellow Room (emergency care), the first contact of the students with the patient occurred the next day, thus was performed the first stage that consisted of obtaining information in the medical records about the history and Admission.

Individual victim of automobile accident, in which he was ejected from the vehicle. With various abrasiings and lowering of the level of consciousness. Patent airways with cervical collar without rigid plank. In

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pulmonary auscultation vesicular murmurs present, bilaterally, without adventitious noises, with symmetrical thorax with good expansiveness, with saturation 100%. Dry and normostained skin, blood pressure 110x60, heart rate 80, normophonetic heart sounds in two-stroke without blowing, with flat abdomen and flaccid without reactivity, stable pelvis. Glasgow Coma Scale: 2 + 1 + 5 = 8 with pupils with isophotoreactors, such as motricity and sensitivity in upper and lower limbs. Extensive scalp injury, no instability or crackling. Injuries in the limbs, with hematoma in the right eye and upper lip, abrasions on the shoulder, scalp injury in the right parietal region, food rest in the airways.

She soon performed imaging exams, such as cranial tomography, which evidenced TBI of the Subdural Hematoma Frontotemporoparietal type, with midline deviation, open base cisterns. In this way he immediately performed the Decompressive craniotomy, and followed in immediate postoperative, sedated in mechanical ventilation.

In a retrospective study on the risk factors associated with decompressive craniotomy in patients with Subdural Hematoma, it was observed that immediate and adequate procedure realization can prevent brain damage, and found a significant relationship Among the mortality rates, older patients, scores < 6 on the Glasgow Coma scale and extension of the lesion (midline deviation ≥ 10 mm and hematoma thickness ≥ 15 mm)(Yılmaz et al., 2019).

In the complete physical examination performed by the academics: Ramsay scale 6. Anisocolic pupils, mydriasis to the left, not photo reagents. Blepharhaematoma on the left. Monitored in multiparameter, hypothermia (T: 34 º C), normotensive, Tachycardic (P:106), saturating 96%. Intubated on controlled mechanical ventilation; Peep 7, Fo2 40%, FR: 19. Cervical region with bilateral edema. A Central venous catheter with a lumen in the right subclavian vein, maintained in occlusive dressing, receiving vasopressin at 0, 5ml/h + hydration at 120ml/h in continuous infusion pump. Symmetrical thorax, in the pulmonary Asculta vesicular murmur present, without adventitious noises. In cardiac Asculta, normophonetic heart sounds in two rhythmic times. Flat abdomen, tense, with hydroaerial noises present and diminished, presence of open gastric oral probe, draining bilious content in small amount. Diuresis concentrate present, by Vesical delay catheter, fixed in supra pubic, indicated to monitor urinary output. Presence of edema in the limbs. Evacuations absent at the moment. Aspiration of the airways, performed at the moment, with aseptic technique, in the tube presented mucous content in little quantity, in the nasal cavity, mucosanguinolento content in moderate amount, in the oral cavity mucoid content in small amount.

After the first stage, it was possible to identify the main nursing problems and to trace the nursing diagnoses according to NANDA (John Wiley & Sons, 2014).

The main problems were: TBI, orotracheal intubation, hypothermia, invasive devices, bed restriction and craniotomy. From these problems follows the nursing care plan, with all its stages, as a reference we sought to elaborate a proposal for nursing interventions, according to the classification of the nursing Interventions Classification (NIC)(Johnson et al., 2007).See the table below.

*Table 1 – Care plan*

| **IDENTIFIED PROBLEMS** | **HUMAN NEED PATTERN AFFECTED** | **NURSING DIAGNOSIS** | **EXPECTED RESULTS** | **NURSING PRESCRIPTION** |
|---|---|---|---|---|
| TBI | Neurological regulation | Ineffective Cerebral tissue perfusion. Characterized by lowering the level of consciousness, motor response, behavioral and pupil reactions. Related to brain trauma | It is expected to maintain cerebral perfusion | Monitor vital signs every two hours. Monitor throughput and aspect of the contents of the clamp that drain present in the cerebrum, always keep the accordion below the place where it is inserted. Monitor intracranial pressure every two hours. Keep immobilized with cervical vest to avoid increased intracranial pressure. Assess neurological regulation (apply the Ramsay scale). Evaluate cutaneous-plantar, corneal-palpebral, oculocephalic and patellar reflex maintain a-caudal alignment. |

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| | | | | |
|---|---|---|---|---|
| | | | | Communicating Otoliquorrhea, Rhinoliquorrhea, Hemotímpano. |
| TBI | Electrolytic Regulation | Risk of electrolyte imbalance related to impaired regulatory mechanism | Electrolyte levels are expected to remain in physiological patterns | Perform water balance every 1h. Monitor urinary output, volume and aspect every 2h. Check the patient's hydration conditions (mucous membranes, edema, pulse and heart rate). Monitor serum electrolytes levels. Check for bleeding |
| Orotracheal intubation | Oxygenation | Risk of aspiration. Related to Orotracheal tube. | It is expected to avoid accumulation of secretions in the airways | Monitor consciousness level, cough reflex, nausea and swallowing capacity. Keep Vacuum cleaner available. Perform aspiration once every shift or when necessary, with aseptic measures. |
| Temperature (34 [a]) | Thermal regulation | Hypothermia, characterized by decreased body temperature. TBI related | The patient's temperature is expected to increase by up to 2h | Use heated bags with the patient. Control the ambient temperature. Control temperature every 15 minutes and successively every 30 minutes. Cover the patient with blankets. Install thermal blanket, if available. Avoid discovering the patient unnecessarily. Monitor skin color, temperature and moisture. Evaluate perfusion. Infuse heated venous solutions. |
| Invasive devices | Mucosal cutaneous integrity | Risk of infection. Related to the presence of invasive devices | Preventable infections are expected to be prevented | Evaluate surgical incision condition, catheters every 2h. Monitor signs and symptoms of infection (edema, hyperemia, heat, flushing, hyperthermia). Sanitize hands with alcoholic gel before and after each procedure. Perform disinfection with alcohol at 70% in endovenous devices (Equipo, Bureta), before administering medications. Use aseptic technique for aspiration, vesical probing, venous puncture and in other procedures in which it is pertinent. Apply the Phlebitis scale at the time of medication administration. |
| Bed restriction | Body Mechanics, physical integrity | Impaired physical mobility, characterized by bed restriction, related to TBI | Prevent complications | Keep bed linen clean, dry and without wrinkles or folds. Perform decubitus change every 2 hours. Provide alignment of the patient's body. Evaluate skin conditions. Maintain prophylaxis for venous thromboembolism (elastic stockings and intermittent compressor). |
| Craniotomy | Body Mechanics | Self-care deficit for bathing and intimate hygiene. Characterized by the inability to perform self-care activities, related to severe clinical condition. | It is expected to maintain the patient's personal hygiene | Make Bath in bed 1x/day perform oral hygiene, with oral antiseptic. Keep care of nails, perineum, hair, eyes, ears and feet. Perform intimate hygiene 2x/day, or when necessary, change of Frada and hydration of the skin. |

**Source:** Research authors.

The performance of the nurse in a patient with TBI is essential for the efficacy of this individual's recovery. The SNC allows to assist in an organized and safe manner, thus guaranteeing the quality of the service

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and patient safety. One study revealed that adequate nursing care to patients with severe TBI decreases the risk of secondary injury, providing a better prognosis for these subjects(Oliveira et al., 2018).

A review study evidenced the main nursing interventions provided to the victims of TBI. Among the measures instituted by nursing are: drainage and evaluation of cerebrospinal fluid as to color, clarity and quantity; intracranial pressure monitoring; Neurological assessment through the Glasgow Coma scale (GCS) including evaluation of pupils(Oliveira et al., 2018). However, in the neurological evaluation, the review refers to the use of GCS only, and does not cite that used in this studyRamsay scale.

The Ramsay scale classifies the degree of sedation of an individual based on essentially clinical criteria ranging from agitation to unresponsive coma and has simple and intuitive definitions, enabling it to be quickly applied to the bedside(Mendes et al., 2008). Although recent studies point to greater reliability and greater accuracy in the use of another scale, the scale of RASS (Richmond Agitation Sedation Scale)(Rasheed et al., 2019).

Nursing care is characterized in preventing complications, restoration of damage and intensive monitoring of vital signs, control of hemorrhages, shocks, intracranial pressure, level of consciousness. Another important factor is the monitoring of the hydroelectrolytic balance every hour, and it is necessary to maintain a calibrosus venous access, bladder probing and verification of serum electrolytes, due to the cerebral trauma being able to cause hormonal dysfunctions and Metabolic, which is the case of electrolytic regulation(Pereira et al., 2011).

For the diagnosis of aspiration risk related to Orotracheal tube, the measures taken are aimed at decreasing the risk of developing infections related to health care, such as ventilator-associated pneumonia. The indication of airway aspiration follows the criteria indicated in the literature according to the need of each patient from the pulmonary auscultation, which should be performed every 2 hours. The presence of adventitious noises (snoring, inspiratory wheezing or rales) or reduction of the physiological vesicular murmur associated with other signs, such as dyspnea, accessory musculature use, visible presence of secretion in the orotracheal tube , decreased partial oxygen saturation (SPO2) < 92%, for example, is indicative of the need for aspiration(K. R. A. Ribeiro, Lima, & Brito, 2018).

In the case of hypothermia, there are some strategies of passive and active heating to prevent loss of heat such as the use of blankets, sheets or quilts, or the use of mattresses or blankets with water circulation or even electric blankets. The infusion of heated liquids can also reduce the drop in body core temperature(D. R. Ribeiro & Longo, 2011).

It is known that the use of invasive devices causes an increase in the risk of triggering infections related to health care. As for example the orotracheal tube, central venous catheter (CVC), delayed and nasoenteric bladder probe are some of the main causes of infections related to health care, and the length of stay of these devices is crucial for the emergence of Infections, for this reason, control and prevention measures are indispensable(Cardoso et al., 2018).

Care with the CVC goes from the identification of signs and symptoms suggestive of bloodstream infection such as hyperemia, drainage of exudate at the catheter insertion site, fever, malfunction of the device, bradycardia, Oliguria and others, Through the care of the insertion ostium, until the manipulation and maintenance of the catheter. It is noteworthy as one of the main recommendations the hand sanitization with antiseptic solution, preferably alcohol(Almeida et al., 2018).

Bed restriction predisposes risk factors to the development of pressure injuries and thromboembolic events. Critical patients have greater chances of developing pressure injuries in the sacral, trochanteric and calcaneal areas, prominent regions of the body's support with the surface in contact, due to positioning (dorsal or lateral decubitus) (Borghardt, Prado, Bicudo, Castro, & Bringuente, 2016).

The most frequent nursing interventions faced by this problem include: Change in decubitus every 2 hours (except if there are contraindications); Use of emollients in dry skins, such as essential fatty acids for hydration; Use of comfort cushions in bony prominences; Keep skin clean and without moisture, as well as constant exchange of diapers and bed linens that are damp; Skin inspection and risk assessment for the development of pressure injuries on admission and daily assessment of clients, such as the application of scales in order to prevent this problem; Etc.(Mendonça, Loureiro, Frota, & Souza, 2018).

Bed restriction is related to the patient's clinical picture, including the performance of the Decompressive craniotomy, which leads to their confinement in bed and the loss of their ability to perform daily life activities, such as their own hygiene, High degree of dependence on the team. Thus, based on Dorothea Elizabeth Orem's self-care deficit theory, it is possible to offer assistance based on the nursing needs presented by the individual in everyday practical situations(Neto et al., 2017).

Bed bathing is one of the nursing assignments performed with patients with physical limitations due to their critical condition. This procedure provides individual

comfort and maintains the integrity of the skin, because it favors the physiological circulation and hydration, besides being an important measure of prevention against infections, such as the bloodstream by the use of CVC, the urinary tract Bladder catheter, and ventilator-associated pneumonia(Costa, Souza, Diaz, Toledo, & Ercole, 2018). It is also necessary to perform oral hygiene that is associated with this last type of infection (K. R. A. Ribeiro et al., 2018).

## IV. CONCLUSION

Nursing care to patients with TBI demands critical and clinical reasoning, are measures that should be evaluated and decision-making quickly. The SNC provides the nurse to identify the priority problems in a systematic way, guaranteeing quality in the service provided by the nursing team.

Thus, nursing care to patients with TBI needs qualification, because it is very complex and individualized cases. Thus, having such a function of monitoring, treating and preventing problems related or not to the TBI. The nurse operates from the first care, until the patient's discharge, then the knowledge of the pathophysiology, interpretation of laboratory and imaging exams and the SNC are essential for quality care, preening patient safety.

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# Application of Hall Effect Sensor in temperature control valve of automotive Internal Combustion Engine

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***Abstract*****—** *The growing demand for new technological solutions in automobiles, often to replace mechanical with electromechanical solutions, seeks better system controls to improve fuel economy and reduce pollutant emissions, while also improving the comfort and safety of vehicle users. With the recent advances in microelectronics, many sensors are being used in unexpected applications, an example of which is the Hall Effect Sensor, which is increasingly used in vehicles due to its ease of application. The contribution of this work is the development of a temperature control valve (TCV) that replaces the thermostatic valve with a more accurate temperature control system, using a Hall Effect Sensor to control the flow of the engine cooling fluid. The implementation of the Hall Effect Sensor enables new functionality to the TCV, which previously had just two operative states (On and Off). In this way, it is possible to improve the temperature control of the combustion engine.*

***Keywords*****— Flow rate, Hall Effect Sensor, Magnetic field, Temperature control valve.**

## I. INTRODUCTION

The use of new technologies in automobiles has led to a significant increase in sophisticated vehicle electronic systems, which are also called embedded systems. Analysts estimate that 90% of the innovations in the automotive industry are related to electronic systems [1], [2], [3], [4]. In recent years, new research has emerged to improve vehicle performance with respect to four main factors: safety, comfort, the economy of energy consumption, and reduction in gas emissions. This has spurred the development of new products, many of which are sensors [5], [6]. Sensors are devices installed at strategic points in the motor to record signals that are then analyzed by the motor control unit to determine which strategy to follow. According to Lopes [7], sensors must be located where the measurement is performed. Although some types of sensors need not be in contact with the object being measured, they must be located in the vicinity. Sensors, in general, are expensive and fragile and must be specially adapted to ensure their durability and reliability. The Hall Effect sensor has recently become a versatile option for applications within vehicles. Figure 1 shows some applications of Hall Effect sensor in automotive systems. One of the fundamental employments of the Hall Effect sensor in automotive frameworks is for the detecting of position, distance and speed. For instance, the precise position of the crankshaft for the firing edge of the sparkle plugs, the position of the vehicle seats and safety belts for air-bag control or wheel speed recognition for the anti-lock braking system.

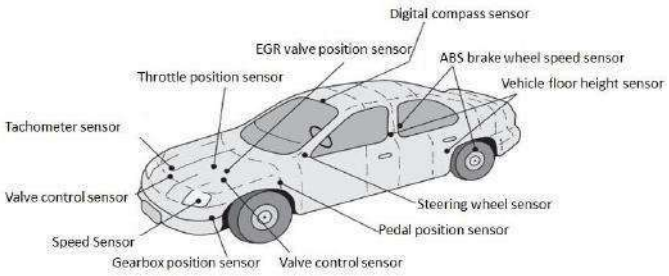


*Fig. 1: Hall Effect sensors used in an automotive system*

Many authors have considered the Hall effect sensor in an automotive system. For instance, Xiao et al [8] demonstrated a method of position detection for permanent magnet linear synchronous motors (PMLSM) by linear Hall-effect sensors. Based on finite element analysis of the motor's magnetic flux and considering the dimension limit of the motor in practice, the best mounting position of the sensor is given to eliminate the influence of the back iron and improve the accuracy of the detection.

Joo et al [9] implemented a device that can measure a small magnetic field by measuring a linear movement of the switching current by adding the spin Hall Effect to the

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abnormal Hall Effect of the perpendicular magnetic thin film. Nama et al (10) apply a smart Hall Effect sensor system used for sensing the rotor position in a 3-phase BLDC motor. The intelligent sensor system proposed allows the motor to continue working even when one of the Hall sensors is damaged and not working. Lalnunthari et al [11] present an interface between the Hall Effect flow sensor with Arduino to study the effect of pipe size on the frequency and rate of flow of the sensor. Hall Effect flow sensor is found to be largely affected by the attached pipe size at the inlet. Mercorelli et al [12] built a hybrid actuator composed by a piezo and a hydraulic part. A cascade PI-PID control structure for camless engine motor applications is considered. The idea of this contribution is using the advantages of both: the high precision of the piezo and the force of the hydraulic part. Piezo electric actuators are mostly used for precision positioning, despite piezoelectric actuators present nonlinearities, such as saturation, hysteresis and creep.

The contribution of this work is the development of a temperature control valve (TCV) that replaces the thermostatic valve with a more accurate temperature control system, using a Hall Effect sensor to control the flow of the engine cooling fluid. The implementation of the Hall Effect sensor enables new functionality to the TCV, which previously had just two operative states (On and Off). In this way, it is possible to improve the temperature control of the combustion engine.

This paper is organized as follows: Section 1 gives the general introduction of the topic. Section 2 gives a brief description of the Hall Effect sensor and the automotive cooling system. Section 3 presents the application of the Hall Effect sensor in the temperature control valve while section 4 provides the results and conclusion.

## II. THEORETICAL BACKGROUND

### *2.1 Hall Effect Sensor*

According to Xiao [13], the Hall Effect sensor is a magnetic-field sensor that is based on the effect discovered by Edwin Hall in 1879. This electrically isolated device can be applied to sense continuous and alternating currents of typically up to hundreds of kilohertz. Due to its simple structure and compatibility with microelectronics, a Hall device can be monolithically integrated into a fully integrated magnetic sensor and manufactured using conventional complementary metal–oxide–semiconductor (CMOS) technology.

When a conductor is crossed by a current and placed in a magnetic field, the voltage will be perpendicular to the current and field. This principle is known as the Hall Effect. When there is no magnetic field and the current distribution is uniform, no potential difference appears at the output. When a perpendicular magnetic field is present, a Lorentz force is exerted on the current. This force causes a disturbance in the current distribution, which results in a potential difference between the output terminals. This voltage is known as the Hall voltage (HV). The Hall voltage is proportional to the cross product of the current (I) and the magnetic field (B), as shown in Equation (1).

$$V_{HV} \propto I \times B \tag{1}$$

The yield signal for straight (analogue) sensors is taken straightforwardly from the output of the operational amplifier with the output voltage being proportional corresponding to the magnetic field going through the Hall sensor (Figure 2). This output Hall voltage is given by Equation 2.

$$V_H = R_R(\frac{I}{t}) \times B \tag{2}$$

Where:

$V_H$ is the Hall Voltage in volts;

$R_H$ is the Hall Effect coefficient;

I is the current flow through the sensor in amps;

t is the thickness of the sensor in mm;

B is the Magnetic Flux density in Teslas.

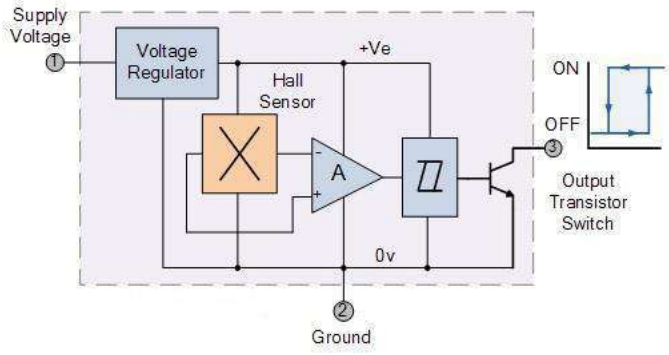


*Fig. 2. Typical Hall effect sensor circuit.*

Analogue sensors give a persistent voltage output that increases with a strong magnetic field and diminishes with a feeble magnetic field. In direct output Hall Effect sensors, as the power of the magnetic field expands the output signal from the amplifier will likewise increase until it starts to immerse by the cutoff points forced on it by the power supply. Any additional increase in the magnetic field will have no effect on the output but drive it more into saturation.

A Hall Effect device is basically a field-effect sensor. It requires an additional circuit to condition the signal and produces an output voltage usable for most applications,

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consisting of an amplifier stage and temperature compensation. A typical Hall transducer has a limited current peak, due to core saturation, and limited bandwidth (<1 MHz), although it can measure DC current. In addition, it is very sensitive to external magnetic fields. Hall Effect sensors operate mainly in closed-loop mode to realize better accuracy and greater dynamic range. These sensors are sensitive to the polarity of the magnetic field (north and south), as is the amplified output, which provides a voltage proportional to the magnetic field to which it is exposed. Saturation occurs in the amplifier, not in the Hall element, and will not damage the sensor [14].

Hall effect sensors are solid state gadgets that are becoming more and more popular since they can be utilized in a wide range of sorts of use, for example, detecting position, speed or directional movement. They are additionally a well-known choice of sensor for the gadgets designer due to their non-contact wear free task, their low support, a strong plan and as sealed Hall Effect gadgets are insusceptible to vibration, residue and water.

*2.2 Automotive Cooling System*

The automotive cooling system consists of the following main components: fluid passageways in the cylinder block or engine jacket, radiator, coolant pump, thermostat and expansion tank. Figure 3 shows a circuit diagram of the automotive cooling system.

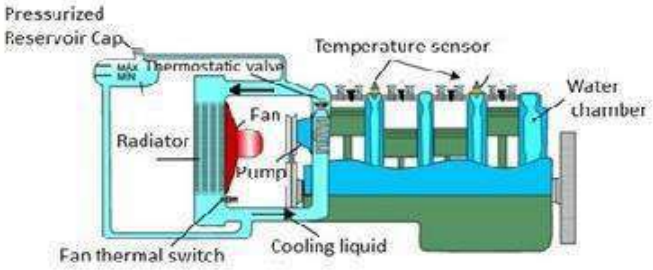


*Fig. 3. Cooling system.*

According to Thomson [15], coolant is pumped through the engine liners, which are the paths surrounding the hot parts of the engine, such as cylinders, blast chambers, and exhaust outlets. The heated liquid flows from the engine linings through a hose to the radiator where aided by a fan, it cools and returns through another hose to the engine. The coolant thus circulates under pressure throughout the cooling system. The water pump drives this circulation, accelerating the passage of the liquid through an impeller. While the engine does not reach its optimum operating temperature, the coolant circulates only through a small circuit through the engine compartments, which is controlled by the thermostatic valve.

When the optimal temperature is reached (85–95 °C), this valve opens, and coolant begins to flow through the complete circuit. This circuit passes through the radiator, where the outside air and the air stream generated by the ventilator lower the temperature of the coolant. Because it helps to control the engine temperature, the thermostatic valve is an important part of the vehicle's cooling system (Figure 3). When the engine is cold, the valve passage is closed, causing the coolant (water and additive) to return to the engine block. At a certain temperature, depending on the vehicle, this passage opens to allow the passage of the liquid to the radiator so that it is cooled and returns at a lower temperature for the engine block.

The thermostatic valve is a ceramic element and its behaviour is proportional to the temperature of the fluid, it functions passively. The ceramic expands (at temperatures above 30 °C) by moving the piston until it reaches maximum displacement (60°C). At this point, the valve allows maximum fluid transfer to the radiator. As the temperature decreases, the ceramic returns to its initial state, decreasing the flow to the radiator [15]. Other valve models have been developed, with an emphasis on designs with pitch motors (butterfly valve body) and membranes.

In its automotive segment, the company Melling do Brazil has patented a concept for a TCV (patent number US8474419 B2) that uses the membrane concept (Figure 4). Its operation is based on pressure control in the upper chamber of the membrane. As with other models, the outflow is proportional to the amount of fluid supplied by the water pump and is controlled by a solenoid valve located at the top. There is a small passage connecting the inlet to the upper chamber and another passage connecting the chamber to the valve outlet. To prevent the passage of the fluid, the solenoid is actuated by closing the small alternative passage from the upper chamber to the outlet. In this way, the chamber pressure increases, pushing the membrane down. To start the fluid flow, the solenoid is switched off, thus relieving the pressure in the upper chamber.

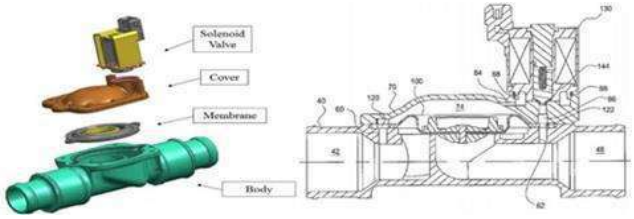


*Fig. 4. Temperature control valve with the membrane.*

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## III. APPLICATION OF HALL EFFECT SENSOR IN THE TEMPERATURE CONTROL VALVE (TCV)

Figure 5 shows the application of the Hall Effect sensor for monitoring the position of the membrane with the use of a TCV with position feedback. The Hall Effect sensor is positioned parallel to the membrane with a magnet, thus enabling measurement of the magnetic field of the magnet. This configuration allows the sensor to detect the magnetic-field strength of the magnet via a transfer curve to determine the actual position of the membrane.

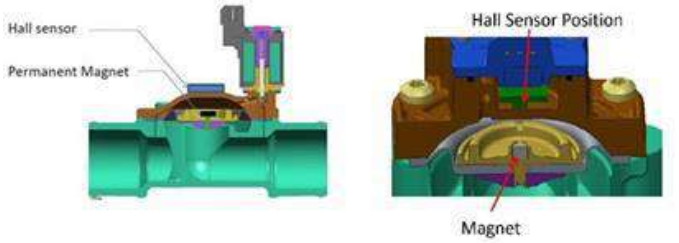


*Fig. 5. Temperature control valve with position feedback.*

The control system measures the output of the Hall Effect sensor and calculates the position of the membrane according to the function. With this value, the error can be calculated for setting the best duty cycle for the solenoid. This solenoid operates at a fixed frequency of 10 Hz and the control system adjusts the duty cycle based on the error calculation. The adjustment speed is a software parameter that increases or decreases the duty cycle (0 ↔ 100%) as a function of time.

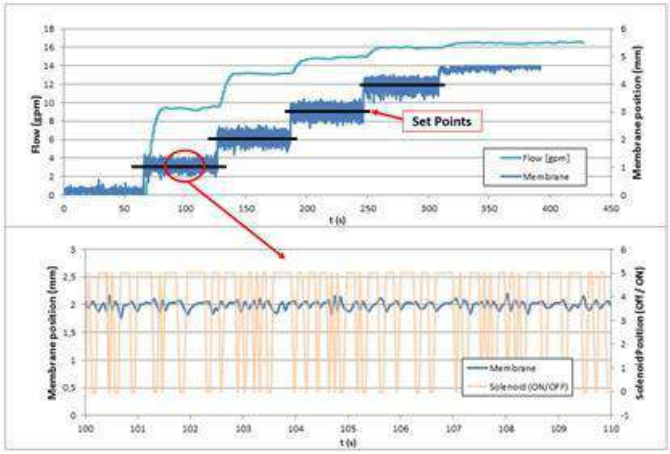


*Fig. 6. Flow control and membrane position.*

In practice, the control can position the membrane infinite positions, and this positioning will restrict the flow of the fluid passing through the valve. As shown in Figure 6 for a case in which the motor has a fixed speed and thus a constant flow, which we refer to here as maximum flow, the control of the membrane position restricts this flow to intermediate values. In the same Figure 6, we can verify the activation of the solenoid to keep track of the membrane position.

## IV. CONCLUSION

The implementation of the Hall Effect sensor in the TCV provides new functionality to temperature control in the internal combustion engine, which has previously operated in just two states (ON and OFF). This advance enhances the precision of the temperature control of the combustion engine, such that its operation now features a multitude of intermediate stages between the open and closed positions, based on feedback regarding the position of the membrane in the valve control circuit. In our experiments, the Hall Effect sensor performed with 100% efficiency in detecting the magnetic field of the magnet attached to the membrane.

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# Mansonic schistosomiasis: epidemiological study in the county Mulungu do Morro-BA

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***Abstract***— *Schistosomiasis mansoni (MS) is a parasitic disease that spreads through water, the trematode Schistosoma mansoni being its etiological agent. This is a serious public health problem worldwide. This paper proposes to analyze the epidemiological profile of cases of schistosomiasis in the municipality of Mulungu do Morro, Bahia, from 2007 to 2017. This is a descriptive epidemiological study of quantitative nature with data collected from the Notification Disease Information System ( SINAN) of the Unified Health System (SUS) regarding information on the number of reported cases and sociodemographic characteristics, where we analyzed the variables: gender, age, race, education, relationship with work and area of residence in the years surveyed, as well as pathology related data such as evolution and clinical form. Research shows that within the region, Mulungu do Morro occupies the 2nd place in number of notifications, with 59 cases of the disease in the period studied. The data show the predominance of males (64.4%), the economically active age group, from 15 to 50 years old (72.8%), cases from rural areas (79.7%) and from educated people. elementary school incomplete and complete (71.1%). Regarding the forms and evolution of the disease, both intestinal form and cure appear with 84.7%. The paper concludes that socioenvironmental factors are determinant for the maintenance of schistosomiasis in Mulungu do Morro municipality, providing subsidies for the formulation of strategies to combat the disease. Therefore, integrated actions between surveillance and medium- and long-term primary care should be implemented with the participation of the public and community sectors, ranging from the preparation of health professionals and the provision of tests for early diagnosis, the guarantee of treatment. to those infected in a timely manner, health education, even improvements in basic sanitation and supply of treated water, aiming to reduce the number of cases of the disease in the municipality.*

***Keywords***— ***Schistosomiasis mansonica; sociodemographic characteristics; integrated actions.***

## I. INTRODUCTION

*Mansonic Schistosomiasis* (MS) is a parasitic disease that spreads through water, by being the *Shistosoma Mansoni* Threamatode its etiological agent. This helminth has in its biological cycle the involvement of snails of the Biomphalaria genus, by being these ones the only intermediate hosts, and men the definitive host. Popularly known as "snail disease" and / or "water belly", it causes an acute or chronic condition, often with few symptoms, but it may also manifests with more severe forms, by leading to host death (ROCHA et al., 2016).

The MS is still a serious public health problem worldwide. There are many areas in Brazil that are endemic to the disease, by being an important cause of population mortality (CANTANHEDE; FERREIRA; MATTOS, 2011; SOUZA et al., 2011). Its endemic character is associated to the poverty and the low economic development, by being found mainly in countries in Africa, Asia and South America (WHO, 2016).

Its distribution is more intense on a continuous and contiguous strip of land along almost the entire coast of the Northeast, from Rio Grande do Norte to the South, by including the hot and wet zones of the states of Paraíba, Pernambuco, Alagoas, Sergipe and Bahia, where it reaches inland reaching Minas Gerais, in the Southeast, by following the path of important watersheds (BRAZIL, 2014). In the Bahian territory, the endemicity reaches a vast extent, by being that among the total of 417 counties in the state of Bahia, 167 are endemic, 122 are focal and

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128 are free for the schistosomiasis transmission (SAÚDE, 2018).

Among the several counties of Bahia that present relevant endemicity to the disease, Mulungu do Morro stands out due to the incidence of schistosomiasis cases. Thus, the goal of this study is to analyze the epidemiological profile of schistosomiasis cases in the county of Mulungu do Morro-BA and discuss the main prevention, promotion and health care measures that might be taken, by aiming its control and eradication.

## II. MATERIAL AND METHODS

It is about a descriptive epidemiological study of quantitative nature, related to the county of Mulungu do Morro Bahia - Brazil. The descriptive epidemiological research observes, records, analyzes and sort data without manipulating it, that is, without the interference of the researcher. It seeks to find out how often a fact occurs, its nature, its characteristics, causes, relationships with other facts (PRODANOV; FREITAS; 2013).

Thus, the data were collected from the Notification Disease Information System (NDIS) of the Health Unique System (HUS) concerning information about the quantitative of reported cases and sociodemographic characteristics related to schistosomiasis manson notified in the county of the study from 2007 to 2017.

For proceeding the analysis, the data were initially entered on Microsoft Office Excel spreadsheets by using of simple percentage calculations, which will be presented through tables and graphs.

For the selection of profile features of the disease carriers, the following variables were analyzed: gender, age group, education, relationship with work and area of residence in the surveyed years, as well as regarding data to the pathology, as evolution and clinical form.

## III. RESULTS AND DISCUSSION

Schistosomiasis is endemic in large extension in the Bahian territory, by being still considered a serious public health problem. From the total of 417 municipalities in the state, 167 (40%) are endemic, 122 (29.3%) are focal and 128 (30.7%) are free for schistosomiasis transmission (SAÚDE, 2019).

In the analyzed period, from 2007 to 2017, 27,735 cases of schistosomiasis were registered in Bahia. Of these, 354 cases occurred in the region of Irecê, regional health where the county of Mulungu do Morro is inserted. By establishing a ranking by number of cases of the disease, the region occupies the 16th position in the federation unit (Table 1).

*Table 1. Number of Schistosomiasis cases reported by Health Region – Bahia, 2007 – 2017*

| REGIONAL RESIDENCE | NUMBER OF CASES | RANKING |
|---|---|---|
| **Salvador** | 3293 | 1º |
| **Jequié** | 2941 | 2º |
| **Santo Antônio de Jesus** | 2884 | 3º |
| **Itabuna** | 2824 | 4º |
| **Alagoinhas** | 2748 | 5º |
| **Vitória da Conquista** | 2606 | 6º |
| **Cruz das Almas** | 1625 | 7º |
| **Itapetinga** | 1332 | 8º |
| **Gandu** | 1241 | 9º |
| **Eunápolis** | 692 | 10º |
| **Brumado** | 615 | 11º |
| **Teixeira de Freitas** | 585 | 12º |
| **Barreiras** | 580 | 13º |
| **Ilhéus** | 574 | 14º |
| **Cícero Dantas** | 430 | 15º |
| **Irecê** | **354** | **16º** |
| **Amargosa** | 348 | 17º |
| **Seabra** | 347 | 18º |
| **Caetité** | 307 | 19º |

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| | | |
|---|---|---|
| **Senhor do Bonfim** | 285 | 20º |
| **Santa Maria da Vitória** | 251 | 21º |
| **Serrinha** | 221 | 22º |
| **Jacobina** | 155 | 23º |
| **Guanambi** | 133 | 24º |
| **Feira de Santana** | 125 | 25º |
| **Itaberaba** | 73 | 26º |
| **Juazeiro** | 73 | 27º |
| **Boquira** | 50 | 28º |
| **Mundo Novo** | 20 | 29º |
| **Ibotirama** | 12 | 30º |
| **Paulo Afonso** | 11 | 31º |
| **TOTAL** | **27735** | - |

Source: SESAB/SUVISA/DIVEP/SINAN – Notification Disease Information System

Beyond that, when analyzing the occurrence of the pathology inside the region, it is verified that Mulungu do Morro occupies the 2nd place in number of notifications, along with the city of Barra do Mendes, by being responsible for 16.7% of cases, by showing the relevance of the research (Table 2).

*Table 2. Number of Schistosomiasis cases reported by municipality – Irecê Region Bahia, 2007 – 2017.*

| MUNICIPAL OCCURRENCE | NUMBER OF CASES | % | RANKING |
|---|---|---|---|
| **Irecê** | 104 | 27.8 | 1º |
| **Mulungu do Morro** | **59** | **16.7** | **2º** |
| **Barra do Mendes** | 59 | 16.7 | 3º |
| **Uibaí** | 26 | 7.3 | 4º |
| **América Dourada** | 23 | 6.9 | 5º |
| **João Dourado** | 21 | 6.3 | 6º |
| **Canarana** | 20 | 6.0 | 7º |
| **São Gabriel** | 14 | 3.9 | 8º |
| **Cafarnaum** | 10 | 3.0 | 9º |
| **Xique-Xique** | 4 | 1.2 | 10º |
| **Barro Alto** | 3 | 0.9 | 11º |
| **Jussara** | 3 | 0.9 | 12º |
| **Lapão** | 2 | 0.6 | 13º |
| **Presidente Dutra** | 2 | 0.6 | 14º |
| **Central** | 1 | 0.3 | 15º |
| **Gentio do Ouro** | 1 | 0.3 | 16º |
| **Ibipeba** | 1 | 0.3 | 17º |
| **Ibititá** | 1 | 0.3 | 18º |
| **Total** | 354 | | - |

Source: SESAB/SUVISA/DIVEP/SINAN - Notification Disease Information System

It is noteworthy that the county of this study is classified as focal, that is, it has a circumscribed endemic area, in an area until then indene (where there is no schistosomiasis record), as consequence of environmental or socioeconomic changes that become possible the establishment of the disease transmission (BAHIA, 2019). Among the years of 2007 and 2017, a total of 59 cases of Mansonic Schistosomiasis were reported in the county. By analyzing the Figure 1 it is possible to observe that some

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years presents silent or with an insignificant number of cases, such as 2010, 2012, 2013, 2016 and 2017. In this situation, it is possible to infer that occurs the subordination of cases or that no population surveys were performed, even if it is a city with outbreaks of the disease that needs of frequent actions to the control of the pathology (BRAZIL, 2014). According to Vidal et al. (2011), the subordination generates major problems for the control of schistosomiasis, since the identification of the case, treatment until the preventive measures and fight against reinfection.

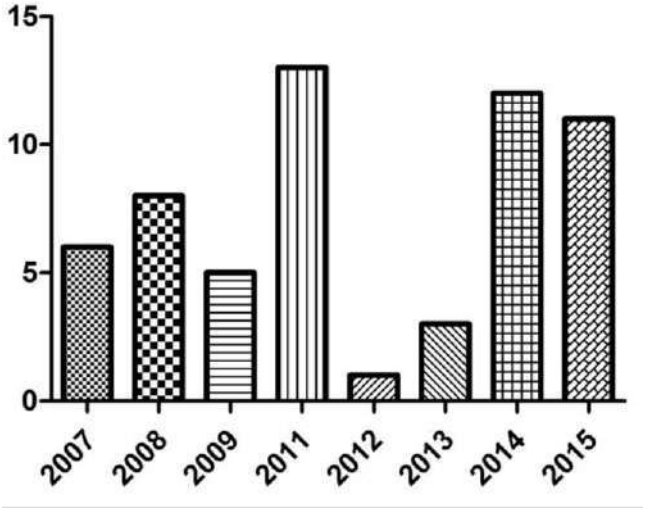


*Fig.1. Number of reported Schistosomiases Cases Mulungu do Morro - BA*
Source: SESAB/SUVISA/DIVEP/SINAN - Notification Disease Information System

Regarding to sex and age group of those ones infected with S. Mansoni (Table 3), in the years of the study, the data show a predominance of males (64.4%) and the economically active age group, from 15 to 50 years. (72.8%), by corroborating with other studies as Cardim et al (2011), in which the male population represented 63.4% (638 / 1,006) and in the economically active range 75%. Besides this, Vasconcelos et al. (2009) verified 21 men from the total of 38 individuals examined in the city of Sabará, Minas Gerais, and Vidal et al (2011) in his research in the city of Jequié, Bahia, found that the most part of confirmed cases of schistosomiasis are concentrated on people aged from 20 to 39 years (2,910 cases) and belong to the male sex.

*Table 3. Schistosomiasis cases reported by sex and age – Mulungu do Morro/BA – 2007 – 2017*

| Sex | Number | % |
|---|---|---|
| **Feminine** | 21 | 35.6 |
| **Male** | 38 | 64.4 |
| | **59** | **100** |
| **Age range** | | |
| **< 1 year** | 1 | 1.7 |
| **1 – 4 years** | 1 | 1.7 |
| **5 – 9 years** | 2 | 2.4 |
| **10 – 14 years** | 7 | 11.9 |
| **15 – 19 years** | 10 | 17.0 |
| **20 – 34 years** | 23 | 38.8 |
| **35 – 49 years** | 10 | 17.0 |
| **50 – 64 years** | 4 | 6.8 |
| **65 – 79 years** | 1 | 1.7 |
| | **59** | **100** |

Source: SESAB/SUVISA/DIVEP/SINAN – Notification Disease Information System

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Regarding to socioeconomical factors, the numbers represent the occurrence by residence area, urban or rural, by showing a hegemoneity of cases occurred in rural areas (79.7%).

It is worth mentioning that, in the year of 2010, the basic sanitation in Mulungu do Morro reached only 0.4% of the population, according to IBGE data (2010), and that despite of the public investments in the area, the sanitary conditions in the last years are still unsatisfactory. This situation is even more precarious in the rural area of the county, where the benefits for the population have not been prioritized yet, by existing a significant discrepancy when they are compared to the benefits of the urban area.

According to MORAES (2011), in all the country around 73% of the sanitation deficit is concentrated in the rural area, where approximately 8.8 million Brazilians do not have adequate access to water supply, while 3, 3 million inhabitants of the urban area are in the same situation.

In the rural area of Mulungu, this fact is verified when it is still verified a lack of supply to the residences of treated water or sewerage system, by being these conditions favorable for the transmission of the pathology as it was verified in other researches.

According to Gomes (2016), the lack of sanitation is a determinant factor for the occurrence of schistosomiasis, since it provides the fecal contamination of hydraulic collections - natural breeding sites of the vector snail. Additionally, according to Silva et. al (2015), the conditions of better quality of life that are not enjoyed by the population, such as a decent income, quality education, access to basic services such as water treatment, sanitation and garbage collection constitute factors that initiates in this area a proliferation of schistosomiasis.

It is known that the most affected areas by schistosomiasis are those ones that presents very poor basic sanitation conditions, poverty and low levels of education (BRASIL, 2014). This way, another social issue to be considered is the relationship of the pathology and educational level of the individual affected. The figure 2 presents considerable indices of low education, by being that 71.1% are represented by people who have only elementary school.

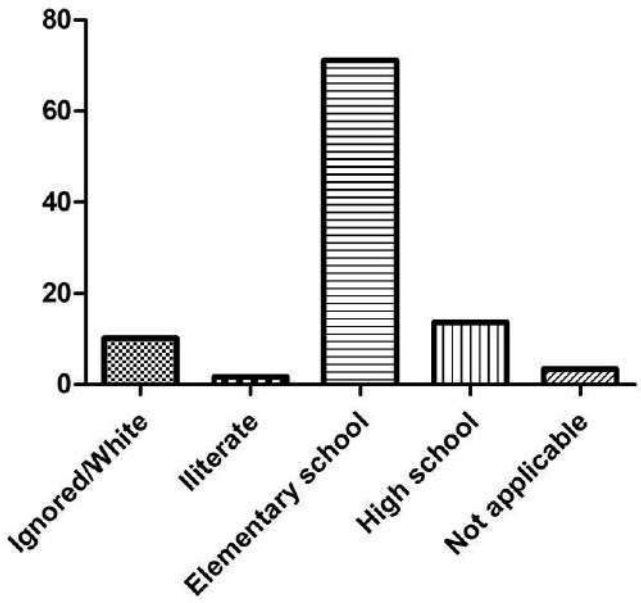


*Fig.2: Percentage of Schistosomiasis cases notified by level of education*
Source: SESAB/SUVISA/DIVEP/SINAN – Notification Disease Information System

Although illiteracy is not significant in the data survey, the low education level is evident in the high percentage of people with only the elementary level, a fact also identified by Silva (2011), who observed a high percentage of illiteracy (27.7%) on the analyzed population, while Silva, et al (2015) report that among the families surveyed by them, 70% had only incomplete elementary school.

Still about the level of education, the study by Melo et. al (2019) shows that schistosomiasis is prevalent in individuals who does not know to read and write (illiterate) and among the ones with few years of schooling (incomplete primary school).

In dealing with the forms of the disease, the data pointed on Figure 3 are referring to the chronic phase of the

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disease, where the intestinal form is the most prevalent, with prominence to the ignored / blank information with very high percentage, by suggesting that there was no definition of the clinical phase or that there was incompleteness in information.

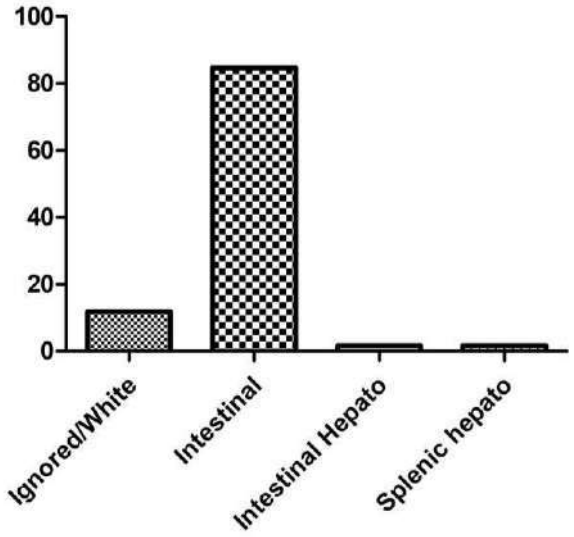


*Fig.3. Percentage of Schistosomiasis Cases by Clinical Form*
Source: SESAB/SUVISA/DIVEP/SINAN – Notification Disease Information System

It is worth mentioning that, according to the information collected, there were not reported any case of schistosomiasis in the acute phase, by highlighting the control of the disease in the early phase. About this issue, Marculino et al. (2016) shows that the parasitological method of feces, according to the Kato-Katz technique, has been used as a unique method for diagnosing the disease. However, in areas where the disease is of low severity, with mild and few specific manifestations, the actual prevalence of the disease is underestimated when it is used only this method to diagnose schistosomiasis.

Additionally, the figure 4 shows aspects related to the evolution of the disease in the period proposed by the study. The high cure rate refers to the use of praziquantel provided by the HUS network and confirming what other studies explain that the rate of adherence to drug treatment in this research was satisfactory, by being above what is recommended (80%) by the Ministry of Health (MELO). , 2019).

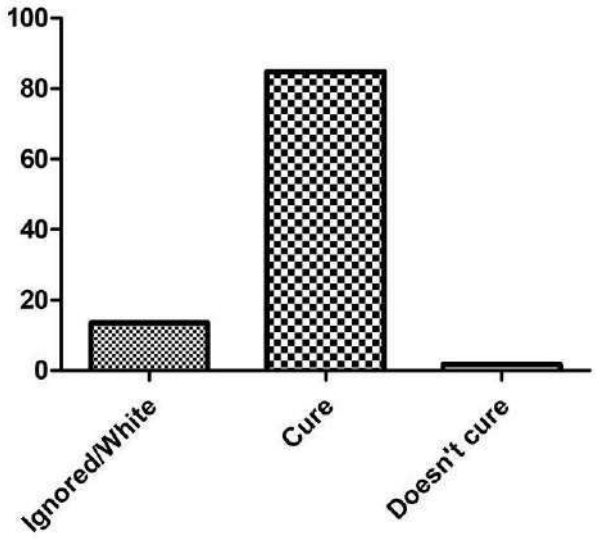


*Fig.4. Percentage of Schistosomiasis cases confirmed by disease progression*
Source: SESAB/SUVISA/DIVEP/SINAN – Notification Disease Information System

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The high cure rate ensures the life of the patient and prevents serious complications of the disease. According to Vidal et. al (2011) it is important that in the treatment of the individuals infected with schistosomiasis, be avoided the worsening of the clinical condition and, consequently, the death.

Throughout the investigation of this study, it was observed the frequency of ignored / blank data, by ranging from 10 to 13.5%, what may interfere in the quality of the information, thus making it impossible a critical evaluation and more trustworthy about the epidemiologic profile of the disease in the county of study.

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# Creating urban health through the promotion of green walls

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***Abstract*****—** *Since the industrial revolution took place, the gap between people and nature has been increasing rapidly. Nature-deficit disorder is the major issue in most cities worldwide. The lack of nature affects our daily lives negatively by threatening our mental and physical health. Many people are experiencing heart disease, high blood pressure, mental illness, and many more due to unhealthy living conditions: air pollution, noise, high temperature and lack of nature.*

*Plants can improve public health by reducing the negative effects of those factors. Although there are some ways to turn nature back to the cities such as public parks, green roofs or street trees, vertical gardens would be a considerable trend in crowded cities where there is a shortage of land as they can cover large areas, and accessible for those who can not afford going to public parks regularly to enjoy the nature.*

***Keywords*****— Green wall, Vertical Garden, Public Health, Mental Illness.**

## I. INTRODUCTION

Urban development has been causing serious economic, social, environmental and health issues in the built environment. It is estimated that 70% of the world's population will live in cities within thirty years. That would be a major shift from nature to crowded cities where the air pollution, temperature and noise are high, Figure (1). This movement would affect the human health negatively as many people will be experiencing different kind of diseases (Danielle & others, 2015).

Cities used to design for 5 miles/hour, yet it goes to 70 miles/hour due to the change of life styles. Back in the days, city planning was based on the human and animal scale, yet it is based on speed of vehicles and public transportation. This shows how far we get away from interacting with nature.

Changing the urban living conditions such as nature connection, air quality, noise, temperature, traffic and so on would improve the health of the city in some points (Dannenberg & others, 2011), Figure (2).

*Fig.1: The gap between people and nature: New York*
Source: https://www.flickr.com

Living walls, green walls, vertical gardens or bio-walls are plants growing vertically on buildings. They can be found on the external or internal walls. A few years ago the notion of green wall was discussed among specialists. However, recently the demand of connecting with nature have been rising including living walls. Since the invention of the hydroponic system, which plants can grow without soil, the usage of living walls has been increasing and changing the way that our cities look (Tong, 2017). A green wall is one of the green architectural practices aimed to reduce the impacts of global warming and increase public health by reducing indoor temperature, noise, air pollution, urban heat island effect and stormwater. Also, vertical gardens can

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improve indoor air quality, building aesthetic, human comfort and biodiversity (Hopkins & Goodwin, 2011).

*Fig.2: The possibility of changing the living conditions.*
Source: https://www.archdaily.com

Green walls can cover large areas, especially in the built environment where high rise buildings are dominated. By doing a math for a tower that has a green wall ratio of one to seven of elevation areas, the plant area would be equal three times the site area. This means we would get more vegetation then what was on the site (Sheweka & Magdy, 2011), Figure (3). Also, " Green walls not only bring nature back into city life, they do so in a way that is accessible to everyone" (Weinmaster, 2009).

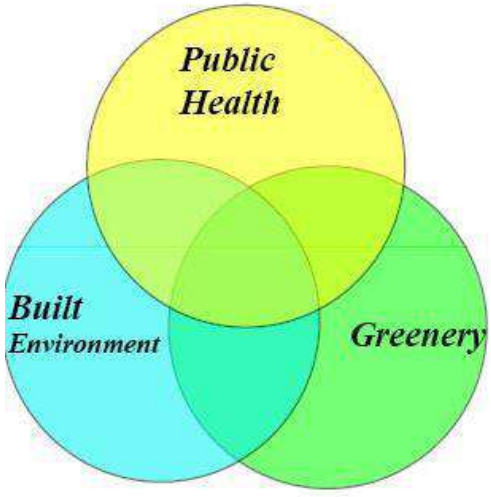
## II. HYPOTHESIS

"The more high-tech our lives become, the more nature we need to achieve natural balance" (Louv, 2011). To achieve natural balance in our daily lives, vertical garden would be a new trend for achieving that as large areas would be turned green especially in crowded cities where high rise buildings are dominated.

## III. IMPORTANCE

Recently many studies have shown that reconnection to nature is the key to human health. The power of nature has impacts on human sense and intelligence including our physical, psychological and mental health (Louv, 2011). Greenery can improve public health by reducing air pollution, urban heat island, noise, and mental illness (Danielle & others, 2015).

*Fig.3: Green walls can restore nature in a larger area of the site.*
Source: https://www.justclick.sg

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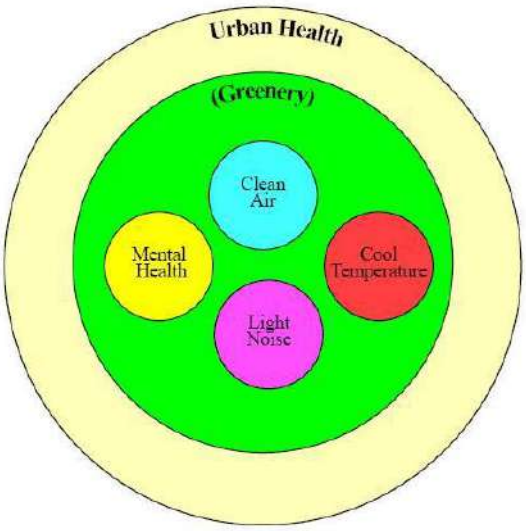


Relationship between plants & urban health

**A- AIR POLLUTION & GREENERY**

Air pollution is a situation where is unhealthy substances are present above their average levels. Those ambients material as a result of traffic vehicles (cars, trucks, motor bikes, etc), waste, wildfire, industrial and residential activities. In 2014, it was estimated that 92% of humans are living under poor air quality that does not meet the air quality standards established by the World Health Organization (WHO). There is an urgent need to improve the air quality since it is invisible threat that affects our health by causing some common diseases like lung cancer, stroke, respiratory diseases and many more. Although 3.7 million premature deaths globally caused by outdoor poor air quality in 2014, that number was estimated to be approximately 9 million annually within forty years (Appuhamillage, 2018).

**Greenery** (vegetation) enhances the quality of the air through the phenomenon of deposition and dispersion. It depends on the kind of plants, their location related to the source of pollution, level of air pollution and the wind direction. Generally, plants can deposit airborne particles once they get to their surface. Plants has 10 to 30 times faster deposition compared to manufactured surfaces such as glass and cement that exist in the built environment. The airborne particles stay on leaves for a while then turn back to the soil once it rains. For a better deposition plants should be hairy and have large leaves, and penetrated for air movement. While trees have the most effective filtering air compared to shorter plants, they should be close to the source of pollution like traffic sources since air passing above or down the leaves is not filtered. For example, lower vegetation on streets that close to the human scale and pollution sources,vehicles, would improve the air quality better than large trees in the same street since the latter gives a chance for wind to spread pollution all over (Janhall,2015).

In addition, plants can increase the oxygen during the day through photosynthesis phenomenon. It is indicated that between 1-3 ton of oxygen per day can be produced in one km2 of trees. This can improve the air quality during the day in crowded cities where CO2 is produced heavily by vehicles. A single tree can filter an average car's exhaust by around 2500 miles/year (Muharam, 2015).

Moreover, indoor air pollution could be as much as ten times outdoor air pollution since finishing materials made by combining many different toxicity chemicals that leads to major health problems. According to EPA more than 300 contaminants are inhaled by people who are living and working in buildings of artificial substances. Almost 90 percent of the time people spend indoors surrounded with toxic substances. A recent study of (NASA) shows that plant can improve the indoor air quality by taking off the toxic chemicals through their leaves or roots depends on the kinds of toxic substances. As a result of that a new integrated system between HVAC system and green wall is invented. This works by using fans behind a green wall to draw the air through vegetation to deliver the harmful ambitions to leaves and roots. Also, Indoor air quality is enhanced since plants enrich oxygen which keeps people alert. Then the clean air is circulated through the building (Weinmaster, 2009).

**B- NOISE & GREENERY**

Noise is known as undesirable sound, and one of the most harmful environmental factors to urban health. According to World Health Organisation (WHO), noise is the second threat to public health, after air pollution. In cities, traffic, trains and airplanes are the main source of noise. Around 36% of disease due to noise in a poor quality of urban planning. Noise makes the response system activated that leads to high stress and heart disease (Ione Avila & others, 2018).

The average noise level in a quiet neighborhood at night around 40 decibels while in a busy street goes up to 75 decibels. In the design process, around 40 decibels would be the goal for a healthy environment ( Hammer & others, 2014).

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Studies have shown, in Manhattan, people have to speak loudly even though they are on the eight floor as the noise level is 66 decibels. In the 1970s, it was found that children living in lower and noisy floors had more difficulty learning than those in higher floors. In 2011, a study demonstrate that 10-decibel increase in airport noise can rise the medication use of anxiety by 28%. Another study showed that depression and heart problems would be increased by 25% for people living in a noisy road traffic than those living in a quiet neighborhood (Sheikh, 2018).

**Plants** and trees can be used as noise barriers in the built environment. Green wall would do the same since vegetation absorb and reduce the penetration of the noise. It depends on the kind of plan and the foliage area. An experiment found that 15 decibels can be reduced of the indoor noise by using green wall system. This indicates the significant benefit of vertical gardens as a sound insulation. Also, this experiment aimed to determine the amount of sound that a vertical garden can absorb. A green wall with ,10m2, was placed on the building and at frequencies of 100–5 000 Hz. The results showed that 40% of the sound was absorbed by green wall. Although 30 to 70 decibels of noise could be reduced by using other systems like double-glazing, green wall is an environmentally friendly insulation that has other benefits such as filtering air pollution, reducing temperature, improve biodiversity, visual quality and creativity (Azkorra & others, 2015).

## C- TEMPERATURE & GREENERY

Temperatures in cities tend to be up to 10°C higher than in surrounding areas. This effect is known as "urban heat island" that causes health, environmental and economical problems. High temperatures increase mortality, due to cardiovascular and respiratory diseases (Ione Avila & others, 2018).

According to Centers for Disease Control (CDC) extreme heat causes around 688 deaths annually in the US. While heat waves don't always case the death, other health consequences can be dangerous, including sunstroke and organ damage. For example, around 692 killed and 3,300 people sent to hospitals once a heat wave hit Chicago in 1995. A study showed that 28 percent of the patients who had a serious heat stroke died within a year of the incident, and most of the survivors have some health issues (Harmon, 2010).

Furthermore, 98.7 degrees Fahrenheit is the normal temperature for the human body. At that level the human body is designed to reduce the temperature through sweating. However, once an extreme heat wave happens, a person may not be able to sweat. That causes serious health problem which leads to death in some cases. People, no matter what their age, with inherent diseases such as heart and lung disease, asthma and diabetes are more affected than others. Heat stroke is not only uncomfortable, but it is life-threatening especially once it lasts for a few days (Carlton, 2018).

Urban heat island effect UHIE occurs since high percentage of solar radiation is absorbed by building and street materials then a huge reflection occurs back and forth among building and urban surfaces. As the temperature is increasing, the demand of air conditioning is increasing too that leads to higher energy consumption and negatively affects the rate of ozone consistence.

**Plants** can reduce the temperature due to evaporation, transpiration and shading phenomenon. This reduction in temperature reduces the negative impacts of the UHIE no matter what kind of plants are used. A study in Oregon showed that non-vegetated areas could reach 50°C in summer whereas vegetated areas stayed at 25°C. Also, green can reduce indoor temperature depends on the kind of plants and greenery systems such as green roofs, green walls or street trees. studies have demonstrated that up to 30% of energy consumption for air conditioning can be reduced by using green walls (Weinmaster, 2009).

Green wall can provide shading for facade that reduces the heat flux into buildings. A study showed that depends on the type of plant ,dense foliage, 40% to 80% of sun radiation can be absorbed or reflected by a fully vegetation wall during summer season (HUI & Zheng, 2013). Also, the thermal performance of vertical garden depends on facade thermal properties, orientation and climate. Studies found that in Berlin, Germany green walls decreased up to 11.3 °C of facade temperature while in Chicago temperatures were reduced up to 1.8 °C, 3.0 °C, 11.1 °C, and 12.6 °C for north, south, west, and east consecutively. In addition, vertical garden can reduce indoor temperature up to 7 °C . Other studies reported a reduction of 0.8 °C to 2.1 °C for ambient air temperature in Chicago, and up to 5 °C in China (Yazdanseta, 2017).

## D- MENTAL HEALTH & GREENERY

In 2005, a study found that 10% of worldwide disease due to mental health problems, and this percentage would be increased to 15% in 2020. Mental health issues can increase anxiety, depression, schizophrenia and suicides. Urban life is high of tension that impacts the mental health

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negatively. However, it is found that greenery such as plants, trees and vegetations, can reduce the negative effects of stress in cities. People are benefited by seeing greenery (Bajirao, 2015).

According to World Health Organization (WHO) mental illness, depression, would be the greatest source of illness by 2020 as it encourages other unhealthy behaviors such as smoking, overeating and over-drinking which lead to serious health problems like diabetes and cancer.

Studies have shown that nature can improve our mental health and reduce stress levels in different levels of engagements. **First** is watching nature through a window or in a picture. **Second** is doing some activities nearby nature such as walking, biking, seating, playing or readings. **Third** is involved with nature in the agricultural industry such as gardens or farms. An experiment indicated that exposure to nature during the physical activity has positive impacts on mental health. The experiment tested the blood pressure, self-esteem, and mood among five groups that were exercising in different urban and rural conditions (Pretty, 2005).

Another review of more than 20 studies indicated that activities such as walking or running ,exposure to vegetations, have greater energy and less anxiety, stress and anger than non green surrounding (Lahart, 2019). Also, an experiment tested the impacts of plants for indoor activities. Heart rate and blood pressure were measured during computer and plant tasks in a room. The results showed blood pressure and heart rate were higher during the computer task than plant task (Lee & others, 2015).

**A question will be asked why people feel more comfortable around plants?**

It was found that around 2,000 shades of green color can be distinguished by the human eye while 100 shades of red color. As a result of that green walls can promote a natural green color that is missing in the concrete cities (Weinmaster, 2009). Also, the relationship between humans and plants is known as Biophilia, natural pleasant that comes from being surrounded by living organisms, that people may not be aware of it. Humans as creatures like to be surrounded by other creatures. For instance, a study found that at Steelcase company 42% of office employees brought plants to their offices. Another study found that plants at workplace reduce anxiety, anger and fatigue by 37%, 44% and 38% respectively, and increase creativity and productivity by +15% (Green Plants for Green Buildings, 2019).

Exposure to green or view images of green spaces can improve patients health. A study in Japan showed that plants can reduce blood pressure, muscle tension, fear, stress, anger and sadness. Another study found that viewing to a green fence has more physiological benefits than concrete fence. Other studies have been conducted that plants can improve the patient's mood, reduce medication use and length of stay in healthcare facilities. On the other hand, a study found negative impacts for patients viewing through windows a sculpture in a garden without any plants. Many studies have recommended investment of gardens in health care facilities, prisons and schools. Plants should be placed in the design of new projects. Increase the awareness of plants benefits for humans. Encourage using any space for placing plants such as window boxes, walls and balconies (Thompson, 2018).

**E- GREENERY & GLOBAL WARMING**

Plants are considered one of the climate change fighters. Global warming occurs as a result of high percentage of CO2, which is due to human activities, in the atmosphere. Photosynthesis phenomenon, which plants take carbon from the air, and provide more Oxygen, can reduce the emissions. However, plants cannot fight climate change by themselves since a lot of water, spaces, budgets, nitrogen fertilizers and technological improvements are needed. It is impossible to plant enough vegations to stop climate change. The only way to avoid natural catastrophes is to cut down on sources of carbon dioxide emissions as fast as possible (DeWeerdt, 2017).

## IV. COST OF VERTICAL GARDENS

Green wall system is considered one of the most expensive man-made walls. In the US depends on the kind of system the installation cost is $75 to $125 per sqft, and the Maintenance Cost is $7 to $12 per sqft (8-10% of installation). This is almost more than double the cost of a green roof system which is $28 to $47 /sqft (Mathew & Salot, 2014). However, the price varies among countries ;for example, in Turkey green facade cost is $3–5 and $4–8 per sqft for a wall with self-winder plants and a wall with wiring mesh system respectively. However, green wall with boxes installed cost $40 per sqft. Also, $5 to $6 per month is the cost of the maintenance per sqft (Meral & others, 2018).

Although it seems that green wall may not be economically sustainable, some studies have shown that green walls can payback the initial cost in the long term regardless of the

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environmental benefits. A study of cost-benefit for living wall systems in a hot climate, showed that 18% of cooling energy was reduced compared to bare wall. It was estimated that vertical garden can payback the initial cost in range of 13 to 17years depends on the local cost of electricity (Haggag & Hassan, 2015).

Another study showed that vertical garden did not create any damage for a plaster over 70 years while the next door building replaced the plater three times during the same period. This means reduce the cost of the regular maintenance. Also, the vertical garden can push the property value up to 15% compared to building in the same location with no greenery systems (Meral & others, 2018).

## V. POLICIES

Although the lack of data, technical issues, risk and cost are the most factors of preventing green walls for spreading out, some countries like Singapore enforces using greenery system with building permits. It is required to create a greenery system ,green roofs or green walls, on the building as much as the area of the land. Singapore government has issued a legislation called LUSH (Landscaping for Urban Spaces and High-rises) for including greenery in buildings. The government is willing to pay up to half the cost of rooftop gardens and green walls. This policy has pushed the movement of green walls rapidly (Velazquez, 2019).

Since the vertical garden system is a new trend in the built environment, it has not yet got governments support or attention as much as green roof systems which spread out in the 1980s. Different policies have been established in different countries based on financial incentives. For example, in Germany 13.5 km2 per year of green roof systems are funded by the government. In Esslingen, government offers 50% back for owners who installed a green roof system while in the cities like Bonn, Cologne, and Mannheim, owners get a reduction for utilities fee. Also, in Toronto, the government subsidizes 50–70% of the entire roof area when in Basel, the government offers 20% of the cost. In the U.S. some states like Oregon 70% of the roofs will be switched to green roofs. New York City encourages the installation of green roof systems by reducing the tax of $4.5/sqft once a green roof system covers 50% or more of the entire roof (Muharam, 2015).

## VI. DISADVANTAGES

While vertical gardens have various advantages, such as reducing temperatures, noise, stormwater, energy consumption, and improving air quality, creativity, biodiversity, aesthetic, mental and physical health, there are some disadvantages such as adding to buildings new loads, costs, damages, high maintenance, allergies and insects. Maintenance is a considerable issue to sustain green wall systems. It is required monthly fertilization and daily or weekly irrigation depending on the climate and plants kind. Another issue might be plant allergies due to their pollen including itchy, sneezing, runny nose and so on. Since some people are sensitive to some kind of plants, designers must study the side effects of plants during the plant selection process (Meral & others, 2018).

## VII. CONCLUSION

Greenery has the potential to be a fundamental factor for improving public health. Cool temperature, clean air, light noise and green connection are creating a healthy environment. Since many cities are crowded, land shortage, and liveless, vertical gardens would be a perfect idea for turning nature back to them. Green walls would increase the chances for people to be surrounded by plants while they are working, walking, driving during a busy day. Low income class would be benefit too as they cannot afford going to public parks constantly. Although green wall systems are expensive, their benefits would pay back on human health and the cost of medicine.

Studies are still needed to investigate the cost reduction on public health as a result of using multiple greenery systems for creating a healthy environment.

It is suggested to increase the awareness of using vertical gardens among designers. Also, governments should subsidize greenery systems, and issue new legislation to encourage developers to do so.

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# Application of Geotechnologies in the Development of Sustainable Agriculture in Brazil

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***Abstract*** *— The global consumption of food, water, fibers and energy is growing at exponential rates. Brazil has become a player of the world economy by becoming an important agricultural producer, and the country has technical and agronomic conditions to produce with quality and sustainability. However, there is a need for more site-specific natural resource management for judicious use of agricultural inputs to promote productivity and ecosystem services. The issue is particularly urgent, as population in rural areas have been migrating to cities for several reasons. Science may decisively contribute to agriculture with sustainability through management procedures that use remote sensing and precision farming. Remote sensing monitoring plays a critical role in supporting strategic decision-making, and to define private and public policies. New researches and innovations have changed rapidly, due to advances in information technology and geotechnology, supported by great data availability, new processing algorithms, data fusion, and developments in data mining. The present review paper aims to present actions of Brazilian Agricultural Research Corporation and collaborating organizations in the application of remote sensing and geospatial databases in the monitoring of Brazilian agriculture.*

***Keywords*** *— **Geotechnology, Natural Resources, Rural Development.***

## I. INTRODUCTION

Brazil covers a total area of 8,514,215 km² and presents a variety of soil and climate conditions reflected in the range of its vegetation types. While agriculture is highly performing producing almost 240 million tons of grains per year on 75 million cultivated hectares [1], it is facing numerous challenges to generate human development in rural populations, and to reduce regional socioeconomic contrasts among territories. The combination of soil conditions, climate, relief, science, technology, public policies, and the competence of farmers has made Brazil one of the world leaders in agricultural production and export. The sector represents approximately 25% of Gross Domestic Product (GDP), and 45% of exports [2].

However, the world population growth, continuous urbanization, long life expectancy, and economic power will further increase consumption of food, fiber and energy in the coming years. Thus, Brazil may assume an even greater role in agricultural production and environmental responsibility. An estimated 9.8 billion people on Earth in 2050 [3] brings up the need to increase food production by 50% when compared to 2013. The need for expansion may occur mainly in regions with high productive potential, such as the Cerrado [4].

The sustainable future of rural areas and agricultural livelihoods relies on the combination and connection of different resource-based products, processes, and services. The underlying concept is Multifunctional agriculture, which is rooted in the fact that farms and farmed landscapes may produce a large array of products and ecosystem services. Although the primary role of agriculture is to produce food and fiber, other functions are important, such as land and water conservation, maintenance of landscape structure, sustainable management of natural resources, biodiversity preservation, and contribution to employment and the socioeconomic viability of rural areas [5; 6]. That is in the context of the 2030 Agenda for Sustainable Development adopted by all United Nations Member States [7].

Geotechnologies expand the possibilities of agricultural monitoring and support rural planning in a sustainable way, not limited to agricultural crops, regions, or class of producers. In increasingly dynamic productive regions, remote sensing and geospatial databases are fundamental for mapping and monitoring the processes of expansion, retraction, conversion, intensification, and agricultural diversification [8]. Multisensor analysis with the synergistic use of satellites, such as Landsat 8 and Sentinel

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create innovative and unprecedented opportunities for more accurate mapping and agricultural monitoring [9].

## II. POTENTIAL OF GEOTECHNOLOGIES

Brazil has an innovative role in the use of geotechnologies in agriculture. However, processes of agricultural expansion, conversion, degradation, and diversification are complex and require innovative, fast, and accurate approaches to spatial analysis. New approaches are required to plan production, management, harvesting, market access, marketing and transportation of grains, fruit, vegetables, meat, milk, eggs, fiber, and timber. The potential use of remote sensing and geospatial databases is part of the 2030 Agenda, which involves 17 Sustainable Development Objectives [10] in the context of digital agriculture (Figure 1 and Table 1).

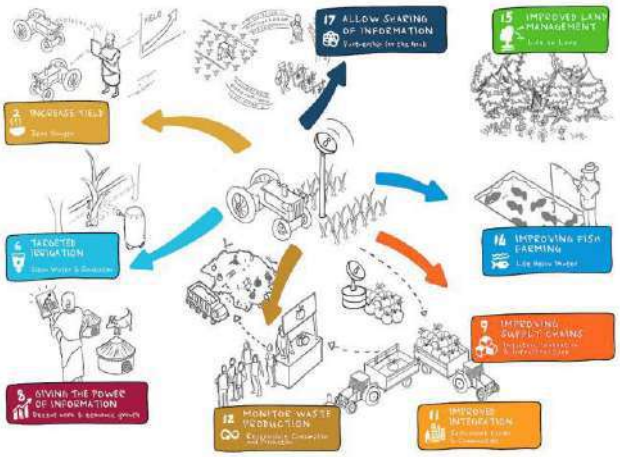


*Fig. 1: Digital agriculture has the potential to advance the SDGs [10].*

*Table 1: Some examples of geotechnologies of application across a wide variety of sectors [10].*

| Sustainable Development Objectives | Areas of Application |
|---|---|
| SDG 2<br>Zero hunger | ▫ Make better farming decisions by supplementing local knowledge developed over generations with real-time, detailed, environmental data.<br>▫ Increase yield per acre and reduce production loss to help improve food security and increase the food output, required to keep up with population growth.<br>▫ Improve transparency and sharing of information. By providing quantitative data on factors that have been difficult until now to measure and interpret, farmers will be able to improve their economic models. Financiers and insurers can also better understand risk to protect farmers financially. |
| SDG 6<br>Availability and sustainable management of water | ▫ Waste less water through a better understanding of soil moisture, crop health and weather forecasting – provide only as much water to the plants as needed.<br>▫ Reduce chemical use and run-off into local water supplies. |
| SDG 8<br>Decent work and economic growth | ▫ Give more power to those working in agriculture and support related innovations such as up-to-date agricultural pricing and trading – particularly the ability to facilitate trade without using intermediaries. |
| SDG 9<br>Industry, innovation, and infrastructure | ▫ Improve resilience and effectiveness of food / farming supply chains through better integrated systems and information sharing. |
| SDG 11<br>Sustainable cities and communities | ▫ Enable more sustainable city growth through better waste management as a result of improved integration across the food value chain. |
| SDG 12<br>Responsible consumption and production | ▫ Provide information which allows consumers to be more responsible.<br>▫ Reduce waste through better decision making across the supply chain, using predictions of harvest yields and quality to improve planning.<br>▫ Reduce waste in storage through improved planning and by linking agricultural sensors with transport management systems to reduce food spoilage.<br>▫ Reduce the chemicals used and improve long-term soil management through better planned crop rotations. |

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| | |
|---|---|
| SDG 14<br>Life below water | ▫ Allow increased freshwater fishing by improving water quality with aquaculture technology.<br>▫ Reduce chemical run-off contaminating oceans. |
| SDG 15<br>Life on land | ▫ Promote more sustainable land ecosystems through a more considered use of farming land and approach to forestry. |
| SDG 17<br>Partnerships for the goals | ▫ Allow companies to partner to increase the impact on all the SDGs through improved availability of information. |

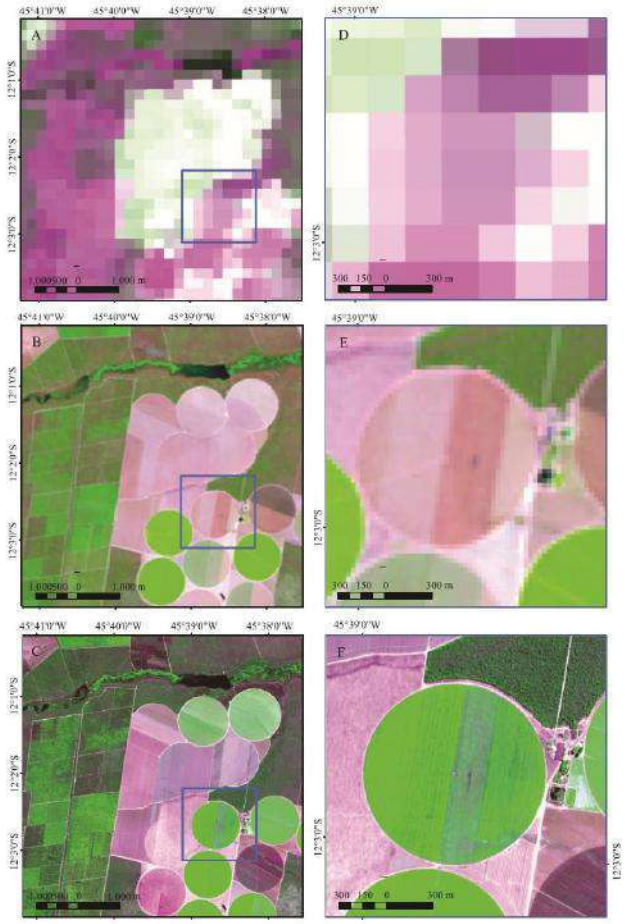

*Fig. 2: Satellite images of: i) low spatial (A and D - Terra / Modis); ii) medium spatial resolution (B and E - Landsat = 30 m); and iii) high spatial resolution (C and F - GeoEye 1 = 2 m) of agricultural region in the Municipality of Luiz Eduardo Magalhães (BA) [13].*

A recent review on the future of Brazilian agriculture [11] identifies megatrends associated with the need for technological and knowledge convergences in agriculture by 2030. The convergences pointed out in geotechnological area are determinant instruments to support decision making of public actions and private activities of rural planning. The remote sensing play an important role in the field, especially in diagnostics as yield estimate, nutritional assessment, detection of pests and diseases, weather forecast, and assessment of plants and water requirement in site-specific [12].

Crop information obtained in a non-destructive, fast, and sometimes at a distance, have become essential to obtain and process agriculture field data. The multiscale and multisensor analyzes offer a myriad of potential benefits in terms of crop yield monitoring, environmental protection, sustainability, food security, and rural economic development (Fig. 2).

## III. APPLICATION OF GEOTECHNOLOGIES

The results of geotechnology applications, such as remote sensing and database multiscale analyzes, will be presented in agriculture monitoring to different regions in Brazil involving the themes: pasture conditions, agricultural mapping, systems of agroforestry mapping, and integrated land-use and land-cover characteristics.

The Brazilian Savanna covers 203.4 million hectares (24% of the country territory), and about 55 million hectares are cultivated with pastures (Figure 3). The study aimed to evaluate the conditions of cultivated pastures. Geoprocessing techniques and Normalized Difference Vegetation Index (NDVI) timeseries data, derived from Spot-Vegetation sensor were applied.

The time-series data indicated 35% of their cultivated pastures under some degradation process. The analyzes were relevant to evaluate the conditions of cultivated pastures, and corroborate to strategic territorial intelligence, as well as the implementation of public and private actions to potential productive pastures [14].

The following study produced land-use and land-cover mapping of the Savannas based on Landsat-8 Operational Land Imager (OLI) images. The results showed that 43.4% of the study area (88.5 million hectares) were already converted into agricultural, urban, and mining areas. The annual croplands represented 8.5% the total area. The red circles indicate traditional agricultural frontiers: western Bahia, southwestern Goiás, and the central part of Mato Grosso. The circle in southern Piauí and Maranhão is the new agricultural frontier (Figure 4) [15].

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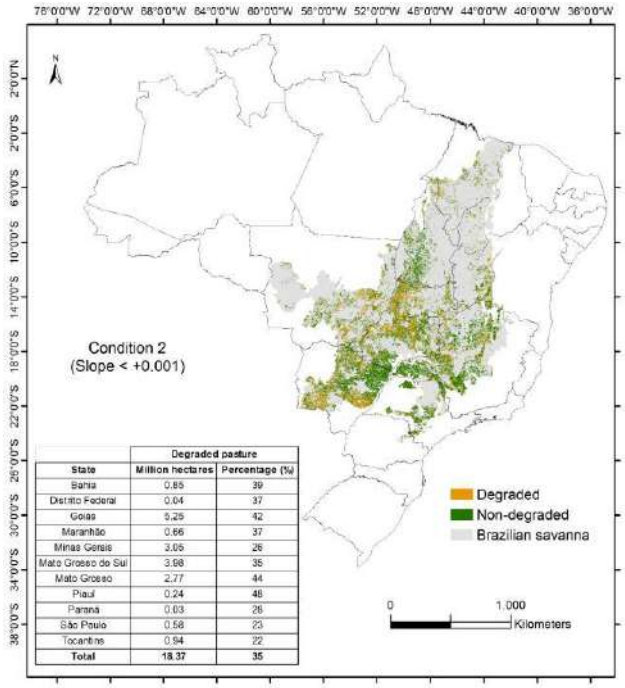


| State | Degraded pasture | |
|---|---|---|
| | Million hectares | Percentage (%) |
| Bahia | 0.85 | 39 |
| Distrito Federal | 0.04 | 37 |
| Goias | 5.25 | 42 |
| Maranhão | 0.66 | 37 |
| Minas Gerais | 3.05 | 26 |
| Mato Grosso do Sul | 3.98 | 35 |
| Mato Grosso | 2.77 | 44 |
| Piauí | 0.24 | 48 |
| Parana | 0.03 | 28 |
| São Paulo | 0.58 | 23 |
| Tocantins | 0.94 | 22 |
| Total | 18.37 | 35 |

*Fig. 3: Spatial distribution of cultivated pastures degraded and no-degraded in the Brazilian Savanna in 2013 [14].*

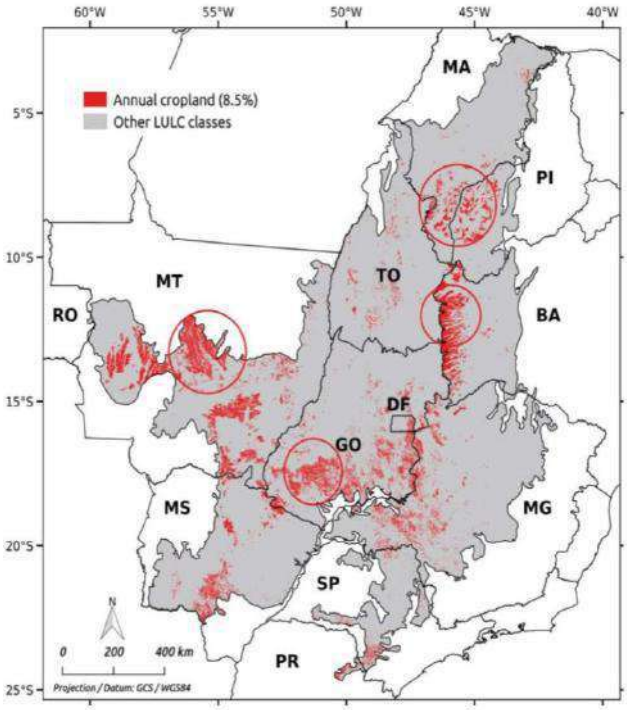


*Fig. 4: Spatial distribution of annual croplands in the Brazilian Savanna in 2013 [15].*

The region known as MATOPIBA (Maranhão, Tocantins, Piauí, and Bahia), in the North/Northeast of Brazil, has become an important agriculture frontier. However, it is important to guarantee that the agricultural expansion in the region happens in a sustainable way. Thus, integrated analyzes of social, biophysical, infrastructure, rural credit, and economical characteristics play important role in establishing regional public policies [16].

This work analyzed the agricultural expansion in the region, and geospatial datasets presenting some conditions - rural settlements, traditional communities, state conservation units, federal conservation units, and indigenous areas (Figure 5).

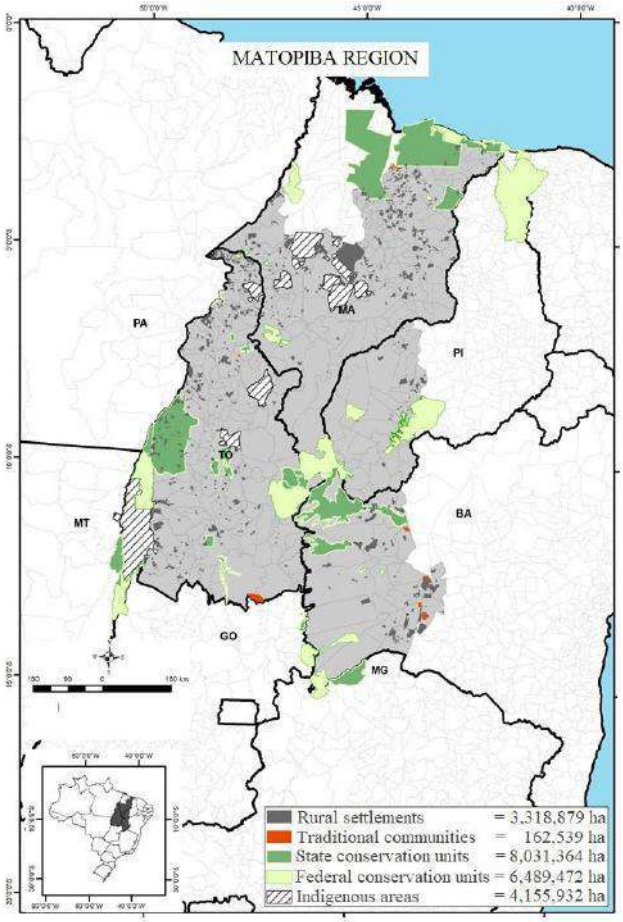


*Fig. 5: Spatial distribution of rural and environmental areas in the MATOPIBA region in 2016 [16].*

The last example analyzes agroforestry systems in Brazilian Amazon. Agroforestry has large potential for carbon sequestration while providing many economical, ecological and social benefits via its diversified products.

The study used Airborne lidar considered as the most accurate technology for mapping aboveground biomass (AGB) over landscape levels. Figure 6 shows maps of vegetation type (a); and AGB predicted with mixed-effect model (b); and fixed-effect model (c); and the difference between AGB predicted with fixed - and mixed - effect models (d). Black color indicates the area masked for analysis [17].

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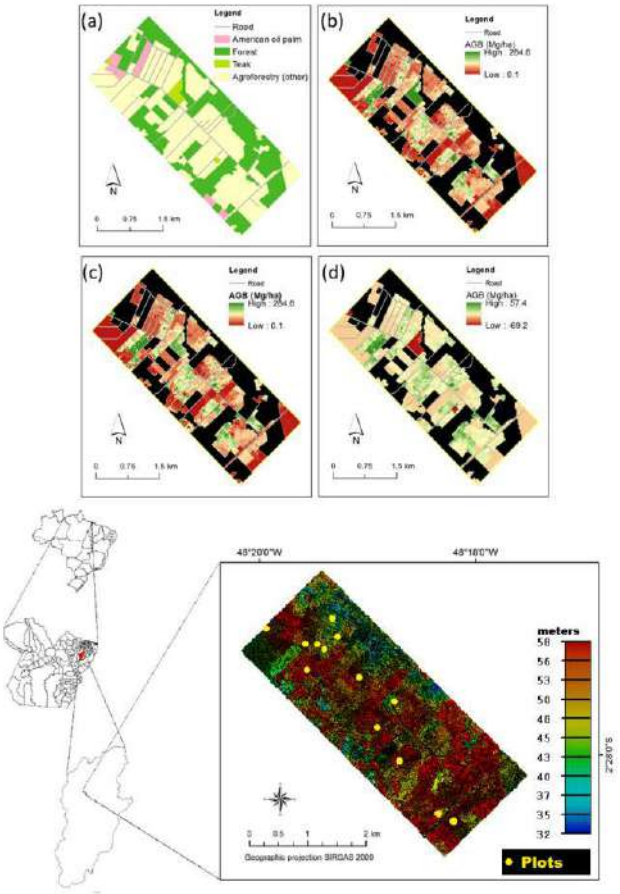


*Fig. 6: Spatial distribution of agroforestry systems in the Tomé-Açu (Amazonia region) in 2016 [17].*

The examples of geospatial monitoring of agriculture by remote sensing presented above support the conservation, recovery, and sustainable use of terrestrial ecosystems. They support the implementation of sustainable management of agricultural crops, pastures, and agroforestry. They enhance the activities of rural environmental register, precision agriculture and agricultural zoning. They also intensify the application of environmental certification of properties, the management of animal welfare, and geotracking, raising food quality and safety. They collaborate planning land-use and occupation with more resilient agricultural practices, such as agroforestry systems.

Geospatial databases store information on plant and animal genetic resources (native and exotic), registration of traditional knowledge, local products and a catalog of attractions that promote rural tourism. They also serve as database for new applications and support decision-making on numerous practices involving animal and plant breeding, as well as to understand the meteorological conditions, such as droughts and floods, collaborating preventively to soil maintenance, water and air quality. Yet, they allow identifying, monitoring and reducing the incidence of pests and diseases in agricultural crops.

Thus, spatial analyzes of mapping and agricultural monitoring assume strategic role in farm planning and to the benefit of more sustainable rural development in a regional way.

## IV. FINAL CONSIDERATIONS

Over the last decades, Brazil has become one of the global leaders in agricultural production. The review paper analyzed how remote sensing and geospatial database may subside and support sustainable development for the country. The results of these actions support public and private decision-making in rural planning and collaborate with the 17 Sustainable Development Goals (SDGs).

Highlighting: i) technology & innovation knowledge to adopt techniques and technologies with adequate agricultural and environmental management; ii) integrated applications of remote sensing and geodatabase providing solutions and information to plan and implement public and private agricultural projects; and iii) use and applications of the emerging space technologies like LiDAR and BigData for agricultural planning and monitoring natural resources towards sustainable rural practices.

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# Effectiveness of acupuncture and myofascial release in analgesia of women with tensional neck pain: Systematic review

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***Abstract*—Introduction:** *Neck pain is defined as the presence of pain in the posterior or lateral postero of the neck and cervical region, which may radiate to the adjacent segments, being a bone, joint or muscle pain. It is a common painful condition that has many forms of treatment, including acupuncture and myofascial release.* ***Objective:*** *To review the analgesic effect of acupuncture and myofascial release in the treatment of patients with tension neck pain.* ***Material and Method:*** *This is a systematic literature review, conducted through a bibliographic survey of articles, theses, monographs, dissertations published from 2005 and books without a specific year. Exclusion attributes were: publications inferior to the year 2005 and that escape the selected theme. Searches were performed on the following databases, Medline, Bvs, Lilacs, Scielo and Google Scholar.* ***Conclusion:*** *It can be concluded that both acupuncture and myofascial release improve pain and quality of life of patients with tension neck pain.*
***Keywords*—Acupuncture, Myofascial, Neck pain, Physiotherapy, Manual therapy.**

## I. INTRODUCTION

Pain in the neck region and cervical vertebrates affect 30% to 50% of the general population, with a predominance in women, leading to occupational clearance according to data from the International Association for the Study of Pain (IASP), updated in 2011 [1, 2].

The cervical spine consists of two segments, upper and lower. The segment consists of the first vertebra, the atlas, and the second vertebra, the axis. These parts are units and together with the occipital, they are part of a joint chain with three axes and three degrees of freedom. The lower segment is formed from the third to the seventh cervical vertebra. The upper and lower segments complement each other for flexion, extension, rotations, and inclinations [3] [4] [5] [6].

The presence of pain in the posterior or posterolateral (PL) region of the neck and cervical region, which may radiate to the head, trunk, upper limbs when it comes to pain of bone, joint or muscular origin. Neck pain is considered a health problem of high prevalence, being even more prevalent than low back pain, but less disabling. It is a common complaint in the general population, making it more frequent with advancing age. It occurs due to the extreme mobility of the cervical spine and the importance of the structures that make up the neck [7].

Risk factors for pathology are age over 40 years, long history of cervical pain, sports such as cycling, low quality of life, emotions such as worry and low vitality [8].

The postural changes found in patients with neck pain are entirely associated with the fact that, from the biomechanical point of view, the cervical region is strongly inserted in the context of the scapular waist through the set of muscles and beams Nervous. Due to the close relationship of origin versus insertion of the muscles of this region, muscle stresses and in particular, the shortening of the high fibers of the trapezoid muscle, will produce traction in the cervical vertebrae and scapula, creating a vicious cycle of muscle shortening, postural change, tension, and pain. Neck pain known as tensions, not a pathology itself, but a symptom or form of manifestation of the type painful muscle syndromes [1].

The painful points of myofascial pain known as

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"trigger points" are more frequent in cervical pain, especially in trapezoid and sternocleidomastoid muscles and little present in this region in an individual without this type of complaint [9].

Tension in the cervical region, currently found itself as one of the musculoskeletal dysfunctions that most affect the population, causing discomfort and pain. Emotional and psychological factors have a great influence on muscle contracture, and stress is the main factor, which may unintentionally lead to muscle contracture of the face, head, and neck. When muscle contraction is intense and frequent, a biochemical reaction begins that releases toxins promotes the reduction of local blood irrigation and muscle pain [10].

In the search for treatments of tension dysfunction, it was possible to observe several types of techniques reported in the literature, including pharmacological and non-pharmacological dysfunction. Among non-pharmacological ones is myofascial release and acupuncture, which currently has efficacy.

Acupuncture has been exercised for about 5.000 years in China and Asian countries. Throughout these millennia, many elaborate concepts and systems have developed that reflected the religious beliefs and medical and socio-cultural traditions of their times. The technique seeks to harmonize the energies of meridians by inserting needles into specific points [11]. Through its technique and methodology, the reflex points that have the property of restoring balance are stimulated, thus achieving the therapeutic benefits [12].

Recently, studies prove the existence of energy channels in acupuncture, which have been identified only by practice and thorough observation of the functioning of the body with its responses and manifestations in line with the nature surrounding it [13].

Myofascial release is one of the techniques widely used in manual therapy, and consists in the release of tension from muscles and fascias, increasing local circulation, reducing pain and spasms [14]. Its main objective is to mobilize tissues facilitating changes in histological length and relieving some of the symptoms of fascial restriction [15].

The fascia is an immense sensitive receiver that reacts to the slightest voltage [16]. Myofascial release is considered a differentiated technique of conventional stretching, depending on the level of muscle stretching being performed passively [17].

This study aims to conduct a systematic review on the effectiveness of acupuncture and myofascial release in the treatment of tension pain in women's necks.

## II. MATERIALS AND METHODS

This is a systematic bibliographic review, carried out through a bibliographic survey related to the theme effectiveness of acupuncture and myofascial release in analgesia in women with tensional neck pain. The inclusion criteria were: articles published from the period of 2005, theses, monographs, dissertations and books without specific year, in Portuguese and foreign. On the other hand, the exclusion criteria adopted: publications without qualis, which do not address the subject treated by the study and of paid character. The research was carried out in the following online databases, Medline (Online System of Searches and Analysis of Medical Literature), Vhls (Virtual Health Library) Lilacs (Latin American and Caribbean Literature in Health Sciences), Scielo (Scientific Electronic Library Online) and Google Scholar. The search strategy consisted of the research of descriptors "Acupuncture"; "Neck pain"; "Physiotherapy"; "Trigger points".

The data collection period was from September to October 2019. After the selection of the material and reading the data, they were analyzed and discussed in order to offer a greater notion about the effectiveness of the therapeutic modalities acupuncture and myofascial release as a treatment for tension pain in the cervical region in Women.

Because it is not a study with humans or animals, the present study did not need to be submitted to the ethics and research committee, according to resolution 466/12.

## III. RESULTS

Based on the searches carried out in the online databases (Medline, Bvs Lilacs, Scielo, and Google Scholar), no articles were found to compare acupuncture and myofascial release techniques in the same study, thus the research was conducted directing the application of each technique.

The crossing of the descriptors and the use of the filters made it possible to obtain a total of 128 references of which 98 were discarded because they did not fit the inclusion criteria. Thus, the sample of this study had 30 references, according to the inclusion criteria and keywords. The tables below show an overview of the reading of the articles chosen for discussion.

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*Table 1 – Studies on acupuncture in the treatment of tension necks pain, according to author, year, type of study, study proposal, methodology, outcome, and outcome.*

| AUTHOR / YEAR | TYPE OF STUDY | METHODOLOGY | OUTCOME |
|---|---|---|---|
| Kim et al, 2013 | Field Study | Retrospective review of electronic medical records of patients receiving acupuncture care between 2010-2012 at the Korean medical hospital of Pusan National University. | The total of 2167 with a mean attendance in acupuncture of 08 sessions was identified. The most treated clinical conditions were back pain (30.5%), necks pain (23.9%) and elbow pain (17.5%). |
| Nakajima et al, 2013 | Field Study | They selected 15 individuals diagnosed with tension at the neck and pain in the upper limbs and/or paresthesias for 13,1 ± 18,0 months. The 15 patients had 16 affected limbs and scored a total of 17 scores of pain and/or paresthesia symptoms. All patients were treated with acupuncture once a week for 4 weeks, at up to 10 sites in the cervical paraspinal region, centered in the affected area. Symptom severity was recorded using an analog visual scale and functional evaluation was performed using a Neck Disability Index | Favorable results were seen in almost 90% of cases. These results show that acupuncture treatment in the cervical region can be effective as conservative therapy in the treatment of tension pain in the neck. |
| Wan, et al, 2014 | Comparative Study | A comparative study Were selected 160 patients with cervical spongy radiculopathy were randomized into three groups: a peer-to-peer group (n = 60) treated with electroacupuncture by the peer-to-peer method; a Jiaji group (n = 60) treated (EX-B 2); a group of medicines (n = 40) treated with oral administration of Jing Fu Kang alone. Clinical efficacies were subsequently compared. | Peer-to-peer electroacupuncture can quickly improve the symptoms and function of patients with cervical spongy radiculopathy and is superior to Jiaji (EX-B 2) and oral administration of Jing Fu Kang in the comparison of clinical efficacy. |
| Figueroa et al, 2015 | Comparative Study | A comparative, open and randomized study in 100 patients of both sexes over 18 years of age, randomly selected. Two groups of 50 patients each were formed; group A acupuncture and treatment of group B with steroidless analgesic and anti-inflammatory therapy the comparative evaluation of the results was performed by the modified Mc Gill Test, on the fifth day and at the end of treatment. For analysis and the chi-square test was used for data processing. | Both treatments are equally effective for relieving neck pain, but acupuncture becomes an elective therapy to be considered as it provides rapid pain relief. |
| Ceccherelli et al, 2010. | Clinical Study | Comparison of the number of needles used to treat neck pain of myofascial origin by checking in patients divided into 02 groups being stimulated om 05 and 11 needles respectively for 100 seconds with pain assessed before, immediately after treatment and with 01 and 03 months of treatment by the MacGill and AVE questionnaire. | In both groups, regardless of the number of needles used, there was a good therapeutic result without relevant clinical differences. |

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*Table 2 – Studies on myofascial release in the treatment of tension pain in the neck, according to author, year, type of study, study proposal, methodology, result, and outcome.*

| AUTHOR / YEAR | TYPE OF STUDY | METHODOLOGY | OUTCOME |
|---|---|---|---|
| Goetten, 2018 | Literature Review | This is a literature review on the theme "effects of myofascial release", carried out through a bibliographic survey, using electronic databases: Scientific Electronic Library Online (SCIELO), Literature Latin American and the Caribbean in Health Sciences (LILACS), National Library of Medicine (MEDLINE), (PubMed), CAPES Portal, Database and Evidence in Physiotherapy. | Myofascial release has shown to have a range of potentially valuable effects for athletes and the general population, such as increased flexibility, increased range of motion, improves joint mobility, decreased pain and improved function. |
| Lambert, et al, 2017 | Systematic Review | Several databases were searched using the terms Mole Tissue Assisted by Instrument, Pain, Function, Graston and Soft Tissue Mobilization (STM). Inclusion criteria included: randomized clinical trials in patients with musculoskeletal impairment, TMS had to be a therapeutic intervention, performed in humans and had to capture a measure of pain or function. The articles were excluded if they were not published in English or whether the subjects were from the pediatric or geriatric population. The included articles were evaluated using the Physiotherapy Evidence Database scale. | These results support the idea that IASTM can have an impact on physiological changes, providing an increase in blood flow, reduced tissue viscosity, myofascial release, interruption of pain receptors and improving flexibility of the underlying tissue. IASTM is suggested to be an effective intervention in the treatment to reduce pain and improve function in less than a period of three months. |
| Rodriguez et al, 2018 | Comparative Study | Forty-one participants with neck pain were randomly allocated to a group of MRT (five sessions) or in a physiotherapy group (TP) (ten sessions) for two weeks. The multimodal TP program included ultrasound therapy (US), transcutaneous electrical nerve stimulation and massage. Visual analog scale (VAS) and PPTs in the suboccipital muscles and upper trapezoid were measured at the beginning, at the end of treatment and in the 1-month follow-up. | This study provides evidence that MRT could be better than a multimodal TP program for short-term pain improvement and PPTs in patients with neck pain. |
| Santos e Joia, 2018 | Literature Review | The present study was conducted through bibliographic research with searches on sites such as Google scholar, Scielo, Lilacs and Bireme on the topic in question. Papers published as articles, theses and monographs were analyzed in order to analyze the efficiency of myofascial release in treatments of neck pain. Publications from 2009 to 2018 were analyzed. | It is concluded that myofascial release is efficient in the treatments of neck pain, but its effectiveness is in fact proof when associated with other types of treatments, whether drug or not. |
| Borges et al, 2013 | Field Study | The study included 15 patients (10 women and 5 men). The significance level adopted was $p < 0.05$. | The present study concludes that physiotherapeutic intervention composed of stretching exercises, relaxation techniques, massages, and electrotherapy were beneficial to improve quality of life and flexibility in patients with chronic neck pain. |

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## IV. DISCUSSIONS

Pain in the neck region is a complaint that removes a large number of workers from their professional activities. Its origin comes from several factors, such as mechanical traumas (whip effect), postural changes that consolidate and compensate in rectifications of normal curvature of the spine. Degenerative processes of arthrosis and osteophytosis that can generate compressions and loss of joint mobility, more common in elderly individuals, since it is a process of degeneration that worsens with age [1].

Physiotherapy is important in the treatment of patients with chronic cervical pain, especially those of tensional origin. Therapy seeks to reduce pain, recover mobility and strengthen muscles, thus providing improvement in quality of life. Acupuncture and myofascial release are practiced worldwide for the treatment of various health conditions, including acute, acute and acute chronic pain [18].

### 4.1 Acupuncture

In the last decade, acupuncture has become a therapeutic option widely used in the treatment of pain. Despite progress in the development of drugs that help in the management of pain conditions, there is growing concern about side effects, especially analgesics and non-steroidal anti-inflammatory drugs [19].

Systemic acupuncture and electroacupuncture, auriculotherapy, craniopuncture, and wind therapy techniques have been shown to be effective means for the treatment of tension pain in the neck [20].

The treatment of tension pain in the neck with the different methods used in acupuncture proved to be quite effective and reached a high rate of improvement in recovery patients undergoing this therapy [21].

Kin [22] states in his study with a sample of 2.167 patients that acupuncture is recommended for the management of persistent chronic pain conditions. In addition, it demonstrates that most of the symptoms treated by acupuncture are low back pain (30.5%) and cervical pain (29.4%) and needle stimulation techniques are manual in 52% of cases or via electroacupuncture in 47.4% of the 16,965 acupuncture sessions performed in their studies.

The use of acupuncture in chronic tension pain in the neck was beneficial in 90% of the cases followed by [23]. When associated with electroacupuncture in treatment with needles symptoms reduce rapidly, thus improving the functions of patients with cervical tension and or radiculopathy [24].

In Perez study [25], acupuncture has been more effective than drug treatment for the relief of nontraumatic cervical tension pain, due to rapid response in pain reduction, thus becoming an elective therapy to consider, especially when the patient may not receive drug treatment due to medical indications or other conditions. The following table shows the results found by Perez.

*Table 3 - Comparison of painful condition in the treatment of cervical pain with acupuncture and drug technique conducted in Perez study.*

| **Relief of Pain** | **Group A Acupuncture** | | **Group B Medicines** | |
|---|---|---|---|---|
| | Number of cases | % | Number of cases | % |
| **Immediate** | 24 | 48 | 0 | 0 |
| **Mediated: 2 – 5 sessions** | 14 | 28 | 6 | 2 |
| **Late: 6 – 10 sessions** | 9 | 18 | 21 | 2 |
| **No relief** | 3 | 6 | 23 | 6 |
| **Total** | 50 | 100 | 50 | 00 |

In relation to the number of needles used in the treatment of tension cervical, Ceccherelli [26]compared the use of 5 and 11 needles and after their analysis found that the number of needles is not an important variable in the therapeutic effect when the stimulation time is the same in both groups, because regardless of the number of needles used the two groups obtained good therapeutic effect without clinically relevant differences.

### 4.2 Myofascial release

According to Goetten [2], myofascial release aims at muscle relaxation and pain reduction through the application of low load pressure and long duration, as well as acting efficiently in reducing neck pain. There is literary evidence that myofascial release associated or not with other therapy, relieves pain and improves skeletal muscle function as much as other conventional techniques and therapies.

Rodriguez [27] investigated the efficacy of myofascial release in mechanical cervical pain in relation to the pressure pain threshold, and 41 adult subjects were evaluated. The interventions that the authors used were myofascial release with progressive deep pressure and multimodal physiotherapy intervention with ultrasound application, Transcutaneous Nerve Electrical Stimulation (TENS) and classical massage. They concluded that at the end of treatment, patients submitted to myofascial release obtained a significant improvement in pain when compared to the subjects of the multimodal program. This result remained after one month, thus, the authors concluded that manual myofascial release proved to be effective and

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superior to multimodal intervention with electrotherapy and classical massage in pain relief in patients with tension pain in the neck of the nonspecific mechanical type.

Santos and Joia [28] affirm that myofascial release is efficient in treatments of neck pain, but its effectiveness is higher when associated with other types of treatments, whether drug or not.

Therefore, myofascial release has efficiency in improving symptoms of tension pain in the neck, being applied exclusively or added to other therapies. It is important to note that this efficiency depends on the degree, type and origin of dysfunction, since each patient may present more or less pain, as well as limitations [2].

Regarding instrumental myofascial release, Lambert et al [29], pointed out that this technique has effects on the inactivation of painful receptors and increased tissue flexibility, indicating the effectiveness of the technique, but emphasizes the need for greater understanding of manual therapeutic methods.

Physiotherapeutic treatment in patients with tension pain in the neck especially the chronic provides significant improvement in the quality of life and range of motion of the region in adults, and the improvement in related aspects is also proven physical, psychological, level of independence and social relations [30].

## V. CONCLUSION

It is concluded that both acupuncture and myofascial release promote improvement in pain and quality of life of patients affected with tension pain in the neck.

Acupuncture promotes significant improvement because its effect on pain is rapidly acting, making it more efficient in relation to drug treatment in non-traumatic lesions. The technique is also efficient in the management of chronic and persistent pain conditions, and its efficiency is potentiated when associated with electroacupuncture.

Myofascial release promotes significant improvement of symptoms to give tension pain in the neck region, and when associated with other techniques has its efficiency potentiated.

Since the way, both techniques promote significant improvement in the quality of life and range of motion of the spine, but still much to be studied about both techniques and together, later comparing which technique is most effective in this algetic picture.

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# Sociodemographic profile and memories of the post-discharge intensive care unit patient

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***Abstract*** *— The objective of this research is to determinate the capacity of the critical patient to remember what he lived through the time into adult ICU hospitalization after discharge and to stablish a sociodemographic profile. It is a descriptive and transversal study, held at an Intensive Care Center from a Large Hospital at Rondônia Countryside. 50 participants were obtained under average age of 53 years. They answered to a sociodemographic questionnaire and to the Costa and Macron Inventory, (2009). The research started after approval from the Ethics and Research Committee under the assent number 2.899.338. The data description was done through Excel® and Word®, and the statistical analysis through the R Studio program. It was found that most of the participants were male (54%), wherein 54% declared to be married, 76% live in Urban Zone, and the average time of internship was 15 days, the highest diagnostic incidence was Postoperative Surgery related to Tumor and Cancer (28%). About the memories; 18% of the participants do not preset memories, 82% present memories from real facts, 73.17% present illusory memories. Considering the p-value was 2.89; it is stated that the null hypothesis from this work was disregarded. The gathered data is of extreme relevance for hospital psychologists, making it possible to know the patients' reality. It is necessary for new researches to be done for a deeper analysis of these data, thus evaluating the possible causes for the absence of memories from the minority, and the care relation concerning the majority.*

***Keywords*** *— **Memory; Hospital Psychology; Intensive Care; Memory.***

## I. INTRODUCTION

According to Le Goff (2017); memory is a gathering of psychic functions whose objective is to store information. Therefore memory is an indispensable process for the human being, because it allows us to create memories about our life's history. Dividino e Faigle (2004) add by stating that memory is a complex process by which the received information from the surroundings are manipulated and comprehended through codification, retention and recover mechanisms which allow people to live a situation and then revive it through memories.

Izquierdo (2018), reports that memories comes from experiences, therefore there are so many memories as possible experiences. Thereby it is possible to say; that which is experienced by the subject and the way through which he understands a certain situation, will constitute his memory about that moment. Therefore when considering memories from hospitalization periods, many different variants should be considered, as for environment, weather, the subject's psychic structure, conscience state, the medications, lastly, there are many different factors that can alter the subject's perception, and consequently;

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his memories from what happens through this period (Le Goff, 2017).

Before that, Rovatti (2010) states that each subject has an individual and unique way do perceive and crate memories, while some left the intensive care unit – ICU carrying positive and real memories, others will remember anguish, pain and suffering, which makes the patient to perceive the ICU as a hostile environment that may contribute for psychic illness.

The intense care unit is a place specialized in high complexity treatment of severe patients at risk of death and for this reason; it has greater mystification in popular belief accounting a large number of people still relating it to death instead of perceiving it as an intense care ambiance that may allow a better chance for life. It encompass the subject as a whole, turning him previously fearful of something, frequently experiencing an anticipated mourning, factors that can unleash a change of behavior caused by fear, anguish, stress and anxiety. Along that; the subject can end up developing a series of forthcoming problems, such as Post-Traumatic Stress Disorder – PTSD (Costa, Marcon & Rossi, 2012).

A study by Pina, Lapchinsk and Pupulim (2008), stated that some patients relate internship in ICU with emotional aspects such as family health, lowliness, shame, while others identify this place as one that can promote cure and therefore the continuity of life. Thereby it can be said that the perception each patient will have about the unit meets what was experienced, if they had their physical and emotional needs attended and hosted by the team, and also the care for the relatives.

According to Rovatti (2010), the ICU hospitalization will mark not only the subject's life, but also the lives of his relatives and the team. Being this period defined by the generated memories about the entire ambience and the provided conduct, which may in turn have various effects which Amaral (1997 as quoted in Rovatti, 2010) describes as consequences from the hospitalization period, which are: delirium, organic confusion, some disorders such as PTSD, anxiety, depression and cognitive deficit.

Therefore this research is of paramount importance and relevance, because from this one it will be obtained the memory evaluation from the patients thus allowing a multi-professional team use aiming to humanize the attendance of the subject who is there; by knowing that hearing is essential to understand the patient, since it will allow a communication improvement, which on its turn will allow the comprehension of the subject's real necessities, being a toll that the whole team may and should use.

Given the above; the necessity to evaluate the memories presented by the patients about their ICU hospitalization period is justified, because this information can be used as a toll for a humanized multidisciplinary treatment. Thus, the research objective was to determine the critical patient capacity to remember what he experienced through the adult ICU hospitalization time after the discharge, and to stablish a sociodemographic profile.

## II. MATERIAL AND METHOD

It is a transversal study of descriptive character, under a quantity-qualitative approach, performed at the Intensive Care Center – ICC from a Large Hospital at Rondônia (Brazil) South Countryside, from May to June 2019.

The population universe amounted to 153 patients; the inclusion criteria was people from both genders; older than 18 years old; not accounting for religious belief; patients who have being placed in adult ICU for a period superior or equal to 72 hours; patients who were or not in mechanical ventilation; patients who were or not in induced coma who, by the moment of discharge, are clinically able to answer to the questionnaire; those who have agreed to the research and have signed the Informed Consent Form (ICF).

Were excluded from the research: people who were under no condition to answer to the inventory; indigenous patients; people with injuries that made them unable to speak; patients who died before the moment of discharge; patients who displayed some previous disease which could affect his cognition and ability to remember; those who did not agreed on participating from the research. Under the inclusion and exclusion criteria the sample unit amounted to 50 patients.

The gathering of information was done through form fulfillment and validated by Costa and Marcon (2009), entitled as an Instrument to Identify Memories from the Intensive Care Unit – IAM [Brazilian abbreviation], adapted accordingly to the researchers' demands, being composed of 7 open questions and 13 closed ones. The analyzed variants were: Age, Gender, Schooling, Diagnostics, Period of Hospitalization, Residence, Profession, Marital Status, Time of discharge from the ICU, and the factors directly tied to the patients' memories. On their turn these factors were subdivided by three realms classified as: total absence of memories (total amnesia), real fact memories (memories from the treatment/ambiance/emotional) and illusory memories (nightmares, hallucinations, dreams).

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The research was made after consent from the Research and Ethical Committee (CEP) [Brazilian initials] from the Cacoal Biomedical Sciences College (FACIMED) under CAAE [Presenting Certification for Ethical Evaluation] number: 97078518.9.0000.5298, favorable assent number 2.899.338 in the year 2018, as for the Hospital General Office and Nursery Management responsible for the ICU and clinics, authorized under memo approved in 10/01/2018.

The data gathering and description was done through *Windows Explorer: Excel® and Word®* (2010) operational system, where the charts were made separating the data for further statistical analysis through the *R Studio* program using *R* language.

For the demographic data analysis and observation; the regression analysis was done through the general idea of examining two elements: (1) a pack of predictor variables do a good job by preventing a variable from a (dependent) result (2) which particular variables are significant predictors from the outcome variable and by which manner they – indicated by the magnitude and signal from the *beta* estimates – affect the outcome variable. These regression estimates are used in order to explain and predict the relation between one dependent variable and one or more independent variable.

Through this analysis it is also obtained the *F* statistical value. Including the *t tests*, this is the second "test" that the abstract function produces for the linear regression models. The *F* statistic is a "global" test which verifies if at least one of its coefficients is different from zero.

Lastly, the *p* value is also obtained. In the classic statistic field, the *p-value* (also known as descriptive level or probability of significance) is the probability to achieve a test statistic equal to or more extreme than the one observed in a data sample under null hypothesis. As a pattern in hypothesis tests; the null hypothesis can be rejected under 5% in case the p-value is less than 5%.

Non-parametric tests were used, because there is no normality or homoscedasticity guarantee from the data. The *Friedman* non-parametric test, according to Hodges and Lehmann (1962), is applied to point statistical differences between groups of results. After confirming the existence of differences between the groups, a *post hoc* test is applied in order to verify which groups show these differences. For that; the *Wilcoxon* (Wilcoxon, 1992) non-parity non-parametric test was used.

## III. RESULTS

50 patients participated in the research, ages between 18 and 88 years old, an average of 53 years old. About gender; the higher admission rate was from males (54%), followed by women (46%). The marital status has shown that (54%) were married, (20%) single, (10%) divorced, (12%) widowed and (4%) did not answered. Most of the patients live in urban zone (76%) and (24%) live in countryside. About the average time of stay in the ICC; from the ones who participated in this research the obtained result was 15 days.

About the medical diagnostics; the research revealed 21 categories, among them: the immediate postoperative from surgeries related to Tumors and Cancer (28%), followed by diagnosis of Chronic Kidney Failure (10%), Sepsis and Botulism representing 8% of the participants. As revealed by chart 1 where all shown diagnostics are displayed and its proportions relating to the studied population.

Besides the simple data description; this work did statistical analysis in the sociodemographic data, aiming to verify and validate the gathered information. Considering the previously presented facts about the medical diagnosis, gender and internship period from the patient; the linear regression was statistically applied, where I have obtained the presented values: minimal (-38,412), 1° *quart (4,130) and median* (0,000) 3° *quart* (7.523) and maximum (7,773).

The residual standard error value was 14,84 in 26 degree of freedom. The resulting multiple *R-squared;* also known as coefficient of determination, is a frequently quoted measure of how well your model adjust to the data. Although there are many problems by using it alone, it is a fast verification and pre-calculated for its model. In this model the value is 0,7275 for the *multiple R-squared*. The adjusted *R-square* normalizes the *multiple R-squared* considering how many samples you have and how many variants are being used. In this model, the adjusted *R-square* value is 0,4864.

In this analysis it is also obtained the *F* statistic value. The result from the *F* statistic for this model was 3.018 in 23 variants and 26 degrees of freedom. Lastly, the *p* value is also obtained. In the particular case of the data sample from this project, for this case, the *p-value* was 0,003754

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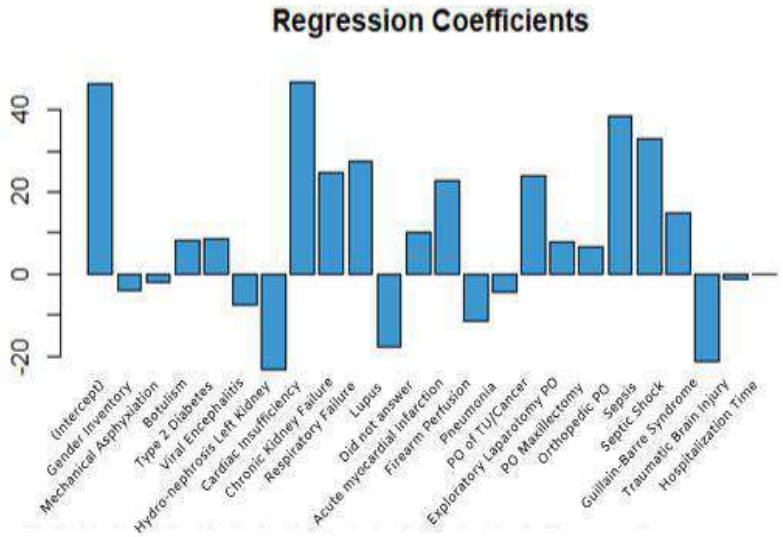
*Chart 1: Distribution of the medical diagnostics and the proportions found among the adult ICU from the HRC – Rondônia(Brazil), 2019.*

| **Medical Diagnostic** | **N** | **%** |
|---|---|---|
| Did not answer | 3 | 6% |
| Lupus | 1 | 2% |
| PO of TU/Cancer | 14 | 28% |
| Botulism | 4 | 8% |
| Sepsis | 4 | 8% |
| Liver Abscess | 1 | 2% |
| Orthopedic PO/Osteomyelitis | 2 | 4% |
| Guillain-Barre Syndrome | 1 | 2% |
| Chronic Kidney Failure | 5 | 10% |
| Mechanical Asphyxiation (Suicide Attempt) | 1 | 2% |
| Firearm Perfusion | 2 | 4% |
| Respiratory Failure | 1 | 2% |
| Hydro-nephrosis Left Kidney | 1 | 2% |
| Acute myocardial Infarction | 1 | 2% |
| PO Maxillectomy | 1 | 2% |
| Pneumonia | 3 | 6% |
| Exploratory Laparotomy PO | 1 | 2% |
| Cardiac Insufficiency | 1 | 2% |
| Type 2 Diabetes | 1 | 2% |
| LIGHT TBI | 1 | 2% |
| Viral Encephalitis | 1 | 2% |
| TOTAL | 50 | 100% |

**Source: The authors** (2019).
***Label:*** *PO: Post-operative, TU: Tumor, TBI:* Traumatic Brain Injury.

*Graphic 1: Ilustration of the linear regression for all of the medical diagnistics, gender and period of hospitalization from the used variables, Rondônia(Brazil), 2019.*




**Source:** The authors, (2019).

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The non-parametric test of *Friedman* (Hodges and Lehmann, 1962) is applied to point out the statistical differences between groups of results. The considered significance level for the hypothesis test was 0,05. This methodology was applied through all base variables from the utilized data. The *Friedman* test value was equal to 122,28 with 3 degrees of freedom and the *p-value* equal to 2,2. This result does not show data relevance when applied the *Friedman* test for such variables.

About memory; only (18%) does not present any kind of memory from the period of hospitalization in ICU, while (82%) presented memories from the period of hospitalization, which were concerning to the treatment, ambiance, and both physical and emotional experiences.

The memories from treatment revealed that the highest memory was from body and oral cleansing moment (95%), followed by the daily proceedings, common to all patients such as routine exam collection (92%), and the devices placed around them such as monitors, infusion bomb and mechanical ventilator (90%). Those with the least memory were the extubation moment (87%), use of endotracheal tube (70%), and airway aspiration (61%).

As for the ambiance characterized memories, it was verified a predominance in the presence of memories through all the evaluated factors, being the most frequent ones: the moment of visitation from friends and relatives (97%), followed by the presence of other patients from the unit (92%) and also the alarm noises from the devices (83%).

From the evaluated physical and emotional experiences the ones which obtained most memories were: anxiety feeling and/or fear (73%), trouble sleeping (68%), breaking even with memory of being thirst/hunger (68%) and memory of feeling pain (68%). The least remembered were: being restrained to bed (73%), feeling alone (63%) and difficulty to communicate (56%).

About the illusory memory; it was found that (73,17%) of the participants who remember the ICU period of hospitalization, remember having dreams, nightmares and/or hallucinations during the period of hospitalization.

In order to obtain a statistical analysis from the results referring to memory; the linear regression of the data was done and tests of non-parametric hypothesis were used, because there is no guarantee of the data normality and homoscedasticity.

From the linear regression of these data I obtained the following data, related to the presence of the patients' memories: minimal (-1.841), 1° *quart (-1.032)* and *median* of (0.931) 3° *quart* (0,931) and maximum (1.728).

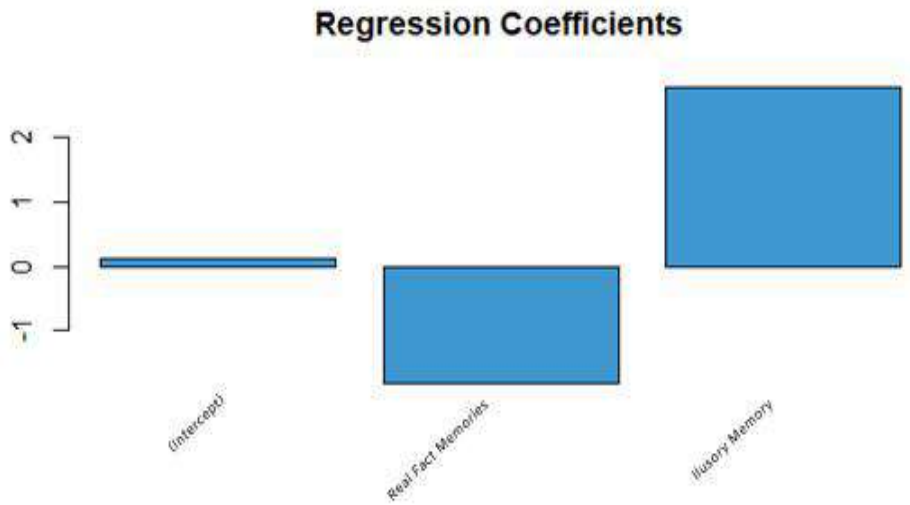
*Chart 2: Clipping from the linear regression results for the illusory and real fact memories results, Rondônia(Brazil), 2019.*

| **Coefficients** | **Estimated** | **Standard error** | ***T-value*** |
|---|---|---|---|
| *Intercept* | 0.10547 | 0.19578 | 0.539 |
| Real fact memories | -1.80880 | 0.08044 | -22.485 |
| Illusory memories | 2.77229 | 0.09591 | 28.906 |

**Source:** The authors, (2019).

A residual standard error was obtained: 1.244 in 49 degrees of freedom, *multiple R-squared:* 0.9511, *adjusted R-squared*: 0.9491, *F-statistic*: 476.8 in 2 variables and 49 degrees of freedom and the *p-value*: 2.2.

*Chart 2: Illustration of the linear regression for all the utilized variables in this model, Rondônia (Brazil), 2019.*




**Source:** The authors, (2019).

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Beyond the linear regression, the *Friedman* test (Hodges and Lehmann, 1962) was applied to the data, a non-parametric test which is applied to point out statistical differences between groups of results. The significance level considered for the hypothesis test was 0,05. Where a value was obtained in the *Friedman* test equal to 30.114 under 2 degree of freedom and the *p-value* equal to 2,89.

Based on the linear regression and the *Friedman* non-parametric test, it can be stated that the presented value for total amnesia was not significant, being disregarded for that reason, which confirms the true hypothesis of this research.

## IV. DISCUSSION

The aforementioned results have being contextualized based on ideas from researchers of hospital psychology field, such as Alfredo Simonetti. Correlating the results from the research, we can infer them upon the diagnostics concepts proposed by Simonetti (2018), who has stablished in chapter II from his book entitled "Manual de Psicologia Hopitalar*"* [Hospital Psychology Manual] that in order to obtain a psychological diagnostics in a hospital unit it is necessary to go beyond the known traditional psychodiagnosis used in clinics, being necessary to pay attention to the four diagnostic axis: situation, medical, reactionary and transference diagnostic axis.

About the presented sociodemographic data, Simonetti (p. 74, 2018), states that this category is part of the situational diagnostic, which is the diagnostic that allow observation of the patient's life from a panoramic view in order to verify the areas not directly related to the sickness, but which are influenced by it. Upon that, it is necessary to draw the sick subject's sociodemographic profile and to observe the factor that may hinder the disease treatment.

Contemporary studies by Melo, Menegueti and Laus (2014), revealed that the average age from the studied patients in a public ICU from Paulist countryside was 49 years old, under predominance of (64,9%) of males, yet the present research revealed that the average age was 53 years old and about the most predominant gender, it meets the aforementioned study being the male under 54%, which is also reinforced in the Rocha, Caetano, Soares and Medeiros (2007) study, where most of the patients were male (59,1%), Cavalcanti (2019) pointed through his results that men were predominant in ICU (64,3%), all of those data befits the presented reality. Men historically present the caretaker, householder and alfa male role, which can frequently represent a consequential lack of self-care with his physical and mental health, thus inferring that men are more susceptible to the need for an intensive hospitalization than women are.

Melo *et al* (2014), states in his study done at a public ICU in Paulist countryside; that married/cohabiting patients were the most acknowledged in ICU under (45,5%) followed by singles, moreover, about the marital status the present study has shown that (54%) were married and (20%) were single.

When the residence variable was analyzed, the study stated that most of the patients live in urban area (76%) and (24%) live in countryside, confronting these data against the ones found by Schmidt (2014), (65,9%) of the patients live in urban area and the rest in countryside, the life style of countryside people is different from the ones who live in urban areas, these ones are constantly stimulated, thus having a frequently intense and exhausting life style, with no time to look for attendance for their health, and other preventive measures that could contribute over preemptively identifying abnormal findings; besides the stress and anxiety daily conditioned.

When analyzing the points where the subject is inserted and his peculiar characteristics, the medical diagnostic which is considered one of the psychodiagnosis axis by (Simonetti, p.70, 2014), it is relevant, because from it we can gather information to guide the kind of psychological treatment to be offered for the patient. Inside it, we can gather information about the disease, proposed treatment, medication, adherence to the treatment, prognostics, risk of contagion and comorbidities.

The Neoplasia represents most of the diagnostics which has taken patients to ICU. Such disease is still considered little known nowadays, although according to Brazilian Ministry of Health – National Cancer Institute (INCA) (2018), it has affected 282.450 women and 300.140 men in Brazil. The estimation from the same institute for new cases in Rondônia is: 1.620 neoplasia cases among men and 1.360 among women, at 2019. The research has revealed that neoplasia is at first place in ICU hospitalization ranking, and these high numbers of new cases justify the necessity for surgeries and consequently a higher number of post operatory in ICU.

By knowing who the patient is, which sickness affect him, the next step is to understand how the person reacts to the sickness. For that it was necessary an analysis from the Reactionary Diagnosis. Sicken is so intense that it completely changes the person's life structure, making his life revolve toward the sickness. About that, the reaction form, called by Kubler-Ross (2008) as: coping cycle, can be: denial, anger, revolt, bargain, depression and lastly: acceptance.

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Inside this research it was found a group (18%) of people who remembered nothing of what was experienced in ICU, other related not being able to remember the worst moments, and knew what happened from family statements. To block the memory from a fact is a form of denying it thus extinguishing its existence.

According to Freud (1899), there is something called: selective memory; in clinics it is observed that some adults do not remember facts occurred in childhood, facts perceived as traumatic. The unconscious blocks some memories due to the fact that dealing with it can be more painful that facing it.

Bohleber (2007), paraphrasing Freud, states that in the beginning it was believed to be possible to connect to a memory exactly as it has occurred, a fact that was lately perceived as inconsistent to reality, because our memories are influenced by unconscious desires just as by environmental factors, that can lead to displacement or repression. According to Silva, Sertterval and Souza (2012), post traumatic amnesia can be represented as a temporary state of confusion and disorientation, characterized by insomnia, psychomotor agitation, fatigue, confabulation, and eventually they can originate affective and psychotic symptoms.

Nevertheless, the present study stated a total 82% of the participants who remember this moment. Costa, Marco, Macedo, Jorge and Duarte (2014), who evaluated ICU patients' memories at post discharge from the unit, found that 84,4% of the patients present some kind of memory from the ICU.

Among the ones who presented memories from the hospitalization period there are the ones who present real fact memories, a category which includes memories from the ambiance, treatment and emotional ones, from which; every patient who present memories from hospitalization presented this kind of memories.

The fact that the patients have presented more memories from aspects related to the environment than from emotional and treatment factors draws the attention. As for the characteristic memories from environment, it was verified a predominance in the presence of memories through all the evaluated factors, being the relatives visitation (97%), presence of other patients (92%), and noises (83%), the most predominant ones.

For Lemos and Rossi (2002), the intensive therapy center - besides counting with high end equipment and intensive care – is the most stressful environment for its users. The environment itself presents many stress trigger factors, besides the fact that the user is bound to live under the life and death dilemma, which is constant in ICC, which was revealed to us by some patients as the worst experience in the intensive environment, which is; to deal with a possible death just as end up witnessing the death of others.

All of these factors turn the ICU into a technical environment, where it ends up advocating the care directed to the physical well-being, ceasing to be worked the socio-affective skills of the subject, making the assistance an impersonal one, forgetting the subject behind the patient. Before that, the role of the hospital psychologist is necessary in this context, because differently from medicine which aims to treat the subject's disease, the psychologist should treat the subject in the disease (Simonetti, 2014).

Shinotsuka (2010) points that it is still undefined how much the ICU hospitalization – just as the techniques and procedures used in this environment – can interfere with treatment. Nevertheless, it is known that these processes contribute toward an unfavorable psychosocial disclosure.

The most remembered emotional aspects were anxiety/fear (73%), trouble sleeping (68%), felling thirsty and/or hungry (68%) and pain (68%). One of the participants related in her interview.

> *[...] my worst moment was depending on the team in order to fulfill my basic needs, because there were certain moments when they were not willing to help me [...].*

Pina, Lapchinsk and Pupulim (2008) stated that some patients relate the ICU hospitalization with emotional aspects, such as missing family, loneness, shame, while others identify this place as capable of promoting cure, therefore also with the continuity of life. Thereby it can be stated that the perception each patient will have from the unit meets their experiences, if they had their physical and emotional needs attended therefore they were hosted by the team, besides the care to the relatives.

Soares (2010), recall that the team deals with other patients associated to each bed which, in this case, would be the family. They end up getting sick with the patient, and demand time and attention from the team in order to comprehend their necessities, besides the emotional factor correlated to the situation.

In the factors related to the environment we can perceive the relevance of the visitation, since (97%) of the participants remember this moment, being the most recalled factor through all the research. Soares (2010), also points to the relevance of communication with the relatives, this communication should be clear and realistic, properly providing relevant information for the situation,

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clear and coherent information provide them tools for dealing with anguish.

## V. FINAL CONSIDERATIONS

Lastly we can state that ICU patients have memories from the experienced moments and such memories are directly related to the experienced aspects, thus confirming as true the hypothesis of the research.

Upon that, we should reconsider our attitude as multidisciplinary team searching for a way to increasingly humanize our assistance to offer each patient an individualized care. The subject as a whole should be attended, always aiming for the biopsychosocial concept toward wellbeing, knowing that listening is essential to understand the patient, because it improves our communication which, on its turn; allow us to comprehend the real necessities from the being, being this tool one that all members of the team can and should use.

Through the course of the research it was possible to notice changes that could help in the final data analysis, such as the creation and comparison between a group of patients who underwent the mechanical ventilation and those who did not, thus precisely knowing if the data related to this process are due to the fact of the patients really not remembering it or not being submitted to it.

Therefore it is suggested for more studies to be developed about the Post Traumatic Stress Disorder – PTSD, and that the proposed study provides a trigger to stimulate the scientific community into making more research in this area under a multi-professional approach.

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# Development of functional cake with probiotics and prebiotics for insertion in the diet of elderly institucionalized elderly

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***Abstract*****—** *Studies have been performed by aiming at the identification of new bioactive compounds and the establishment of scientific bases to prove the pleadings of functional properties of foods. This study had as the goal to develop a functional cake with probiotics and prebiotics for insertion in the diet of elderly institutionalized residents. This is a descriptive cross-sectional study conducted with elderly people residents in a Long Stay Institution (LSI) in Feira de Santana-BA. Two analyzes were performed, being one sensory of the attributes: aroma, taste, color, texture and overall impression, and other one of acceptability. Chemical composition analysis was also performed by considering the following determinations: moisture (greenhouse at 105 ° C) and ash (muffle 550 ° C). Therefore, it was observed that the two formulations offered had a satisfactory acceptance, demonstrating the viability and excellent nutritional value, both formulations had a satisfactory acceptance, demonstrating the viability, and especially for their excellent nutritional value. Besides that, the chemical composition analysis in both formulations presented moisture content considered high, possibly due to the large amount of fibers present in its formulation. The ash contents were slightly different but not very discordant. It is concluded that the possibility of using green banana biomass and kefir fermented in cake formulations demonstrated potential for market acceptance and purchase, including with the replacement of wheat flour, for presenting important nutritional and functional values to the health of the consumers, especially in elderly people.*

***Keywords*****— functional foods; old man; antioxidant; dysbiosis.**

## I. INTRODUCTION

Aging is defined as a progressive process in what biological, functional and psychological changes occur. In this context, the so-called functional foods take place, with emphasis on prebiotics, probiotics and symbiotics. Thinking about the insertion of these foods in elderly patients, it is essential that there is a constancy in their use in order to minimize possible pathological conditions resulting from the natural process of aging (TAVARES, 2012; CONRADO et al., 2018).

With aging, changes that occur in the gut, as reduction of the mucosal surface and villi, change motility, allowing bacterial hyperproliferation. With these changes, there may be a propitious medium for the appearance of gastrointestinal tract diseases, as the intestinal dysbiosis. Possible causes of dysbiosis are: poor diet, advanced age, stress, availability of fermentable material, poor digestion, intestinal transit time, intestinal pH and host immune status. Other factors may include the indiscriminate use of medicines and excessive consumption of processed foods (ALMEIDA et al., 2009; CAVALLI et al., 2011).

It is noteworthy that numerous researches have been realized by aiming at the identification of new bioactive compounds and the establishment of scientific bases to prove the claims of functional properties of foods. Functional foods are worthy as those ones that produce physiological or metabolic effects through the performance of some nutrient in maintaining the functions of the human organism. Concerning to these foods, it is important to remember that they do not cure diseases, they only prevent

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their appearance, helping the body to fight them in a more effective way (SALES et al., 2008; VIDAL et al., 2012).
functional prebiotic foods, because they have resistant starch, what is by great interest for food industry because it has important nutrients for human health, given that it might be used on the elaboration of products with reduced lipid and sugar content, besides helping in the control of blood glucose, cholesterol and helps on the treatment of intestinal disorders (TOPPING; FUKUSHIMA; BIRD, 2011; FREITAS; TAVARES, 2005).
This way, functional nutrition is an alternative for the treatment, prevention and control of intestinal dysbiosis, using the importance of gastrointestinal tract functionality as a basic principle, followed by the biochemical specificity, patient-oriented therapy and not on pathology, nutritional stability, nutrient bioavailability and the intervention of external factors to the organic health (ALMEIDA et al., 2009; TEIXEIRA, 2010; MAHAN et al., 2011; GAVANSKI; BARATTO; GATTI, 2015).
Given the above, this study has the goal of developing a functional food product with probiotics and prebiotics for insertion in the diet of institutionalized elderly residents.

## II. MATERIAL AND METHODS

This study was part of a larger project entitled "Characterization and analysis of the health conditions of elderly residents in a long-term care institution in the city of Feira de Santana Bahia", what was approved by the Ethics Committee on Research with Human Beings, by means of Consubstantiated Opinion of the Zip Code No. 3,190,475. This is a descriptive cross-sectional study conducted with elderly people living in a long-term facility care (LFC) in Feira de Santana-BA.
The study included individuals of both sexes, aged sixty and over, residents in the Asilar Institution - Feirense Social Welfare Association of Feira de Santana (FSWA), who agreed to participate in the study after signing the Free Consent Form and Clarified (FCFC).
The study did not include individuals that for some reason were unable to answer the questions, as well as elderly people with some gastrointestinal tract pathology such as chronic diarrhea or enteral, parenteral and diet-specific conditions medical procedure. Data were collected by the multidisciplinary team, composed by undergraduate students in Nutrition and Physiotherapy, being all these ones properly trained. The procedures for obtaining the data were standardized as a measure of quality control and consistency of information.
The development of the formulations was performed in the teaching kitchen of UNIFACS, in what was used green banana biomass, kefir ferment, rice flour, brown sugar, Among functional foods, bananas, especially when cooked and green, are included on the group of cinnamon, egg, rolled oats, corn flour and kefir fermented to the three different formulations. The ingredients used to produce the cake were purchased at the local trade fair of Feira de Santana-BA, observing the expiration date and quality of the packaging of each product. The green banana, a key ingredient of the experiment was selected to meet the required criteria for recipe functionality.
The tests for the acceptability analyzes were performed in a room previously prepared for this purpose, at Salvador University - UNIFACS Campus 3 - at Feira de Santana. The analyzes were performed in triplicates, considering each cake a replicate. The target audience consisted by students from Health School, professors and employees of UNIFACS by self-interest on participating in the study.
Three samples were prepared with approximately 30g each one. The samples were evaluated according to the preference and acceptability of the participants, considering the attributes, aroma, flavor, color, texture and overall impression. Among the tasting of the three samples, each taster was instructed to ingest approximately 50 mL of water so that sensory interference do not occur between the two samples during the test. It was used the sensorial tests from the Hedonic Scale of nine points varying from 9 - "very much liked" to 1 - "very much disliked" for the requirements: appearance, texture, aroma, taste, color. It was still performed the test of attitude order of purchasing varying from 1 - "would certainly not buy" to 5 - "would certainly buy".
The tests for the acceptability analyzes with the elderly were performed in the outhouses of the institution under study. Acceptability analyzes were performed in triplicates, considering each cake a replicate. The target audience were elderly people from the nursing home, of both sexes, aged sixty years and over, with their own interest in participating on the study.
Two samples were prepared, with approximately 30g each one, according to the preference and acceptability of the participants, considering the attributes, I LIKED, YES and NO. Each taster was instructed to ingest approximately 50 ml of water so that there is no sensory interference between the two samples during the test.
The chemical composition analysis was performed by collecting the samples of the cake formulations in triplicate, considering the following determinations: moisture (in an oven at 105 ° C) and ashes (in muffle 550 ° C) according to the methods described by Adolfo Lutz Institute (ZENEBON, PASCUET; TIGLEA, 2008). The analyzes of the formulations were performed at the Chemistry Laboratory of the University of Salvador -

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UNIFACS. The determination of the quality control of two functional cakes, one made with rice flour and the other one with corn flour, was performed at the Biochemistry Laboratory of the University of Salvador, in Feira de Santana - Ba.

The data from the analyzes were charted in Microsoft Office Excel 2009 and presented in tables and graphs.

## III. RESULTS AND DISCUSSION

The results of the acceptability and purchase intention tests of the cake formulations are presented on Figures 1,2,3,4, 5 and 6. Among 90 judges, 67 were female and 23 male, with a predominant age group from 17 to 25 years old, because it is a place frequented by undergraduate students.

The Figure 1 shows the percent acceptability appearance of the developed cake formulations.

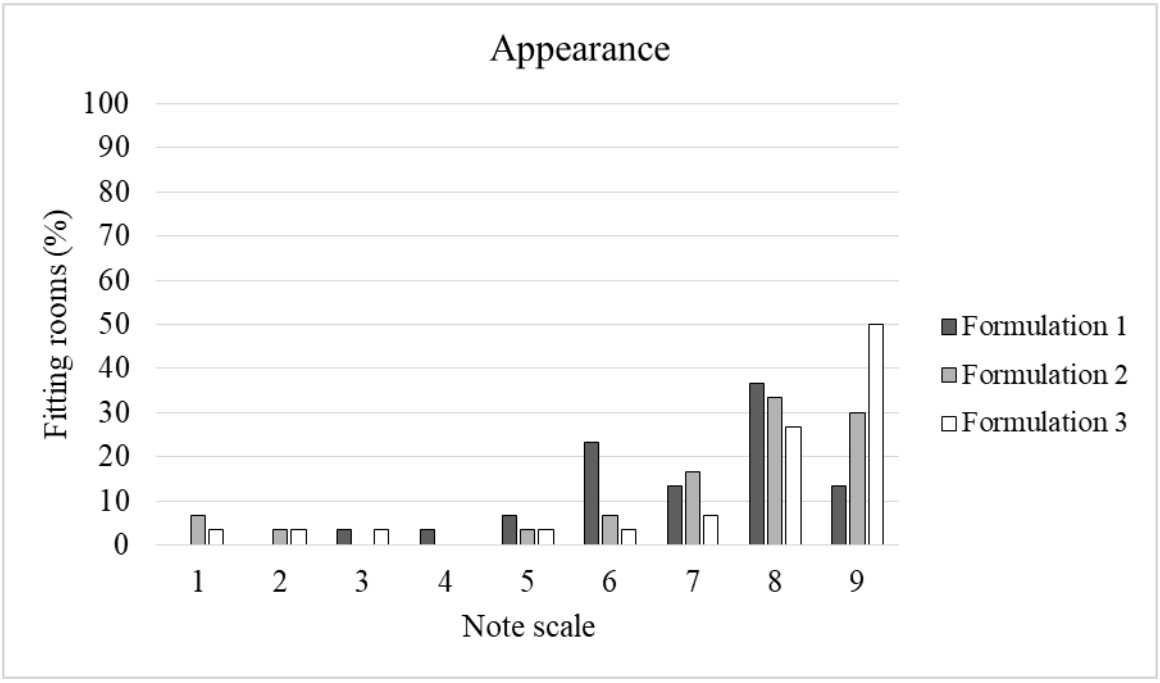


*Fig.1. Acceptability of appearance*

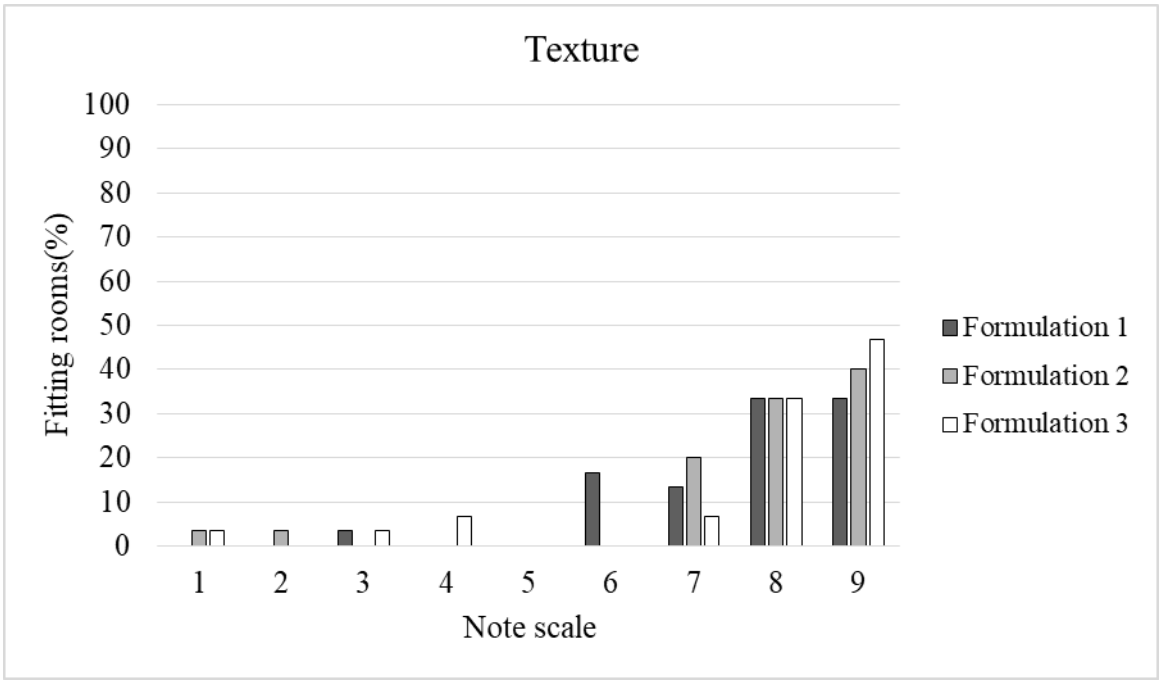


*Fig.2. Acceptability of texture attribute*

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As for the appearance attribute, the formulation 3 reached a higher acceptability percentage (50%), obtaining (grade 9), proving that the appearance attribute of the formulation developed with the replacement of corn flour obtained better acceptance. In the study of Silva (2018), he proves that the substitution of ingredients in the formulation for containing cornflour and banana biomass, the fibers present contribute so that the product shows a rougher and apparently less silky surface than the traditional, favoring greater acceptability.

The Figure 2 shows the acceptability percentage of the texture attribute of the cake formulations developed.

With respect to the texture attribute, the formulation 3 reached a percentage of 49% (grade 9). Similar results were found in the study by Leon (2010) about elaboration and acceptability of corn cake with green banana biomass, whereupon 74% of the interviewed considered it very good, noting that, despite the corn cake has a heavy texture, the author, used banana biomass, favoring to confer lightness, without interference in the flavor.

The Figure 3 shows the percentage of aroma attribute of the developed cake formulations.

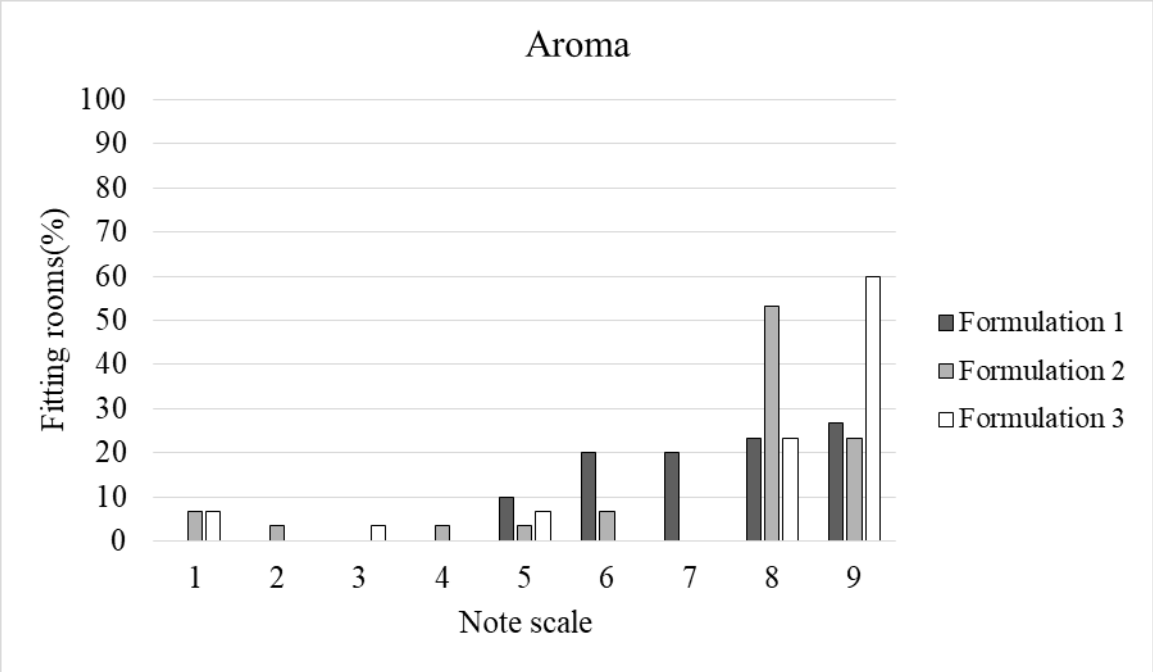


*Fig.3. Acceptability of aroma attribute*

With respect to the aroma attribute, the formulation 2 reached 50% (grade 8) and the formulation 3 with 60% (grade 9). Similar results were found in the study by Marques and Lemos (2016), in what they developed muffins containing green banana biomass, totaling 77% of acceptance regarding to the aroma. In the work by Amorim et al. (2016), the aroma of the cake developed with chocolate and green banana biomass, the preparation had a good acceptability index, and 56.66% said they liked it a lot.

The Figure 4 shows the percentage of the flavor attribute of the cake formulations developed.

Regarding the flavor attribute, the formulation 2 reached 70% and the formulation 3 69%, being attributed (grade 9). The flavor was one of the attributes that was highlighted in the formulations 2 and 3. Although the taste causes influence on the sensory properties of the food products one of the attributes that was highlighted in formulations added with frequently unused ingredients (ALAMANOU et al., 1996), it can be stated that, in this study, the addition of rice flour and cornflour was considered a positive factor.

The Figure 5 shows the percentage of the flavor attribute of the developed cake formulations.

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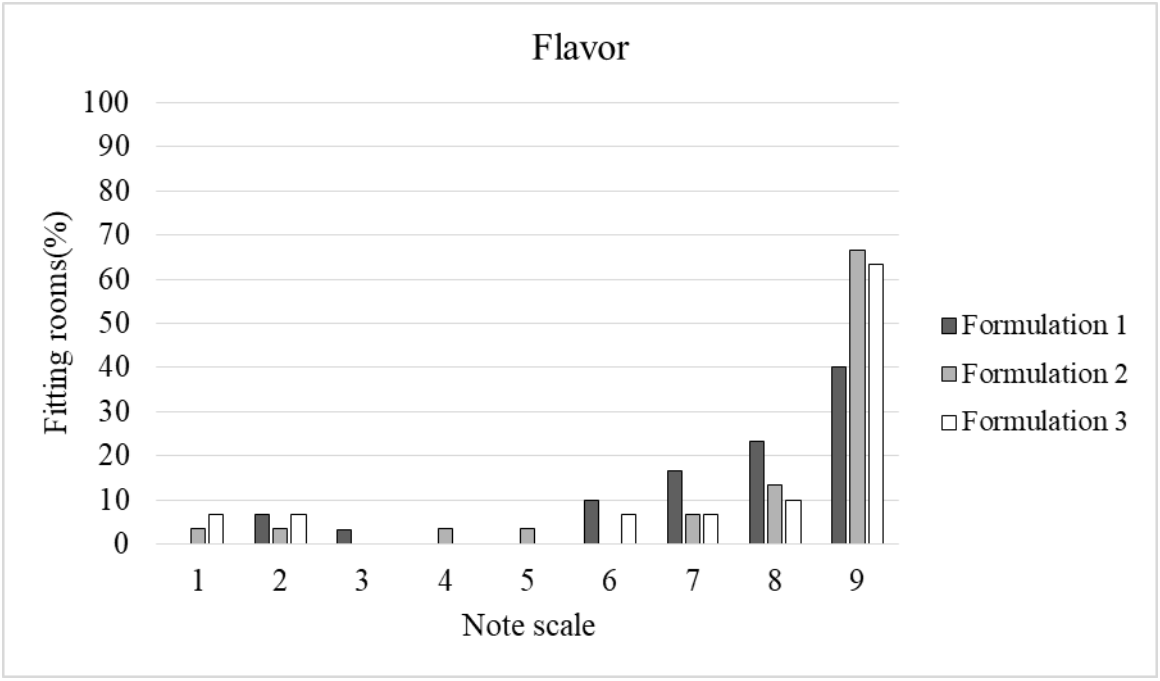


*Fig.4. Acceptability of the flavor attribute.*

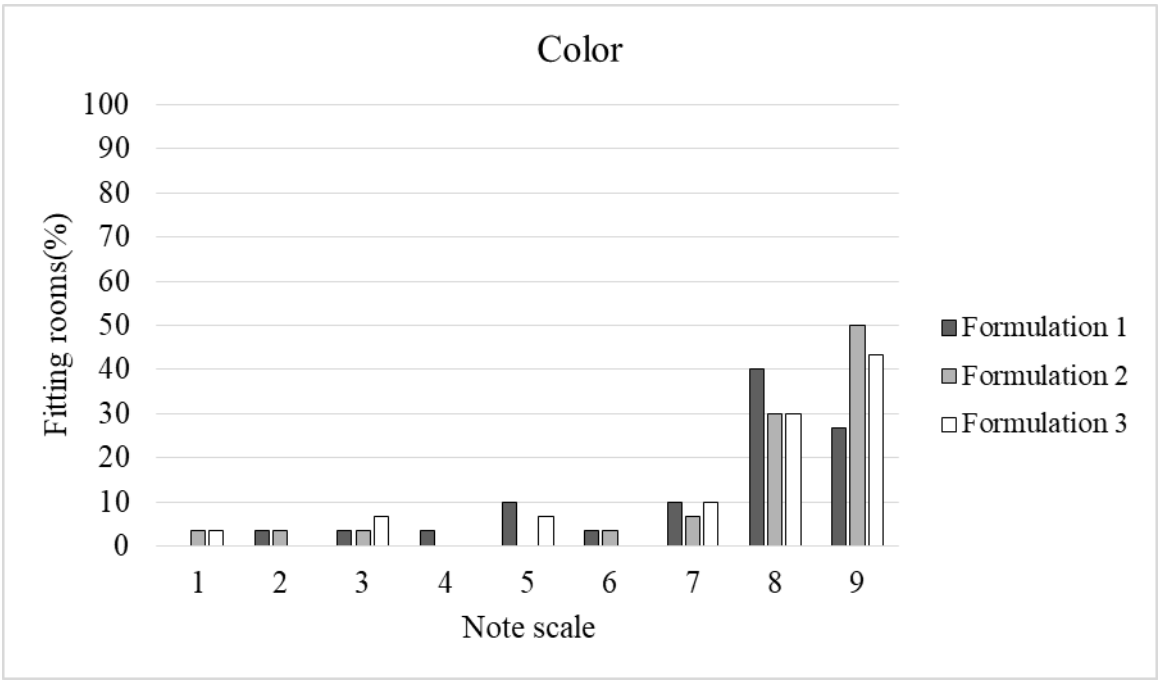


*Fig.5. Acceptability of color attribute*

Regarding to the color attribute, the formulation 1 reached 40% for formulation 1 (grade 8), 50% for formulation 2 (grade 9) and 40% for formulation 3 (grade 9). According to Ribeiro and Seravalli (2004) bananas, while green, have a large amount of tannins, what leads to astringency of the fruit. The tannins have a yellowish to dark brown color, therefore it contributes so that the formulations have a brownish tone.

The Figure 6 shows the percentage of purchase intention of the developed cake formulations.

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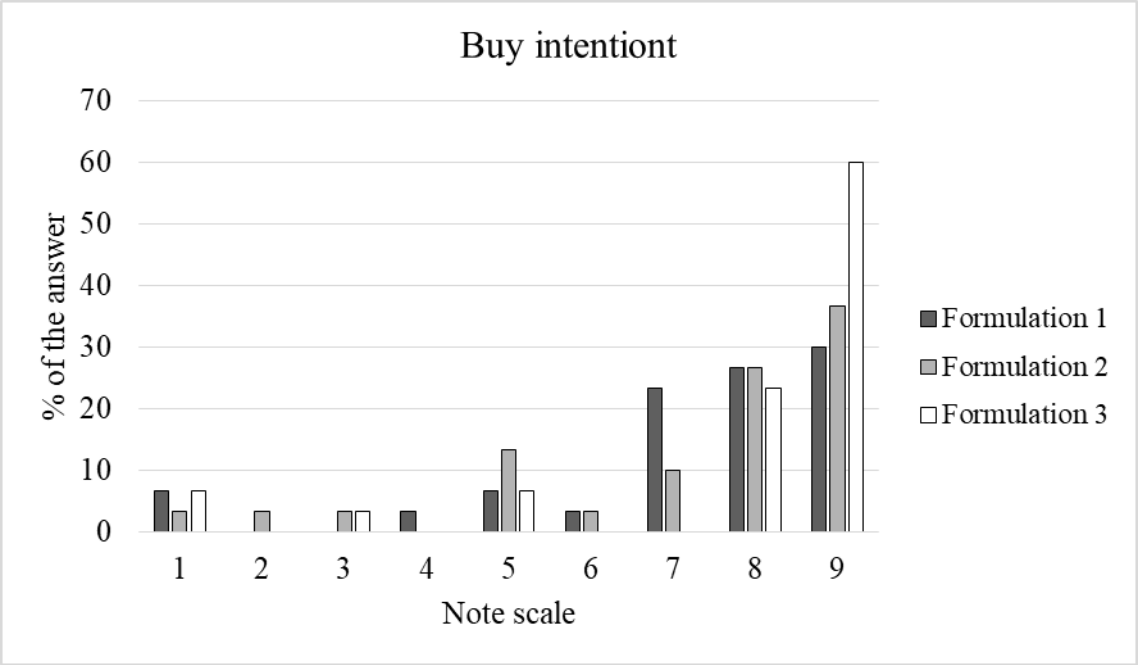


*Fig.6. Purchase intention of the formulations developed.*

The intention-to-buy test of both cake formulations obtained the highest percentage, 50% (formulation 1) grade 4 “Probably would buy”. Higher purchase intention was observed 60% (formulation 3), given grade 5 "would certainly buy". Similar results were found in the study by Freitas and Camargos (2002) in what 75% of tasters said they would "certainly buy" the product if it was available for sale.

Overall, it was observed that the grades assigned to the three formulations were above 6, indicating a positive assessment for acceptability. Likewise, De Carvalho et al. (2012), when developing cupcake formulations, added with banana peel flour, found that the products were well accepted by tasters, as occurred in the present study.

After evaluating the nutritional and functional benefits in the three formulations, it is found that one of the benefits of wheat flour replacement is the difference in refined carbohydrate for having high glycemic index, while oatmeal, corn and rice have a concentrate value of fiber with beneficial health effects

The results of the acceptability tests performed with the elderly people, from the formulations developed with cornmeal and rice flour, are shown in the Figure 7.

The result of the analysis of the acceptability test with the elderly people demonstrates better acceptance for the cake developed with cornmeal being 29 (87.9%) liked; 4 (12.1%) did not like it, and the cake made with rice flour 26 (78.8%) liked it and 7 (21.2%) did not like it.

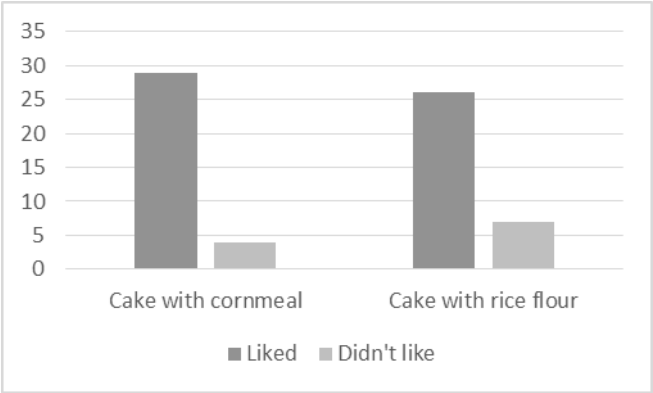


*Fig.7. Acceptability tests performed with the elderly people*

In the study by Leon (2010), the preparation of corn cake with green banana biomass obtained a good acceptability index and many of the academics commented that the biomass did not interfere with the taste of the elaborations. Already from the work by Maia et al. (2018), the corn cake formulation presented good acceptability, receiving hedonic values of global acceptance and taste acceptance corresponding to “moderately liked”, and hedonic value for appearance corresponding to “liked very much”. "

In the study by Ramos; Piemolini-Barreto and Sandri (2012) the addition of rice flour in the proportions tested on the formulations did not affect the acceptance of cakes, that presented a minimum acceptability index (70%) and among them, any significant difference was observed, representing a great consumption alternative for people with celiac disease or for the ones who are adherents of a gluten-free diet.

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For Silva and Lima (2015), the products developed with gluten-free flour do not have the same sensory characteristics as those ones developed with gluten, compromising the taste of these foods. The study by Urala and Lahteenmaki (2004) the authors report that the acceptance of functional foods is related to the information that these consumers receive about these products and the perception of benefits promoted by that food.

It was also observed that the two formulations offered had a satisfactory acceptance, demonstrating the viability, and especially for their excellent nutritional value. During the sensory analysis it was observed that none of the elderly people knew to identify how the formulations were made of, what becomes extremely relevant to their constant distribution in the institution, favoring of this way the health of the elderly people.

Average results of the composition of the two bolus formulations are shown in Table 1, expressed in g / 3g.

*Table 1. Centesimal composition of functional cakes, produced in the biochemistry laboratory of the Salvador University of Feira de Santana – BA, 2019.*

| Formulations | Moisture | Ashes |
|---|---|---|
| A | 37.66% | 1.41% |
| B | 36.87% | 2.11% |
| C | 25.30% | 1.0% |

* Formulation: A- corn functional cake; B - functional rice cake; C reference value according (USDA, 2001).

According to the analysis of the centesimal composition, both the corn and rice functional cake presented moisture content between 36.87% and 37.66%, values considered high, according to the literature. In the same way, Carneiro et.al. (2015) observed moisture content of (24.45%; 24.59%; 24.32%) in oatmeal, quinoa and flaxseed cake formulations. In the study by Souza et. al. (2013), with cakes developed with rice flour and manioc peel, the authors found moisture of: 11.5% and 12.8%.

Borges et al. (2011) state that the high values of moisture content may be attributed to the amount of fibers present in the product, directly favoring the increase of water absorption, mainly due to the large number of hydroxyl groups present in the structure of food fibers.

Rodrigues et al. (2011), in their study show that moisture analysis is important to indicate signs of microorganisms proliferation, that once present in food in inadequate quantity may damage to the quality of the same one, and moreover, if it presents significantly low value, it may indicate a decrease in nutritional value.

The ash contents were slightly different: sample 1 (1.41%) and sample 2 (2.11%), but not very different from those ones obtained experimentally. In the study by Carneiro et al. (2015), in what three types of cake were produced with partial replacement of wheat flour by oats, quinoa and flaxseed in different proportions. The proportions used were: F1 = 30% oatmeal, 10% quinoa flour and 10% flaxseed; F2 = 15% oatmeal, 5% quinoa flour and 5% flaxseed flour; F3 = 7% oatmeal, 3% quinoa flour and 3% flaxseed flour.

It was not observed any significantly statistic difference in the ash contents of formulations F1 (1.33%) and F2 (1.29%), but differed significantly from formulation F3 (1.10%). These differences in ash content may be associated with the insertion of quinoa and flaxseed, since they contribute to the mineral input when added to food (BORGES et al., 2006) justifying the increase in ash content in samples 1 and 2. which presented a higher proportion of these ingredients. Lopes et al. (2009) and Lamacchia et al. (2010) found in the composition of quinoa flour minerals such as calcium, zinc, potassium and iron, and furthermore, obtained ash concentrations approximately seven and four times higher from that one present in rice and wheat flour, respectively.

The determination of ashes aims to quantify the total minerals present in the food (RODRIGUES et al., 2011). Among the functions that minerals perform in the body, it is noteworthy that they act as ions dissolved in body fluids, regulating the activities of many enzymes, besides keeping acid-base balance and osmotic pressure (CECCHI, 2003).

Based on the study by Celestino (2011) that lays down the rules, standards, and applicability methodologies for food drying principles, as well as the ash results obtained from scientific studies the two types of functional cakes presented here are according to specifications, and fit for consumption.

The results of the ash fraction analysis, the corn functional cake obtained a concentration of 1.41% of ash for each 3g of the sample, while the rice fraction obtained 2.11% of ash for each 3g of the sample. , which correlates with the reference value established by the United States National Bureau of Agricultural Statistics (2001), where it establishes 1.0% of ashes, did not show significant variation (USDA, 2001).

According to Silva and Moreira – Araújo (2019), the "ash" fraction represents the inorganic substances present in the food. When a food is burned the organic matter is transformed remaining only the minerals present in the food. Already the study of Ozores; Storck and Fogaça (2015) formulated a cake enriched with okra flour obtained an ash content of 1.82%, a result similar to this study where the ash content was 1.79%. Pereira (2014) evaluated the centesimal composition of gluten-free chocolate cake

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and lactose fortified with melon seed flour, it was observed that the ash content was 1.32%. In another study Silva et al. (2015), the ash content was around 3.80% for the biscuit produced with pumpkin seed flour.

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# Robust Control Applied to a Synchronous Buck Converter with Loss and Uncertainty in its Parameters

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***Abstract*****—***This Work presents the application of control with $H_\infty$ problem, together with pole location constraint by LMI formulation in a Buck converter. The uncertainties modeling of the system variables uses the constraint by a convex polytope. Mathematical software with the implementation of algorithms for LMIs solution, as well as software for circuit simulation, were used as an aid for the formulation and validation of the control. The result of the robust controller in a transient period is compared to a classic controller, giving justification for the quality of the results.*

***Keywords*****—Buck, LMIs, Modeling, Pole Location Constraint, Robust Control.**

## I. INTRODUCTION

Direct current to direct current (DC-DC) converters are generally used in many applications due to its ability to increase or decrease voltage with high efficiency. There are several topologies of these converters, one of them is the synchronous buck converter, shown in Fig. 1, which only reduces its input voltage. This when compared to non-synchronous buck has higher efficiency at full load[1]. In order to deliver a near-desired voltage at the output, i.e.a voltage that follows a variable reference, it is essential to use a controller that keeps the system stable to all desired specifications.

The use of linear matrix inequalities (LMIs) has recently been presenting efficient solutions to control problems. This is due to the characteristic of simultaneously considering various requirements, performance constraints and robustness through the formulation of LMIs. In this context, research is growing in several areas, focusing on control through these inequalities [2]. In this work, for example, a robust

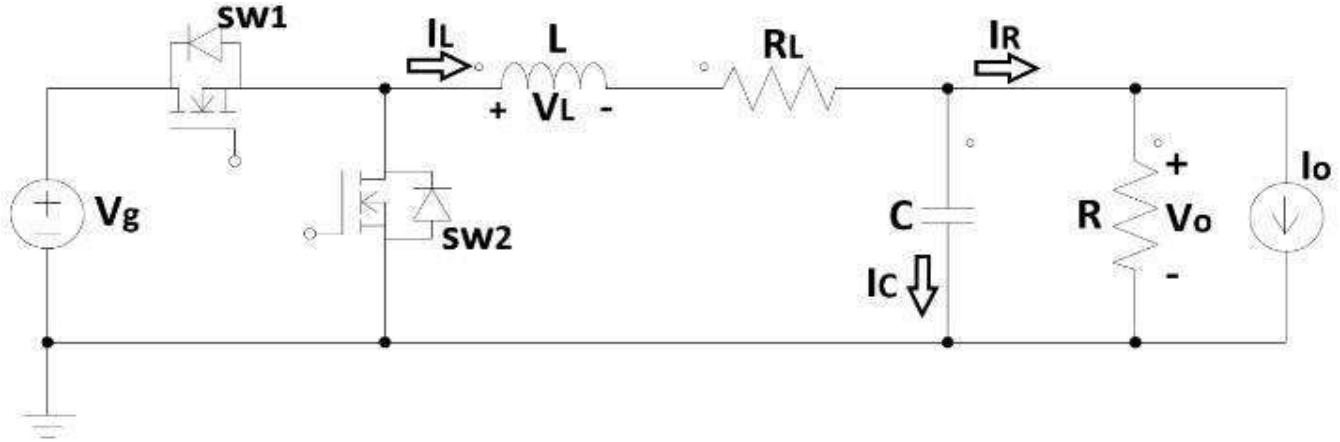


*Fig. 1: Synchronous buck converter.*

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$H_\infty$control is presented, adding constraints on the convex region, in which the closed-loop system poles can be placed. The main reference is the study presented in [3].

To validate this work, two controllers were applied to a DC-DC Buck converter (Fig. 1). The$H_\infty$control, containing the constraints represented by LMIs, is performed by state feedback. In this way, two sensors are required, one for reading the converter output voltage and one for reading the current over the inductor. The second controller uses the classic approach of Proportional Integral (PI) control. MATLAB/Simulink software was used for system simulation. The SeDuMi, YALMIP and ROLMIP packageswere used in the solution and optimization of the LMIs presented in this work.

The comparison of these two controllers allows us to evaluate the advantage that the $H_\infty$control with pole region constraint considering its characteristic uncertainties, has over the classic PI control. Such a comparison is interesting for three reasons, the first is that the load connected to the converter output may vary within a known range in which the converter is designed to work. The second is that the capacitance may decrease, e.g. an electrolytic capacitor has a liquid dielectric, which may degrade over time. The third is that the real components have tolerances,e.g.$\pm 20\%$, and could vary according to temperature, such as the capacitor and inductor present in the converter.

Finally, the comparison of the results of this work aims to present the differences between a $H_\infty$controller with higher implementation cost, due to the development time and hardware cost, and a PI controller that has a less expressive cost.This paper is divided in the following order. Section II presents the modeling of the Buck converter (Fig. 1). Section III introduces the characteristics of the $H_\infty$controller. Section IV presents the implementation of control techniques and the comparison of results. Section V presents the conclusions.

## II. SYSTEM MODELING

Two steps make up the synchronous Buck converter, shown in Fig. 1. On the first step of the switching $SW1$ conducts and $SW2$ shall be open, on the second one $SW2$ conducts and $SW1$ stays open. The duty cycle $d$ represents the portion of the switching period $T_S$, in which $SW1$ is conducting. The addition of the second load in parallel to the resistance $R$, represented by the source $I_O$, represents a disturbance in the output current.

Equating of the inductor voltage to each switching step and its weighting of the values by switching parcel results in (1) and (2). The equating of the capacitor current to each switching step, following the same weighting, results in (3) and (4):

$$< V_L > = \frac{1}{T_S}.\Big(\big(V_g - V_O - R_L.I_L\big).d.T_S + (-V_O - R_L.I_L).(1-d).T_S\Big) \quad (1)$$

$$< \boldsymbol{V_L} > = L.\frac{\boldsymbol{dI_L}}{\boldsymbol{dt}} = \boldsymbol{V_g}.\boldsymbol{d} - \boldsymbol{V_O} - \boldsymbol{R_L}.\boldsymbol{I_L} \quad (2)$$

$$< I_C > = \frac{1}{T_S}.\left(\left(I_L - \frac{V_O}{R} - I_O\right).d.T_S + \left(I_L - \frac{V_O}{R} - I_O\right).(1-d).T_S\right) \quad (3)$$

$$< \boldsymbol{I_C} >= \boldsymbol{C}.\frac{\boldsymbol{dV_O}}{\boldsymbol{dt}} = \boldsymbol{I_L} - \frac{\boldsymbol{V_O}}{\boldsymbol{R}} - \boldsymbol{I_O} \quad (4)$$

From (2) and (4), it is possible to perform alternating current(AC) modeling for small signals. In this, the average values summed to an AC portion replace each variable. The DC terms that represent the permanent response cancel each other. Moreover, it is assumed that the second order AC terms are small compared to the first order ones, to the extent that you can neglectthem [4]. Such process is presented in (5) to (13).

$$V_g = \overline{V_g} + \widehat{V_g} \quad (5)$$

$$V_O = \overline{V_O} + \widehat{V_O} \quad (6)$$

$$I_L = \overline{I_L} + \widehat{I_L} \quad (7)$$

$$I_O = \overline{I_O} + \widehat{I_O} \quad (8)$$

$$d = \bar{d} + \hat{d} \quad (9)$$

$$L.\frac{d\big(\overline{I_L} + \widehat{I_L}\big)}{dt} = \overline{V_g}.\bar{d} + \overline{V_g}.\hat{d} + \widehat{V_g}.\bar{d} + \widehat{V_g}.\hat{d} - \overline{V_O} - \widehat{V_O} - R_L.\overline{I_L} - R_L.\widehat{I_L} \quad (10)$$

$$\boldsymbol{L}.\frac{\boldsymbol{d\big(\widehat{I_L}\big)}}{\boldsymbol{dt}} = \boldsymbol{\overline{V_g}}.\boldsymbol{\hat{d}} + \boldsymbol{\widehat{V_g}}.\boldsymbol{\bar{d}} - \boldsymbol{\widehat{V_O}} - \boldsymbol{R_L}.\boldsymbol{\widehat{I_L}} \quad (11)$$

$$C.\frac{d(\overline{V_O} + \widehat{V_O})}{dt} = \overline{I_L} + \widehat{I_L} - \frac{\overline{V_O}}{R} - \frac{\overline{\widehat{V_O}}}{R} - \overline{I_O} - \widehat{I_O} \quad (12)$$

$$\boldsymbol{C}.\frac{\boldsymbol{d(\widehat{V_O})}}{\boldsymbol{dt}} = \boldsymbol{\widehat{I_L}} - \frac{\boldsymbol{\overline{\widehat{V_O}}}}{\boldsymbol{R}} - \boldsymbol{\widehat{I_O}} \quad (13)$$

The model given by (11) and (13) is a type 0, i.e. the plant has no integrator. For the steady-state system error to be null, for a ramp type input, it is necessary to insert an integrator augmented state, shown in (14) and (15). This transforms the system into type 1 [5].

$$x_3 = \int \big(V_{ref} - \widehat{V_O}\big).dt \quad (14)$$

$$\frac{\boldsymbol{d(x_3)}}{\boldsymbol{dt}} = \boldsymbol{V_{ref}} - \boldsymbol{\widehat{V_O}} \quad (15)$$

Considering (11), (13) and (15), it is possible to represent them in state space notation, as presented in (16) and (17):

$$\frac{dx(t)}{dt} = A.x(t) + B_u.u(t) + B_w.w(t) + B_{ref}.V_{ref}. \quad (16)$$

$$z(t) = C_z.x(t) + D_{zu}.u(t) + D_{zw}.w(t) \quad (17)$$

, wherein:

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$$x(t) = \begin{bmatrix} \widehat{I_L} \\ \widehat{V_O} \\ x_3 \end{bmatrix} \quad \ldots\ldots (18)$$

$$u(t) = \left[\hat{d}\right] \quad \ldots\ldots (19)$$

$$w(t) = \left[\widehat{I_O}\right] \quad \ldots\ldots (20)$$

$$z(t) = \left[\widehat{V_O}\right] \quad \ldots\ldots (21)$$

$$A = \begin{bmatrix} -\frac{R_L}{L} & -\frac{1}{L} & 0 \\ \frac{1}{C} & -\frac{1}{R.C} & 0 \\ 0 & -1 & 0 \end{bmatrix} \quad \ldots\ldots (22)$$

$$B_u = \begin{bmatrix} \frac{\overline{V_g}}{L} \\ 0 \\ 0 \end{bmatrix} \quad \ldots\ldots (23)$$

$$B_w = \begin{bmatrix} 0 \\ -\frac{1}{C} \\ 0 \end{bmatrix} \quad \ldots\ldots (24)$$

$$B_{ref} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad \ldots\ldots (25)$$

$$C_z = [0 \quad 1 \quad 0] \quad \ldots\ldots (26)$$

$$D_{zw} = [0] \quad \ldots\ldots (27)$$

$$D_{zu} = [0] \quad \ldots\ldots (28)$$

The disturbance represented by the $w$ vector, from the current source $\widehat{I_O}$, represents the behavior of the converter output voltage $V_O$, for sudden changes in the output current of the converter[3]. The parameters $\overline{V_g}$, $L$, $C$ e $R$ are uncertain and limited to a minimum and maximum value, as represented by (29) to (32):

$$\beta = \overline{V_g} \in \left[\overline{V_g}_{mim}, \overline{V_g}_{max}\right] \quad \ldots\ldots (29)$$

$$\delta = \frac{1}{L} \in \left[\frac{1}{L_{max}}, \frac{1}{L_{min}}\right] \quad \ldots\ldots (30)$$

$$\psi = \frac{1}{C} \in \left[\frac{1}{C_{max}}, \frac{1}{C_{min}}\right] \quad \ldots\ldots (31)$$

$$\mu = \frac{1}{R.C} \in \left[\frac{1}{C_{max}.R_{max}}, \frac{1}{C_{min}.R_{min}}\right] \quad \ldots\ldots (32)$$

Therefore, matrices $A$ and $B_u$ depend on these $N = 4$ uncertain parameters, generating a polytope with $2^N = 16$ vertices. Table 1 shows the polytopic representation of matrices $A$ and $B_u$.

## III. ROBUST CONTROL CHARACTERISTICS

This Section presents the characteristics of the robust $H_\infty$ control developed in this paper.

### 3.1 LMIs

Considering $x \in \mathbb{R}^m$ as the variable and $F_i = F_i{}'$ as non-variant matrices. An LMI has the form given in (33):

$$F(x) \triangleq F_0 + \sum_{i=1}^{m} F_i x_i > 0 \quad \ldots\ldots (33)$$

According to [6], there is an LMI feasibility problem when a solution $x$ has to be found, such that $F(x) > 0$.

The analysis of LMIs in dynamic systems has over a century of study, beginning in 1890, when Lyapunov's theory was published. This theory shows that a differential equation, given in (34), is stable, if and only if, there is a positive definite matrix $P$, which satisfies (35):

$$\frac{d}{dt}x(t) = Ax(t) \quad \ldots\ldots (34)$$

$$A'P + PA < 0 \quad \ldots\ldots (35)$$

Lyapunov proved that for the LMI in (35) to have a solution $P > 0$, one must choose any matrix $Q > 0$ and solve the equation $A'P + PA + Q = 0$. If $P > 0$ is found, there is a solution [2].

The sequence of studies on LMIs showed that the classic LQR (Linear Quadratic Regulator) problem, associated with the Riccati equation, could be represented as an LMI problem, through the Schur complement [2]. This verification is important because, if possible, several problems can be solved together, if represented in LMI form, as shown in (36) with $k$ constraints.

$$F(x) = diag\{F_0(x), F_1(x), \ldots, F_k(x)\} > 0 \quad \ldots\ldots (36)$$

Over time, several algorithms have been developed for the solution and optimization of LMIs, such as Nemirovskii's algorithm [2]. Today, with computational packages, LMIs have become an efficient tool in many engineering areas, including modern control [7].

### 3.2 Quadratic stability

The existence of a quadratic function, given in (37), that satisfies $\dot{V}(x) < 0$, is a necessary and sufficient condition to assume that the linear system, presented in (34), is stable. Thus resulting in (38):

$$V(x) = x'Px > 0, \quad \forall x \neq 0 \quad \ldots\ldots (37)$$

$$\dot{V}(x) = x'(A'P + PA)x < 0, \quad \forall x \neq 0 \quad \ldots\ldots (38)$$

Then, the system is stable, if and only if, there is a positive definite symmetric matrix $P$, for which $\dot{V}(x) < 0$. To satisfy (38), the conditions in (39) must be met:

$$\exists P > 0 \; ; \quad A'P + PA < 0 \quad \ldots\ldots (39)$$

If the uncertainties in $A$ are polytopic, the feasibility of the LMI problem must be verified, i.e. the polytope must have $j$ vertices. Then, a $P > 0$ solution must be found, such that (40) is met:

$$A_i{}'P + PA_i < 0, \quad i = 1,2, \ldots, j \quad \ldots\ldots (40)$$

The feasibility of this problem implies that the system is stable for every matrix belonging to the polytope.

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*Table 1: Polytopic representation of matrices A and $B_u$.*

| | |
|---|---|
| $A_1 = \begin{bmatrix} -\frac{R_L}{L_{min}} & -\frac{1}{L_{min}} & 0 \\ \frac{1}{C_{min}} & -\frac{1}{R_{min}.C_{min}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_1} = \begin{bmatrix} \frac{\overline{V_g}_{mim}}{L_{min}} \\ 0 \\ 0 \end{bmatrix}$ | $A_9 = \begin{bmatrix} -\frac{R_L}{L_{max}} & -\frac{1}{L_{max}} & 0 \\ \frac{1}{C_{min}} & -\frac{1}{R_{min}.C_{min}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_9} = \begin{bmatrix} \frac{\overline{V_g}_{mim}}{L_{max}} \\ 0 \\ 0 \end{bmatrix}$ |
| $A_2 = \begin{bmatrix} -\frac{R_L}{L_{min}} & -\frac{1}{L_{min}} & 0 \\ \frac{1}{C_{max}} & -\frac{1}{R_{min}.C_{max}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_2} = \begin{bmatrix} \frac{\overline{V_g}_{mim}}{L_{min}} \\ 0 \\ 0 \end{bmatrix}$ | $A_{10} = \begin{bmatrix} -\frac{R_L}{L_{max}} & -\frac{1}{L_{max}} & 0 \\ \frac{1}{C_{max}} & -\frac{1}{R_{min}.C_{max}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_{10}} = \begin{bmatrix} \frac{\overline{V_g}_{mim}}{L_{max}} \\ 0 \\ 0 \end{bmatrix}$ |
| $A_3 = \begin{bmatrix} -\frac{R_L}{L_{min}} & -\frac{1}{L_{min}} & 0 \\ \frac{1}{C_{min}} & -\frac{1}{R_{max}.C_{min}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_3} = \begin{bmatrix} \frac{\overline{V_g}_{mim}}{L_{min}} \\ 0 \\ 0 \end{bmatrix}$ | $A_{11} = \begin{bmatrix} -\frac{R_L}{L_{max}} & -\frac{1}{L_{max}} & 0 \\ \frac{1}{C_{min}} & -\frac{1}{R_{max}.C_{min}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_{11}} = \begin{bmatrix} \frac{\overline{V_g}_{mim}}{L_{max}} \\ 0 \\ 0 \end{bmatrix}$ |
| $A_4 = \begin{bmatrix} -\frac{R_L}{L_{min}} & -\frac{1}{L_{min}} & 0 \\ \frac{1}{C_{max}} & -\frac{1}{R_{max}.C_{max}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_4} = \begin{bmatrix} \frac{\overline{V_g}_{mim}}{L_{min}} \\ 0 \\ 0 \end{bmatrix}$ | $A_{12} = \begin{bmatrix} -\frac{R_L}{L_{max}} & -\frac{1}{L_{max}} & 0 \\ \frac{1}{C_{max}} & -\frac{1}{R_{max}.C_{max}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_{12}} = \begin{bmatrix} \frac{\overline{V_g}_{mim}}{L_{max}} \\ 0 \\ 0 \end{bmatrix}$ |
| $A_5 = \begin{bmatrix} -\frac{R_L}{L_{min}} & -\frac{1}{L_{min}} & 0 \\ \frac{1}{C_{min}} & -\frac{1}{R_{min}.C_{min}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_5} = \begin{bmatrix} \frac{\overline{V_g}_{max}}{L_{min}} \\ 0 \\ 0 \end{bmatrix}$ | $A_{13} = \begin{bmatrix} -\frac{R_L}{L_{max}} & -\frac{1}{L_{max}} & 0 \\ \frac{1}{C_{min}} & -\frac{1}{R_{min}.C_{min}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_{13}} = \begin{bmatrix} \frac{\overline{V_g}_{max}}{L_{max}} \\ 0 \\ 0 \end{bmatrix}$ |
| $A_6 = \begin{bmatrix} -\frac{R_L}{L_{min}} & -\frac{1}{L_{min}} & 0 \\ \frac{1}{C_{max}} & -\frac{1}{R_{min}.C_{max}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_6} = \begin{bmatrix} \frac{\overline{V_g}_{max}}{L_{min}} \\ 0 \\ 0 \end{bmatrix}$ | $A_{14} = \begin{bmatrix} -\frac{R_L}{L_{max}} & -\frac{1}{L_{max}} & 0 \\ \frac{1}{C_{max}} & -\frac{1}{R_{min}.C_{max}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_{14}} = \begin{bmatrix} \frac{\overline{V_g}_{max}}{L_{max}} \\ 0 \\ 0 \end{bmatrix}$ |
| $A_7 = \begin{bmatrix} -\frac{R_L}{L_{min}} & -\frac{1}{L_{min}} & 0 \\ \frac{1}{C_{min}} & -\frac{1}{R_{max}.C_{min}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_7} = \begin{bmatrix} \frac{\overline{V_g}_{max}}{L_{min}} \\ 0 \\ 0 \end{bmatrix}$ | $A_{15} = \begin{bmatrix} -\frac{R_L}{L_{max}} & -\frac{1}{L_{max}} & 0 \\ \frac{1}{C_{min}} & -\frac{1}{R_{max}.C_{min}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_{15}} = \begin{bmatrix} \frac{\overline{V_g}_{max}}{L_{max}} \\ 0 \\ 0 \end{bmatrix}$ |
| $A_8 = \begin{bmatrix} -\frac{R_L}{L_{min}} & -\frac{1}{L_{min}} & 0 \\ \frac{1}{C_{max}} & -\frac{1}{R_{max}.C_{max}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_8} = \begin{bmatrix} \frac{\overline{V_g}_{max}}{L_{min}} \\ 0 \\ 0 \end{bmatrix}$ | $A_{16} = \begin{bmatrix} -\frac{R_L}{L_{max}} & -\frac{1}{L_{max}} & 0 \\ \frac{1}{C_{max}} & -\frac{1}{R_{max}.C_{max}} & 0 \\ 0 & -1 & 0 \end{bmatrix}$, $B_{u_{16}} = \begin{bmatrix} \frac{\overline{V_g}_{max}}{L_{max}} \\ 0 \\ 0 \end{bmatrix}$ |

### 3.3 Quadratic stability for a closed-loop system with state feedback

The LMIs in (39) are adapted for a closed-loop system with state feedback $u = Kx$. Works [3] and [8] simplify these LMIs using the following theorem:

*Theorem 3.1*: The closed-loop system with state feedback $u = Kx$ is stable, if and only if, there is a symmetric matrix$W \in \mathbb{R}^{nxn}$and a matrix$Y \in \mathbb{R}^{mxn}$, such that:

$W > 0$ ..... (41)

$AW + WA' + B_uY + Y'B_u{}' < 0$ ..... (42)

The state feedback gain is obtained by (43):

$K = YW^{-1}$ ..... (43)

### 3.4 Pole placement

The main motivation for pole clustering, in a specific region on the left side of the complex plane, is the transient response characteristics of a linear system. A second order system, e.g. with poles $-\zeta w_n \pm jw_d$, is fully characterized in terms of the undamped natural frequency$w_n = |\lambda|$, the damping rate$\zeta$ and the damped natural frequency$w_d = w_n\sqrt{1-\zeta^2}$.By constraining and fixing $\lambda$ in a prescribed region, bounds can be put on the characteristic values, thus ensuring a satisfactory transient response. The regions of interest, that can be defined, include the$\alpha$-stability regions vertical strips, disks, conic sectors, $(Re(s) \leq -\alpha)$, and others [9].

The prominent region of this project, which has control purposes, is characterized by the set $S(\alpha, \rho, \theta)$, composed of complex numbers $\sigma + jw_d$, that satisfy (44) [9]:

$\sigma < -\alpha < 0; \quad |\sigma + jw_d| < \rho; \quad tan\theta\sigma < -|w_d|$ (44)

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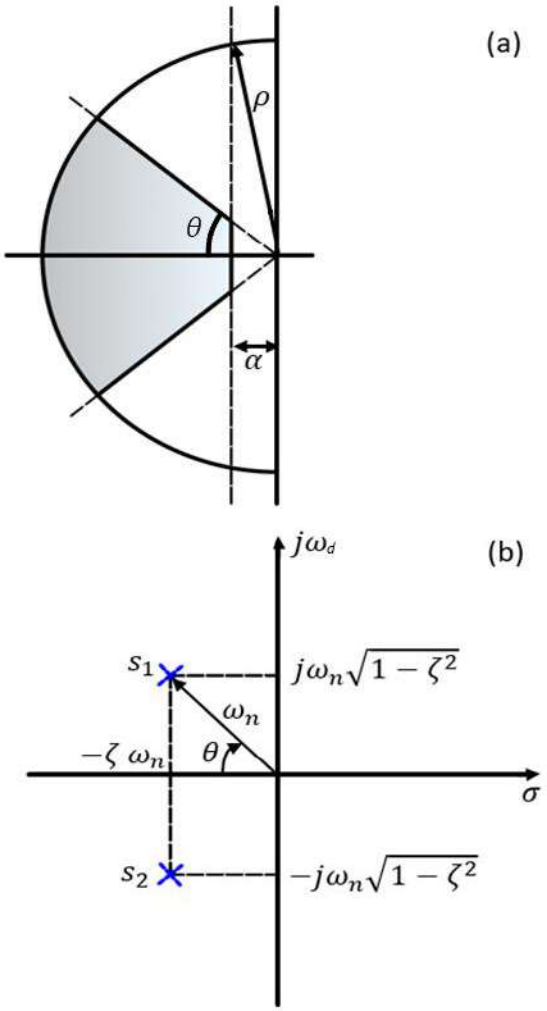


*Fig. 2: Pole region constraint geometry [9].*

Fig. 2 (a) demonstrates the set S and its variables.The comparison of Fig. 2 (a) and Fig. 2 (b) relates certain parameters of a control system, such as the minimum decay rate$\alpha = \zeta w_n$, the minimum damping ratio$\zeta = cos\theta$, and the maximum undamped natural frequency$w_d = \rho.sen$.Setting the minimum or maximum characteristics of each parameterbounds the maximum overshoot, delay time, rise time and settling time [9].

From [9] a study is made for the representation of the constraint, presented in Fig. 2 (a), by means of LMIs. Works [3] and [8] simplify these LMIs by the following theorem:

*Theorem 3.2*: The closed-loop poles of a system, considering the state feedback control law $u = Kx$, are within the region defined by the set$S(\alpha, r, \theta)$, if there is a positive symmetric matrix$W$and a matrix$Y$, such that:

$$AW + WA' + B_uY + Y'B'_u + 2\alpha W < 0 \quad \ldots\ldots\ldots\ldots (45)$$

$$\begin{bmatrix} -\rho W & WA' + Y'B'_u \\ AW + B_uY & -\rho W \end{bmatrix} < 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots (46)$$

$$\begin{bmatrix} sen\theta(AW + WA' + B_uY + Y'B'_u) & cos\theta(AW - WA' + B_uY - Y'B'_u) \\ cos\theta(-AW + WA' - B_uY + Y'B'_u) & sen\theta(AW + WA' + B_uY + Y'B'_u) \end{bmatrix} < 0 \quad \ldots\ldots (47)$$

O ganho de realimentação de estados é dado por (48):

$$K = YW^{-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (48)$$

**3.5 The$H_\infty$ norm**

The$H_\infty$norm can be represented by the $H_2$ norm, being equivalent to the largest value obtained by this one.Therefore, considering the$\mathcal{G}$ operatorsbelonging to the$H_\infty$ space, (49) is defined:

$$\|\mathcal{G}\|_\infty = sup_{x \in \mathcal{L}_2} \frac{\|\mathcal{G}_x\|_2}{\|x\|_2} = sup_{\|x\|_2 = 1} \|\mathcal{G}_x\|_2 \quad \ldots\ldots\ldots (49)$$

If the operator is a transfer function$G(s)$, the definition in (50) can be used:

$$\|G\|_\infty = sup_w \bar{\sigma}\{G(j\omega)\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (50)$$

Considering that$\bar{\sigma}\{G(jw)\}$is the maximum singular value of$G(j\omega)$. If$G(s)$ isa SISO (Single Input and Single Output) transfer function, the$H_\infty$ normcorresponds to the largest value of the Bode diagram, for example.

The$H_\infty$ problemconsists of finding a controller, such that the$H_\infty$norm of the closed-loop transfer function $G_{wz}$ (where$w$is the disturbance and$z$is the output) is minimized, i.e. less than a specified value$\gamma$.This value being determined using a particular case of the small gain theorem.

The work [2] explains how to calculate the $H_\infty$norm for a closed-loop system with state feedback, determining the dual system LMIs, presented by [10] using the following theorem:

*Theorem 3.3*: A closed-loop system with state feedback$u = Kx$ and$\frac{\|Z\|_2}{\|w\|_2} < \gamma$, is stable,if and only if, there is a positive defined symmetric matrix$W \in \mathbb{R}^{nxn}$and a matrix$Y \in \mathbb{R}^{mxn}$, such that:

$$\begin{bmatrix} AW + WA' + B_uY + Y'B'_u & B_w & WC'_z + Y'D_{zu} \\ B'_w & -\gamma I & D'_{zw} \\ C_zW + D_{zu}Y & D_{zw} & -\gamma I \end{bmatrix} < 0 \quad \ldots (51)$$

The constraint proposed in (41) and (42) is included in (51), so Theorem 3.3 ensures quadratic stability.

## IV. SIMULATION RESULTS

The model obtained in Section II for the Buck converter does not take into account its switching frequency $f_S = 100kHz$. In order to prevent the control from destabilizing, it is necessary to limit the maximum bandwidth of the controller to a frequency 10 times lower than the switching frequency [3].

The purpose of the $H_\infty$control is to have a maximum overshoot of 20% ($\%Over$) and a minimum settling time

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of 10ms ($T_e$). The parameters $\alpha$, $\theta$ e $\rho$can be related to the desired system performance through (52) to (55) [5].

$$\xi = \frac{-log(\%Over/100)}{\sqrt{\pi^2 + log(\%Over/100)^2}} = 0{,}45595 \ldots\ldots\ldots (52)$$

$$\theta = arcos(\xi) = 62{,}8739° \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (53)$$

$$\alpha = \frac{4}{\xi . T_e} = 877.28 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (54)$$

$$\rho = 2.\pi.\frac{f_S}{10} = 62831.85 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (55)$$

The synchronous Buck converter always operates similar to the continuous conduction mode, since its switches do not depend on the current flowing in the inductor to polarize, as it does in the non-synchronous converter's diode [1].For any $R$ load, there is a peak-to-peak output voltage ripple of $\Delta V_o = 12{,}5mV$, and in the inductor there is a peak-to-peak current ripple equivalent to$\Delta I_L = 500mA$.

Such ripples are the result of the switching process, and the maximum values are defined in the converter design.The controller itself cannot mitigate these ripples. For the converter operating at steady state, the minimum values of the inductor$L$and capacitor$C$are defined according to (56) and (57). In these, the duty cycle$D = 0.5$is where the largest ripples of current and voltage occur [11]. The inductor $L$in practice is not ideal as it has a fixed resistance$R_L$.

$$L_{min} = \frac{\bar{V}_{g_{max}} . D . (1 - D)}{\Delta I_L . f_S} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (56)$$

$$C_{min} = \frac{\bar{V}_{g_{max}} . D . (1 - D)}{8 . L_{min} . \Delta V_o . f_S^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (57)$$

The values range of the DC-DC Buck converter uncertain parameters is shown in Table 2.

*Table 2: DC-DC Buck converter parameters.*

| Parameters | Values Range |
|---|---|
| $R_L$ | $0.1\ \Omega$ |
| $L$ | $[500, 800]\mu H$ |
| $C$ | $[50, 200]\mu F$ |
| $R$ | $[2, 100]k\Omega$ |
| $V_g$ | $[80, 100]V$ |

Using MATLAB, the converter system, described in (16) and (17), with its polytopic representation of 16 vertices, shown in Table 1, was implemented for the parameter ranges presented in Table 2.With the aid of the SeDuMi, YALMIP and ROLMIP packages, the LMIs, represented by (41), (45), (46), (47) and (51), were optimized.As a result, the state feedback gain, in (58), was obtained. The gamma minimization resulted in$\gamma = 4.0809$. The block diagram representation, built with MATLAB/Simulink, of the Buck converter with state feedback control, is shown in Fig. 3.

$$K = [0.3389 \quad -0.4435 \quad 603.6809] \ldots\ldots\ldots\ldots\ldots (58)$$

The PI controller was designed, for comparison, with the parameters presented in Table 3. As a result, the proportional and integral gains are shown, respectively, in (59) and (60).

*Table 3: PI control design parameters.*

| Parameters | Values |
|---|---|
| Margem de Fase | 45.5950° |
| $f_c$ | $558\ Hz$ |
| $L$ | $650\ \mu H$ |
| $C$ | $125\ \mu F$ |
| $R$ | $5\ k\Omega$ |
| $V_g$ | $90\ V$ |

$$K_P = 3.5951 \times 10^{-4} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (59)$$

$$K_I = 1.1827 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (60)$$

To evaluate the response of the implemented controllers, five test scenarios were defined. In the first one, the performance of the controllers was compared, without considering the uncertainties in the Buck converter parameters.In this scenario, the voltage reference was a step signal equivalent to$V_{ref} = 60\ V$at the initial time, and changed to$V_{ref} = 30\ V$ after$0.05\ s$. The output voltages obtained for the robust and PI controllers are shown in Fig. 4.

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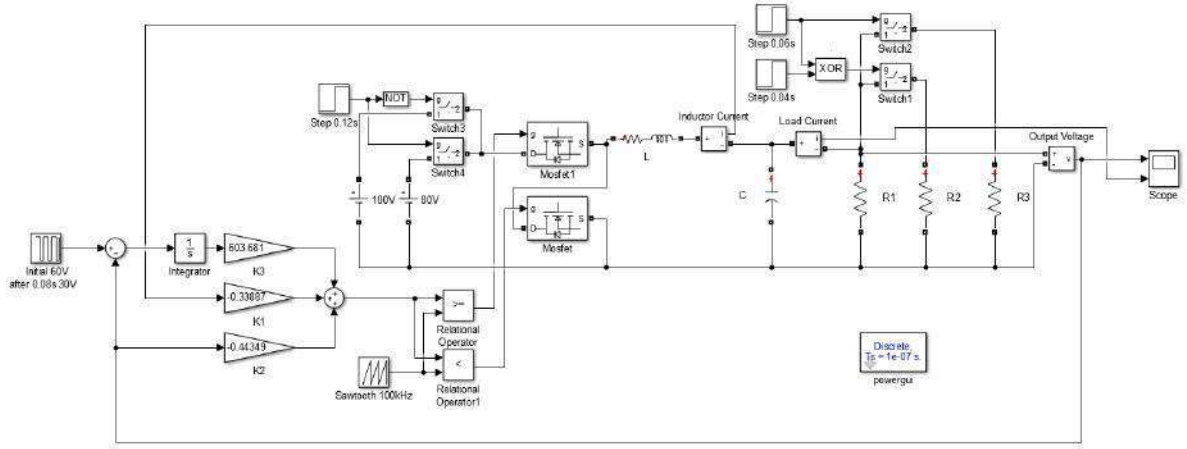


*Fig. 3: Synchronous Buck converter with state feedback control.*

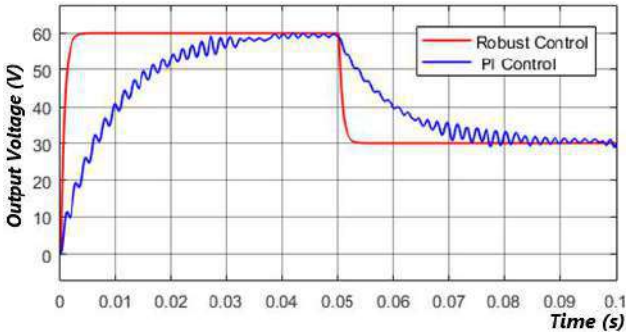


*Fig. 4: Converter output voltage scenario 1.*

The next four test scenarios evaluated the system response considering the uncertainties in the system parameters.The voltage reference was a step signal equivalent to $V_{ref} = 60\,V$ at the initial time, and changed to $V_{ref} = 30\,V$ after $0.08\,s$. The voltage input was a step signal equivalent to $V_g = 100\,V$ at the initial time, and changed to $V_g = 80\,V$ after $0.12\,s$. The load R also varied, initially it was$R = 100\,k\Omega$, changing to $R = 2\,\Omega$attime$0.04\,s$, and to$R = 10\,\Omega$attime$0.06\,s$. These settings were used for the test scenarios 2, 3, 4, and 5.

Considering the values range of the DC-DC Buck converter uncertain parameters, shown in Table 2, the scenario 2 converter was configured with inductance $L = 500\,uH$and capacitance$C = 50\,uF$. Fig. 5 compares the scenario 2 control responses.

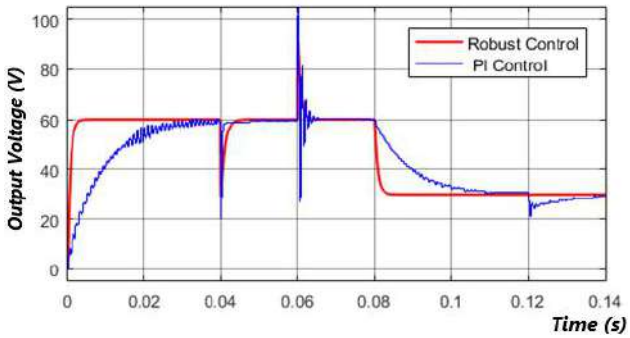


*Fig. 5: Converter output voltagescenario 2.*

The scenario 3 converter was configured with inductance $L = 500\,uH$ and capacitance $C = 200\,uF$. Fig. 6 compares the scenario 3 control responses.

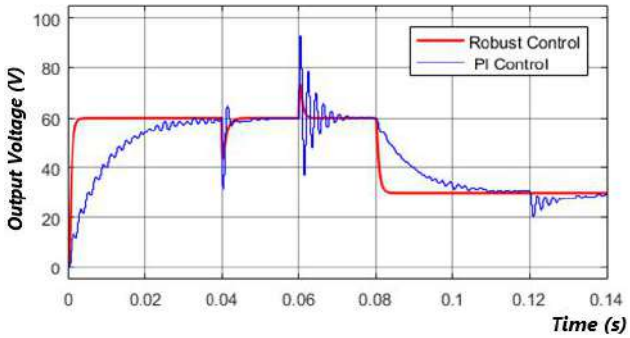


*Fig. 6: Converter output voltage scenario 3.*

The scenario 4 converter was configured with inductance $L = 800\,uH$ and capacitance $C = 50\,uF$. Fig. 7 compares the scenario 4 control responses.

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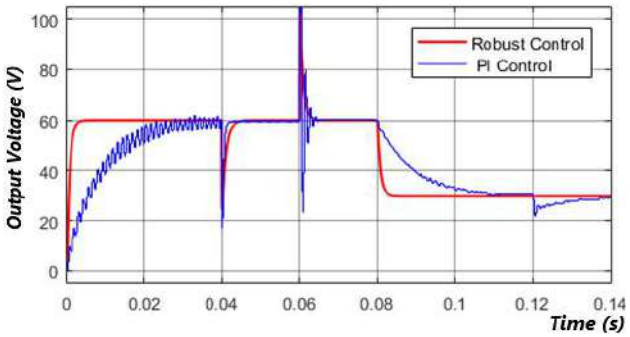


*Fig. 7: Converter output voltage scenario 4.*

The scenario 5 converter was configured with inductance $L = 800\ uH$ and capacitance $C = 200\ uF$. Fig. 8 compares the scenario 5 control responses.

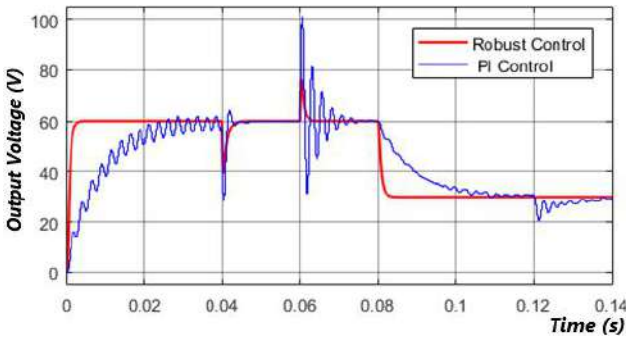


*Fig. 8: Converter output voltage scenario 5.*

It can be observed in Figs. 5 to 8 that for all the uncertainties considered in the design, the proposed robust controller was stable and within the desired performance conditions. The robust controller presented satisfactory transient responses to the $R$ step loads and the applied input voltage $V_g$, in comparison to the classic PI controller operating outside its nominal design range.

## V. CONCLUSION

The set of linear matrix inequalities (LMIs) presented in this work allows us to ensure robustness and closed-loop poles placement within the desired region, for any state space modeled system. In this work, a Synchronous Buck converter was modeled and a state feedback gain, obtained from the LMIs optimization, was applied. The system's robustness and the desired performance were observed through simulation.

The proposed robust controller achieved a more consistent performance over the adopted parameters range, in comparison to the classic PI control. As can be observed when the output loads are changed, and a step signal is applied to the converter's input voltage, for the minimum and maximum values of the adopted inductance and capacitance ranges.

## ACKNOWLEDGEMENTS

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# Analysis of the Service Level of the Manaus Moderna Port: The Perception of the Amazon Vessel Commanders

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***Abstract*****—** *The services that river vessels have provided to Amazonian communities, from the most remote to the great metropolises, are so essential that it is likely that without them the very livelihoods and survival of the peoples of the region would be compromised. Because of their importance, these vessels have become true regional institutions, so it is essential to know their level of service, which corresponds to the satisfaction that their users have in relation to the services available to them. As satisfaction is also due to the services provided by the ports where they dock, it is necessary to investigate the service levels of these ports. This study aimed to evaluate if the service level of the Manaus Moderna port is in accordance with the expectations of the vessels that dock there, according to their commanders. It used the survey method, using a semi-structured interview script focused on evaluating existing services and identifying missing services to test the hypothesis that the services offered are in line with what is expected of them; Data processing was based on simple frequencies and percentages, presented in contingency tables, whose interpretation was centered on the degree of satisfaction of the respondents (port service level) and the clients of the vessels (vessel service level). The results showed that a) only the services provided by the on-site police station cause satisfaction, b) there are numerous infrastructural services that are not available and that are necessary for vessels to operate with the minimum adequacy and c) customer satisfaction of vessels. it concerns only passenger ordering and transport services. The conclusion shows that the level of service offered by the port of Manaus Moderna to the vessels that dock there is below what is expected, according to the perception of its commanders.*

***Keywords*****— *Amazon Logistics, Amazon Ports, Amazon Transportation, Amazon Vessels, Service Level.***

## I. INTRODUCTION

Passenger transport logistics in the Amazon region is quite unique: artisanal vessels with local production techniques, based on centuries-old cultural traditions, predominate. It is these vessels that move the waterway modal in the region and, therefore, the main port activities: loading and unloading, warehousing and handling, reception and delivery and interconnection (Monfort et al, 2012; Silva, 2017). Just as the craft that transports passengers is handmade, so are the logistics services provided. And the result is that the level of services provided by both vessels and waterways terminals seems to be very far from what their users want and need, generally belonging to the lower and middle classes of cities in the interior of the Amazon.

Of course, the level of service is poor not because the commanders of these vessels are dishonest or have any intention of harming their users. On the contrary, they do everything within their perceptions and knowledge so that the degree of satisfaction is as much as possible, often limited by cultural imperatives. But it turns out that port infrastructure and services that are available (or missing) are not traditionally provided by them. The strength of tradition, therefore, seems to be still firmly grounded in the strategies for providing these services in the Amazon region. Of course, as users, they can influence the managers of these ports to offer them. Therefore, it is necessary to know what is missing to increase the service levels of these ports, motivation for this study.

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Therefore, in the case of this region, the focus of logistic studies must be changed, as recommended by Porto et al (2017) and Vieira and Coutinho (2008). Rather than focusing only on traditional dimensions and variables such as efficiency and economic and cost savings, behavioral factors are also privileged, so that the logistics reality and service levels are more appropriately portrayed. The reason for this is that, in the Amazonian case and perhaps everywhere in the world, behavioral factors influence the service levels, the object of this research. This study aims to evaluate whether the service levels of the Manaus Moderna port are in line with what is expected by the vessel commanders who use the services offered there.

## II. THEORETICAL FRAMEWORK

The basic idea underlying the level of service is simple to understand: maximizing the satisfaction of the recipient. Therefore, the level of total logistics service is said to be the result of all the needs-sourcing efforts suppliers provide to their customers (Ballou, 1993). It is obvious that this is not a purely quantitative question. The quality factor is essential (Ballou, 2013), because it indicates how much of what is expected in terms of satisfaction has been achieved. Redone, the bottom line, the logic goes like this: Service levels need to be increased in number of efforts until the quality required by the customer is achieved. And service level quality is more adequately expressed in terms of satisfaction (Costa & Granemann, 2017), so that high service levels lead to maximum satisfaction levels and vice versa, lower service levels generate less satisfaction and even dissatisfaction.

Satisfaction or dissatisfaction results from the performance of the services offered by suppliers (Silva, 2017), the number of things they make available to their customers. Therefore, it is necessary to know how much each service offered contributes to maximize the satisfaction of customers or users. Thus, the challenge of managing logistics service levels is to maximize the performance of each service offered to customers so that they can meet their needs as satisfactorily as possible. Thus, for this study, the level of service corresponds to the quantity and quality of services provided by suppliers available to their customers.

### 2.1 Extrinsic Service Level Relationships

Service levels impact both customers and suppliers. This denotes a multitude of relationships, many of them difficult to perceive and gauge. The study by Duarte & Guarnieri (2016) showed that service level is an essential requirement for long-term relationships and, consequently, customer loyalty. When service levels are perceived as adequate, satisfaction tends to materialize. However, there is a trade-off between service level and logistics costs, which implies an inversely proportional relationship between these two variables. The level of service therefore affects logistics costs (Melo, Moreira & Alencar, 2010). Therefore, Vieira & Coutinho (2008) consider that logistics activities need to be challenged to integrate their key activities to reduce their costs, because only in this way would the maintenance of the desired service levels by customers and their customers be largely guaranteed. may be offered by suppliers. Therefore, the level of service must be part of the logistics planning of organizations (Fernandes, Wrubel & Dallabona, 2015) because costs and level of service is the difficult challenge to balance (Mattos Neto et al., 2017).

Another variable that is related to service levels is the length of service (Silva et al., 2017). This relationship is also inversely proportional: the shorter the time of resupply, the greater will be the level of service provided. This means that in the practice of logistics activities, efforts made, if possible, need to affect the delivery time of customer service. Among the logistics activities, those over which organizations have greater control and which affect service levels, the most important are warehousing activities (Coelho & Marjotta-Maistro, 2017). Between the arrival of the product in the organization and its availability to customers, the lead time needs to be as short as possible. By reducing time, the organization adds time value to its customers.

Often storage is not just about simply stopping products on shelves. It begins, in the case of the use of port infrastructure, in the loading and unloading of ships, continues with the temporary storage of containers in the ports, continues with the reception and delivery of products in the organization and often with the interconnection with other modes (Vieira et al., 2015). And the longer the lapse of these intercourses, the longer the storage time and the higher the costs.

Port logistics activities are almost always based on relatively strict environmental regulations, so that acting in accordance with them can also be configured to increase the level of service provided (Guarnieri, 2016; Silva et al., 2017; Baraúna, 2017). When linked to reverse logistics, the impacts of service levels are even clearer, mainly because they can add environmental, logistical, economic, legal and competitiveness values.

Other types of relationships could be pointed out here, to understand a significant part of the implications of ensuring high service levels in logistics activities. Much of the literature focuses precisely on these factors: costs, customer loyalty, downtime, warehousing, reverse

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logistics, and environmental issues. This means that in addressing these six factors, much of the challenge of raising service levels will be overcome.

**2.2 Intrinsic Service Level Relationships**

We have seen the factors that are related to the service levels. It is also necessary to know what the literature presents as the elements that compose them, that is, their categories, considered here as intrinsic, internal relations. In other words, it is necessary to know what efforts should be made to improve the performance of logistics activities and thus increase customer satisfaction. The first effort is with the delivery time (Duarte & Guarnieri, 2016). Time is as much an external factor, as much of the other logistic activities as the activities of other sectors of the organization and of its clients, as well as intrinsic variable, component of the level of service itself, so that the lesser the time spent by the level effort of service, the greater will tend to be its importance to generate customer satisfaction (Ferreira & Oliveira, 2015).

The second is the differentiation of the services offered. The study by Coelho Júnior et al (2015) showed that differentiated service levels, therefore, for a smaller number of customers, increases customer satisfaction. Differentiation would be a way of grouping customers from similar needs different from the needs of other customer groups. This implies admitting that customers have different needs and that keeping the same efforts for everyone rather than generating superior performance of the efforts can lead to dissatisfaction as an effort may not be desired by multiple customers. In addition, differentiating often means raising the costs of these services.

The third component of service levels found in the literature was the quality of service provided (Monteiro, 2015; Vieira, Gonçalves & Dorion, 2015; Callefi, Barbosa & Ramos, 2017). Service level, in this respect, is a qualitative measure of the efforts made. In the case of port services, for example, the quality would be due to the service provided, safety, reputation for damage, productivity level and efficiency (Vieira, Gonçalves & Dorion, 2015). More broadly, the quality is due to the logistics flow (Callefi, Barbosa & Ramos, 2017).

Ballou (1993) organizes the elements of service levels in three dimensions, structurally related to time. There would be pre-transaction elements, which are efforts made prior to the execution of logistics activities, such as organizational policies and structure, system flexibility, and available technical services; transaction elements, translated into inventory level, ability to handle delays, order cycle, time, transshipment, accuracy, order convenience and product substitutability; and the post-transaction elements, set up at installation, warranties, repairs, spare parts, order tracking, customer complaints, packaging and temporary product replacement during repairs. Transportation service vessels still lack empirical studies to understand what efforts they need to make to ensure their customers' desired performance and service levels. And this lack is even more felt in relation to passenger transport services by Amazonian vessels.

**2.3 Cargo and Passenger Transportation in the Amazon**

The rivers are the Amazonian highways. It is through them that regional wealth is transported, both legally and illegally (Cope & Parks, 2016). Unlike other Brazilian regions, which are characterized by an extensive road matrix and limited systems of river, rail and air modes (Fabiano, 2013), practically everything in the Amazon depends on river transport (Soares & Vidal Filho, 2014; Patrício & Ferreira Filho, 2015; Feitosa, 2016), especially the most hidden and distant cities from the largest regional centers (Belém and Manaus) and the micro-regional hub cities. It is by rivers that small and medium-sized vessels travel every day, every hour of the day. They carry passengers and cargo simultaneously. Regional traders prefer to transport their products in this way because it is cheaper (Matos, 2016; Dray, Muniz & Taveira, 2017), precisely the medium that, on the other hand, is the cause of death in the region (Soares & Vidal Filho, 2014).

Produced by hand (Soares & Vidal Filho, 2014), they are extremely fragile, considering the maintenance services that are hardly done on a regular, scheduled basis. What helps the continuity of these vessels as preferred vehicles of the Amazon is that regional rivers are perennial practically every month of the year (Patrício & Ferreira Filho, 2015) and the absence of other modes (Dray, Muniz & Taveira, 2017). These environmental conditions, together with cultural traditions, help make this mode of transport the preferred one throughout the region, requiring deep thought on any action on it (Vasconcelos et al., 2010).

Vessels are regional integration vehicles (Feitosa, 2016). They are the ones who pull small communities from just a few residents out of isolation into small, medium and large cities. And it was precisely these vessels that allowed the settlement of almost all regional communities to form on the banks of rivers (Calheiros, 2010). While in other regions are the roads that determine the formation of communities, in the Amazon the determining factor is the river.

And there is an organic relationship between cities and communities. Large centers, such as Manaus and Belém, have practically daily exchanges with the polo cities, such

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as Santarém, Parintins, Macapá and others, determined by their attraction (or domination) economic-geographic-political-social (Braga de Moraes & Wilson, 2013). Belém is more related to Macapá than Manaus, which is farther away, while Manaus is more related to Porto Velho. But still, despite the vastness of the territory and its worldwide importance, the logistical knowledge there is still quite limited and unsystematic (Figueiredo & Blanco, 2016).

Teixeira et al. (2017) showed that most of these vessels, on the other hand, do not comply with basic safety measures. It is very common to exceed the limit of load and passengers that can carry, there are no safety equipment, no protection of the motor shaft, which can cause scalping (very common), among many other factors that reduce the level of service that pay. Pires (2014) showed that it is necessary to create a system to evaluate the efficiency of Brazilian ports, specifically for cargo transportation in port facilities. In the case of the Amazon, as cargo and passenger transport are done simultaneously, passengers are often accommodated next to the cargo, this assessment needs to include passenger transport. However, for the assessment system to be designed and executed with validity and reliability, it is necessary to know the elements of the service levels that ports need to make available to their users, notably the vessel commanders, subject of this research.

The theoretical framework that led the empirical surveys and guided their findings is as follows, in relation to the service levels of the Manaus Moderna port: 1) service levels can be assessed from the perspective of user satisfaction in relation to what is provided by the service providers; 2) satisfaction is relative to the performance of the services offered and those not offered, so that the services not offered would be the complement of satisfaction to make it maximum; and 3) it is possible to group the groups by similarities and by supplier.

## III. METHODOLOGY

The method used was the survey, which is characterized by the collection of information from a sample of a larger population, with the purpose of generating inferences. The unit of analysis was the commanders of vessels that dock at the port of Manaus Moderna, with level of organizational analysis, taking each vessel as an organization, since they are composed of at least two people with at least one common goal. The perspective of analysis was synchronic, also called transversal, which corresponds to the generation of explanation about a certain aspect of reality, such as a photograph.

### 3.1 Guiding Questions

To reach the objective of this investigation, two guiding questions were formulated:

a) What are the existing services at the port of Manaus Moderna so that vessels can operate with the minimum of normality?
b) What are the missing services in the port of Manaus Moderna so that the vessels can operate with the minimum of normality?

With the answers to these two questions, we proceeded to the process of understanding how they contribute to forming the current level of service offered to boat customers. If satisfaction with the services offered is low, the service level will also be low; If there are many missing services in the port, this will also contribute to the low level of service offered.

### 3.2 Population and Sample

Surveys and contacts made with vessel commanders' weeks before data collection showed that, on average, approximately 90 vessels land in Manaus Moderna on Fridays and Saturdays. The section of the port considered in this study begins under the Educandos bridge and ends at the demarcation of the Manaus Port, known as Rodway, in a waterfront of approximately 800 meters in length. Along this perimeter there are 4 ferries that serve as berths for the vessels.

Thus, the population of this study was composed of all vessels that were docked in the port, on two alternate weekends (Friday and Saturday), in a total of 90 vessels. It was intended to make a census, seeking to contact all vessels. As many refused or could not respond to the interviews, 49 participants were obtained, which is considered a satisfactory sample.

### 3.3 Research Subjects

It was defined by the study protocol that the answerers to the questions would be the vessel commanders. Often the ship's commanders are the owners themselves. This procedure was necessary to ensure the validity of the information and data obtained, since these two subjects can identify each service offered or missing at the port and its link with the satisfaction of their vessels' customers. However, we do not neglect the search for understanding the satisfaction of commanders and boats with existing services, nor the contribution of these existing services to their satisfaction of their customers. Is that the theoretical framework says that the service level of the vessels is composed of the satisfaction with the services offered by the boats plus the services offered by the port.

### 3.4 Data Collection Instrument

Data were collected with the help of a semi-structured interview script. The instrument consisted of three blocks

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of questions. The first block contained demographic questions of respondents: age, gender, education, place of birth and working time in river transport. The second block contained explanatory questions, composed of three groups, one concerning the services provided by the Port and the other concerning the services provided by the vessels to its customers. The first group concerned the services that commanders would like to be offered at the port of Manaus Moderna, who should provide those services, and why they would like them to be made available; and the second group was in relation to the services that exist and which cause them satisfaction, especially those who provide these services and the reasons for satisfaction. The third set of questions was about the two main customer services of the vessels that caused them satisfaction and the reasons why the customers were satisfied.

**3.5 Data Collection Strategy**

Data were collected through semi-structured interviews. The researchers knew precisely what they needed to know but did not know the possible answers. This means, for example, that the researchers were looking for a list of services in the port and a list of those not offered but needed. In the first case, for each service identified by the respondents, they were then asked about their degree of satisfaction with each of them.

For each missing port service, all respondents were asked to identify why that service was needed and who should supply it, ie who should materialize it. For example, for the missing service "Orla" the responsible person suggested for its construction was mostly the Government, while for the missing service "training" the majority responsible was the private initiative. There were services in which the suggestion of responsibility for materialization came from both government and private initiative.

Data were collected on March 30 and 31 and April 6 and 7. These days were chosen due to the dynamics of the port. The vessels start to dock on Wednesdays and sail again between Saturday noon and Sunday. On other days there are boats, but their commanders are almost always out of them, seeking to close transportation deals or doing other chores.

**3.6 Data Analysis and Interpretation**

Once collected, the data were entered and organized using a spreadsheet. Data that showed no answers, which were blank, were discarded and only their No Response frequencies were computed. The organization consisted of the generation of contingency tables, where, in the left column, the analysis category appears, and in the right columns the simple and percentage frequencies. The same procedure was used for all questions, so that there was a data processing unit and generation of results.

The use of this technique, quite simple, but adequate to achieve the objectives of this investigation, allows to highlight the most salient, evident findings. Thus, for example, it was highlighted that 26 respondents, which is equivalent to 53% of the total, said they had completed high school as their maximum education. These evidences collaborate, therefore, to interpret the obtained results.

Interpretation is nothing more than explaining what that empirical evidence means. In other words, to interpret is to say what logic explains a given observed behavior. Thus, the scheme used in almost every presentation of empirical evidence (tables) was to describe the results on the evidence and, underneath them, to describe the logic that allows us to understand their behavior.

**3.7 Study Limitations**

Like any scientific study, it also has limitations, which does not mean that its results are invalid. The first limitation concerns the method: sampling surveys, because they do not consult all the elements of the sample, present error margins that need to be adequately managed. Probably the results achieved by this study would be different from those contained herein, but this difference would be minimal. Thus, the study results cannot be generalized to all Manaus ports, much less to Amazonian ports.

The second limitation concerns the data collection strategy. The ideal would also be to collect data and information from vessels that arrive between Sunday and intermediate days until Thursday and return during this period. Despite being quite small, their participation in the study would also lead to differences in the results achieved. Again, it is likely that these differences were also not significant in relation to the objectives intended by the investigation.

## IV. RESULTS AND DISCUSSION

Here are presented the research results, in the following order: first the main characteristics of the sample used to generate the results, their demographic aspects will be described. Following are the missing primary services at the port, which are those that first came to the respondents' minds; then the missing secondary services there, those that came in second position pointed out by the participants. The section concludes by identifying the service items that vessel customers are most satisfied with, from the point of view of vessel commanders.

**4.1 Sample Features**

The results of this study show that waterway transport practiced in the port of Manaus is the domain of men with

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great life experience, which implies admitting considerable knowledge of the challenges and adversities of regional logistics. However, despite great experience of life and regional reality, these commanders and owners have a level of education. Although 53% have completed high school, 39% have only elementary school and 8% have not completed any formal education. These results indicate a serious problem that needs to be addressed that may be one of the contributing factors to aggravate the logistical problems of the region, not to mention accidents that often result in deaths.

It is likely that this same scenario will reproduce itself in the reality of other similar Amazonian localities and become even more cruel in the medium and small cities. In terms of technology and its handling, low education prevents its adoption, either in terms of equipment acquisition and handling, or in terms of social and managerial technologies, as both require some cognitive development and intellectual maturity before they can be properly applied on vessels, taken as organizations.

Negative schooling outcomes are somewhat offset by the great experience that masters and owners have in water transport. Almost two thirds (60%) of respondents have at least 25 years of experience, while 40% of them said they have worked with this logistics mode for over 25 years. Again, the experience of these individuals seems to come into play here, notably the cultural knowledge of the regional river reality, used to carry out the challenge of making the connections between the Amazonian communities as adequately as possible.

The strength of regional knowledge is deepened by the place of birth of respondents: two thirds come from the state of Amazonas, compared to 33% born in other states. Of that 33%, more than half were born somewhere in the Amazon. Because adversities and challenges are very similar within the region, caboclos born in one place do not find it very difficult to adapt in another, so the transfer of knowledge and experience from their place of origin to another is almost imperceptible.

**4.2 Missing Primary Services at Port**

In accordance with the theoretical framework of this research, it was sought to know which services the port does not currently offer, but which are considered important to increase the satisfaction of the vessel commanders, who are its users. This question has been divided into two possible answers. The services considered primary were those that first came to the respondents' minds and are contained in table 1.

*Table 1. Missing primary services at port*

| What is missing | Freq. | Freq. % | Category |
|---|---|---|---|
| Orla | 11 | 22 | Infrastructure |
| Ticket Sales Venue | 8 | 17 | Infrastructure |
| Parking | 8 | 17 | Infrastructure |
| Expand the port | 6 | 12 | Infrastructure |
| Digital contacts (website and app) | 6 | 12 | Infrastructure |
| Shopping center | 5 | 10 | Infrastructure |
| Health Center | 1 | 2 | Infrastructure |
| Safety | 1 | 2 | Infrastructure |
| Better access to boats | 1 | 2 | Infrastructure |
| Inspection | 1 | 2 | Infrastructure |
| Time disclosure | 1 | 2 | Infrastructure |
| Total | 49 | 100 | - |

These results are all likely to fall into the infrastructure category. Infrastructure is all physical and administrative support that allows users of a given service to have their satisfaction levels assured or, if they are assured, high. This infrastructure can be subdivided into physical infrastructure (Farias & Brito, 2016; Castro, 2014), which allows logistical operations for respondents of this investigation, and support services (SAFI, 2017), such as security, digital means so that tickets can be traded and also information about the arrival and departure of each vessel and so on.

These needs (considered in this study as first because they were the first to be identified by the respondents), as can be seen from the data contained in table 2, are almost all aimed at vessel customers, except for the "attractive location" purpose. It means making the port of Manaus a tourist spot, therefore not exclusive to the users of the transportation services provided by the respondents of this survey, and" avoiding accidents ", which likewise encompasses the protection of both customers and all those circulating in that area.

*Table 2. Purpose of primary needs*

| Purposes | Freq. | Freq. % | Purposes |
|---|---|---|---|
| Improve service | 16 | 33 | Improve service |
| Attract customers | 15 | 31 | Attract customers |
| Customer Support | 8 | 16 | Customer Support |
| Site attractive | 7 | 14 | Site attractive |
| Customer Safety | 2 | 4 | Customer Safety |
| Avoid accidents | 1 | 2 | Avoid accidents |
| Total | 49 | 100 | Total |

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What these results clearly indicate is the concern with otherness, which involves ethical aspects (Estevam, 2008; Silva, Silva & Gomes, 2014; Bavaresco & Costa, 2011) of ship's commanders. And alterity concerns concern with others, so that when the commanders point out the need for infrastructure in the ports of Manaus City, they have in mind exactly the comfort of their customers so that their satisfaction is raised. These intended satisfactions, therefore, despite coming from what they are lacking today, are complementary to the services provided by vessels.

The data contained in table 3 show who should meet these first needs pointed out by the commanders of vessels using the Manaus Moderna port. It is noteworthy that 45% of the responses focused on partnership between the government, understood as all spheres of public administration, which involves the Navy, for example, and private entrepreneurs.

*Table 3. Primary needs supplier*

| Supplier | Freq. | Freq. % |
|---|---|---|
| Government and businessman | 22 | 45 |
| Government | 16 | 33 |
| Businessman | 10 | 20 |
| Navy | 1 | 2 |
| Total | 49 | 100 |

Although a relevant quantity (35%, considering the 2% of the Navy, which is also a government) suggested only the government and 22% only businessmen, what is noteworthy is the awareness that this large enterprise requires the participation of the spheres. public and private. These results are significant because they show a tendency not only to consider the government as a builder of infrastructure that will be used largely by private initiative, such as the exploitation of cargo and passenger transport services.

**4.2 Missing Secondary Services at Port**

The needs considered secondary in this investigation were those identified second by the respondents. In psychological terms, they are those that appeared after the first ones, which denotes secondary importance, and are listed in table 4. Again, here, the first infrastructural needs appear, followed by those aimed at improving the operations of vessels, as is the case. the case of training of port personnel and the need to make financial resources available for investments in vessel operations. Some needs appear to be duplicated relative to primary needs because what was a priority for some respondents was secondary for others. Since they needed to identify two needs, it was natural for repetition to happen.

*Table 4. Missing secondary port services*

| What is missing | Freq. | Freq. % | Category |
|---|---|---|---|
| Mall | 8 | 16 | Infrastructure |
| Health Center | 6 | 12 | Infrastructure |
| Ticket Sales Venue | 6 | 12 | Infrastructure |
| Parking | 5 | 10 | Infrastructure |
| Border | 4 | 8 | Infrastructure |
| Website Information | 4 | 8 | Infrastructure |
| Attendant Training | 4 | 8 | Operations |
| River Surveillance | 3 | 6 | Infrastructure |
| Financial incentive | 3 | 6 | Investments |
| Customer servisse | 3 | 6 | Operations |
| Ticket Sales App | 2 | 4 | Infrastructure |
| Banks | 1 | 2 | Infrastructure |
| Total | 49 | 100 | - |

However, these results indicate several needs for what indirectly seems to be flawed: infrastructure. This varied range of needs ultimately represents the remodeling of the port itself. If almost everything is lacking, it is likely that the degree of satisfaction of ship's commanders with what is offered to them is extremely low, so that they only use such services because no others are available.

Regarding the question that sought to know the purpose of supplying these secondary needs, the results are shown in table 5. It is noted that 82% of the answers are directed to a single target, which are the clients of the vessels. So, what ship masters want, by supplying these secondary needs, is to increase their customers' satisfaction, thereby increasing the level of service their vessels offer them. These improvements would bring customer ease, customer support, attract more customers, and improve customer service.

*Table 5. Purpose of secondary needs*

| Purposes | Freq. | Freq. % |
|---|---|---|
| Make it easy for customers | 14 | 28 |
| Customer Support | 13 | 26 |
| Attract customers | 12 | 24 |
| Avoid accidents | 3 | 6 |
| Help in health | 3 | 6 |
| Opportunity to expand business | 2 | 4 |
| Improve service | 2 | 4 |
| Total | 49 | 100 |

What can be concluded from these results is that respondents are interested in raising the level of service provided, but through investments and improvements in the port of Manaus Moderna, which is the responsibility of the municipal government. However, as many ferries,

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which serve as berths, are public concessions, there is also a need for private investment to meet these needs.

Table 6 shows the results regarding the question that sought to know who should meet the needs listed by the respondents. The results further accentuate the perception of primary needs. Here, for secondary needs, 76% consider that investments should be made by the government and only 8% by the private sector. Also noteworthy is the importance of appointing a government-private partnership partner, with only 16% of reference.

*Table 6. Secondary needs supplier*

| Supplier | Freq. | Freq. % |
|---|---|---|
| Government | 35 | 72 |
| Government and businessman | 8 | 16 |
| Businessman | 4 | 8 |
| Navy | 2 | 4 |
| Total | 49 | 100 |

What this research has shown so far is that there is a need, yes, for improvements in the port researched. But these improvements are all made by third parties. Although the interest of the respondents is to raise the level of service they offer their clients, they seem to shirk responsibility for investments, which generates a paradox: while indicating a concern with the other, with otherness, with the client, this concern has as its own benefit the ship's commanders themselves.

**4.3 Satisfaction with Existing Port Services**

When we tried to find out which services at the port were the most satisfying, the answers obtained for those considered the most important were only one: police station. No other answers were cited. The issue of violence, not only in the area of this research, but throughout the city, although it does not scare the Manaus inhabitants, who seems to have gotten used to it, is noteworthy. Official figures appear to cover only a third of actual occurrences, which are already very high (Alves, 2017).

Table 7 details the reasons for respondents' satisfaction with the deployment of a police station in the port area. The data show that 43% thought the police station had prevented theft, 31% said the bandits were evacuated and 26% said they won safely. The supplier of this service, of course, was the government of the State of Amazonas, through the Secretariat of Public Security.

*Table 7. Satisfaction reason*

| Reasons | Freq. | Freq. % |
|---|---|---|
| Prevents theft | 21 | 43 |
| Removed bandits | 15 | 31 |
| Brings security | 13 | 26 |
| Total | 49 | 100 |

We sought to identify which secondary services were of importance to vessel commanders. The answers obtained are contained in table 8. Many respondents, even though they had been searching for some time, were unable to answer, which explains the high rate of non-response to this question, corresponding to 80% of them. Extracting Navy oversight, the other two are focused on the problems that parking attendants cause. Parking attendants is what the individuals who are willing to store their cars parked in the harbor area are called.

*Table 8. Second existing service that causes satisfaction*

| Satisfying services | Freq. | Freq. % |
|---|---|---|
| Registration of parking attendants | 2 | 4 |
| Navy surveillance | 2 | 4 |
| Parking attendant's organization | 6 | 12 |
| No Answer | 39 | 80 |
| Total | 49 | 100 |

These results clearly indicate that, in practice, there are no services provided to it, either by the public authorities, except for the security provided by the police station and the Navy, nor by the owners of the berths, regarding the second existing services that cause them satisfaction. . This seems to lead to the conclusion that you are not satisfied with existing services, which implies admitting that your services have at least dubious if not low service levels.

Table 9 confirms the irrelevance of these satisfaction with the level of service: not having fights between the flannel and avoiding traffic accidents. Let this be properly understood: since there is nothing to be satisfied with, the least amount of action that seeks to reduce the number of unpleasant things already sounds like satisfaction. And this is what we detected in relation to the respondents' satisfaction with the second supposedly existing second block of services.

*Table 9. Reasons for satisfaction*

| Reasons | Freq. | Freq. % |
|---|---|---|
| Avoid fights | 8 | 16 |
| Avoid accidents | 2 | 4 |
| No Answer | 39 | 80 |
| Total | 49 | 100 |

Table 10 shows that it was the government that, according to the respondents, organized the flannel and thus greatly reduced the problems it caused not only to boat users, but to all those traveling around the harbor area, whether drivers or pedestrians. The fact, as these results show, is that the disciplinary public sector initiative of these people caused respondents satisfaction for lack of other reasons to compare.

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*Table 10. Needs Suppliers*

| Suppliers | Freq. | Freq. % |
|---|---|---|
| Government | 8 | 16 |
| Navy | 2 | 4 |
| No answer | 39 | 80 |
| Total | 49 | 100 |

From this point of view, this aspect of port service level, relative to existing services that cause satisfaction, points to the difficulty of finding something there that can be considered satisfactory. The exception, as noted, was the establishment of a nearby police station, which helped solve several problems that had negative impacts on port operations and vessel services. As is an exceptional case given the difficulty of finding a service provided by the port, the result was the unanimity that this is the only service available to it.

**4.4 Vessel User Satisfaction**

We sought to know the perception of the commanders about the satisfaction of boat users, to know, according to their views, which would be the central points of the level of service they offer their customers. They were also asked to tell us which two services most satisfied their customers with two response options. The answers, considered first, are contained in table 11. The results show parcel delivery services, with 48% of responses, followed by people transport (22%) and sightseeing (20%) as the most satisfying.

Parcel services are the transportation of small size materials such as letters, mail of all kinds, one or two sacks of grain, frozen packets of fish and meat packaged in refrigerators and so on. Because they take up little space and quantity is high, price x quantity leads to an interesting revenue, often much more economically attractive than the transportation of cargo and passengers, as these results indicate here.

*Table 11. Services that cause primary satisfaction*

| Services | Freq. | Freq. % |
|---|---|---|
| Orders | 22 | 48 |
| People transport | 11 | 22 |
| Sightseeing | 10 | 20 |
| Fishing boat | 4 | 8 |
| Freight Transport | 1 | 2 |
| Total | 49 | 100 |

Fishing (8%) and freight (2%) transport services, surprisingly, appear in the last places, especially freight transport, which was thought to be the main reason for satisfaction. Vessels represent the major means of transportation between the Amazonian cities, especially between the big cities for the medium and the smaller ones, where they work as a socioeconomic hub. These cities are supplied with the services provided by these vessels, since rivers are the roads of the region. Thus, it is surprising that freight is a source of less satisfaction than other services provided.

Table 12 indicates the main reasons that led respondents to point out those services as the most cause of satisfaction. Among these, price comes first, with 54% of the answers obtained, followed by the quality of the service provided, with 28% of the answers, and the service offered to customers, with 18%. These results indicate that the price - quality - service trilogy accounts for 100% of ship customers' satisfaction from the point of view of their commanders.

*Table 12. Primary satisfaction reason*

| Reasons | Freq. | Freq. % |
|---|---|---|
| Price | 26 | 54 |
| Quality | 14 | 28 |
| Attendance | 9 | 18 |
| Total | 49 | 100 |

These results seem to be in tune with the regional socioeconomic reality. Higher-income individuals, when commuting between major cities in the region served by regular air transportation, generally do not use vessels as a regular means of transportation. The same is not true of those who live in smaller cities and where there is no affordable regular air transport, which forces both the largest and the lowest income individuals to use the boats. In addition, as there is relative competition between vessels, price becomes a competitive differential, so it greatly interferes with customer satisfaction at such high intensity.

Table 13 presents the results related to the services considered to be the second with the highest level of satisfaction, also from the perspective of the commanders of river vessels operating in the port. Here again the same system has been repeated: the transport of people is, in fact, the main factor of customer satisfaction of vessels. In second place are parcel services, with 12%, reversing the positions achieved in relation to primary services.

*Table 13. Satisfactory secondary services*

| Services | Freq. | Freq. % |
|---|---|---|
| People transport | 21 | 43 |
| Orders | 6 | 12 |
| Food transportation | 1 | 2 |
| Vehicle Transport | 1 | 2 |
| No answer | 20 | 41 |
| Total | 49 | 100 |

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Together, the primary and secondary satisfactions of people transport reach 65% of all responses, while the sum of orders reaches 60%. Moreover, when these two services are added together, they represent 68% of the total satisfaction of the study. It is interesting to note, too, that there are few services offered by vessels, which also explains the high degree of non-response (41%) to this question. What would be happening, therefore, with the material transportation services, the cargoes that supply the Amazonian municipalities that are not served by other modes of transportation?

The answer is that these services, because they are of such low quality, are a reason for constant complaints from customers and cause a lot of conflicts between customer and carrier. This partly explains their low consideration in this study. Another explanation is the appearance of large carriers, such as ferries and larger vessels, that do not dock in the port surveyed.

*Table 14. Reasons for secondary satisfactions*

| Reasons | Freq. | Freq. % |
|---|---|---|
| Attendance | 14 | 29 |
| Price | 12 | 24 |
| Quality | 3 | 6 |
| No answer | 20 | 41 |
| Total | 49 | 100 |

Table 14 presents the reasons for secondary satisfaction. Note again the presence of the price - quality - service trilogy, which represented 59% of the answers obtained, against 41% of non-answers. These results indicate that there is no other reason, from the perspective of the respondents, that explains the satisfaction of their customers. The level of service that the port presents is still unsatisfactory. This conclusion is because the vessel commanders, who are their main users, pointed out a series of missing primary services, all an infrastructural order. This means that the port does not have the necessary supports for vessels to operate normally, which implies admitting that their operations today are poorly performed. Indeed, it seems that this precariousness has been going on for several decades.

There is a lack of parking, shopping center, health center, security, better access to boats, supervision of the competent agencies and many more modern ones, such as information on the operations of vessels, such as arrivals and departures, and acquisition. of tickets and demand for parcel services and cargo transportation.

These necessary improvements, according to what could be deduced from the answers presented by the study participants, aim to provide the minimum amenities for the vessel's clients. Without these minimum conditions, these customers are unlikely to be fully satisfied. As a result, these customers will find the services provided by the vessels to be inadequate as the port infrastructure is poor. And as the level of service is comprised of port services plus ship services, even if ship commanders raise the level of internal service, maximum satisfaction is still not guaranteed due to the port's infrastructure deficiencies.

To give you an idea, the only service that the port presents and gives you satisfaction, and that was remembered by all survey participants, is the police station. Asked about other services provided, they could only remember the organization of the local parking attendants, which kept bothering the customers and passers-by of the place, which generated constant conflicts there. The numerous missing services, according to the ship's commanders, should be supplied with funding and joint investment from the government and private entrepreneurs, which is already an advance on the perception that the government should provide all these services.

Finally, the services that the customers of the boats demand and that gives them the most satisfaction are the ordering and transportation of passengers. Contrary to what one might imagine, these services are the ones that bring the most financial benefits to vessels, rather than the transportation of cargo, even though it is known that these inland waterways are responsible for supplying inland cities, as well as for distribution. of your products. From the results of this study, the transportation of cargo on these vessels seems to have felt the impact of competition from vessels specializing in cargo transportation, such as ferry ferries.

## V. CONCLUSION

This article showed that the level of logistic service presented by the port of Manaus Moderna cannot be considered satisfactory, according to the view of the vessel commanders who dock there. According to them, several essential infrastructure services are missing, ranging from the physical security of customers to a safer way to access vessels. The port also lacks banking, commercial, health, information, digital and numerous other services, considered by the research participants as fundamental for the high level of service of its operations. Therefore, the study showed that the service level of Amazonian river vessels is composed of the services rendered internally by the vessels, such as the transportation of parcels, cargo and people, plus the services provided by the ports. The total service level would be the sum of these two levels, internal and external to vessels.

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These finds indicate the need for vessel owners and commanders, as well as their customers, to require investments from governments and river transport entrepreneurs in the acquisition of the basic infrastructure necessary for the proper operations of this logistics mode. Without these investments, the level of service is likely to continue to be postponed, as seems to have been done for a few decades.

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# Installation and set up the Smart water-saving irrigation techniques for coffee farm: The case study in Vietnam

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***Abstract***— *Vietnam is among the most vulnerable nations to climate change impacts according to a recent International Panel on Climate Change report. The country's diverse geography means it is hit by typhoons, landslides, flooding and droughts, weather events expected to worsen in coming years. An inadequate of reserved water was the reason which made large-scale water reservoirs loaded only 20 - 40% capacity. Meanwhile, the small-scale reservoirs were almost empty and not able to supply water for farming and inhabitants. Consequently, thousands of crops area died on fire and could not be cultivated. Among them, cafe trees exhibited the most serious effects. According to preliminary statistics, up to now, the whole Central Highlands had up to 95,000 ha of crops lacking irrigation water, of which over 7,000 ha has stopped production due to lack of water. This study works on the installation and set up the smart water-saving irrigation techniques for coffee farm in central highland in Vietnam. The success of this research to agriculture not only saves water for crops, contributes to climate change adaptation but also opens a new step in agriculture, agriculture 4.0.*

***Keywords***— *smart water-saving irrigation, coffee farm, climate change, smart agricultural.*

## I. INTRODUCTION

Central highlands were determined as a potential agriculture region in Vietnam. Over the past years, climate change has caused several complicatedly dangerous weather phenomena in the area. In the year 2005, the average rainfall of the region is 60% in comparison with the observed values of other years. Moreover, 2015 was recognized as the most drought year in central highlands. Due to the effect of El Nino, Vietnam experienced 17 large-scale heat waves with 0.5 - 1.5 $^{o}$C above the mean temperature of previous years, causing many damages for the production and living of people in the whole country. From the early year 2016, drought, water lacking, sanitization occurred widespread in the provinces of South Central, Central Highlands, and Mekong Delta with extremely high intensity in comparison with the year 2015. For instance, the prolonged drought made 123,000 and 319,000 people (the statistics were collected until mid-April) fell into a shortage of living water and foods in Central Highlands, respectively.

An inadequate of reserved water was the reason which made large-scale water reservoirs loaded only 20 - 40% capacity. Meanwhile, the small-scale reservoirs were almost empty and not able to supply water for farming and inhabitants. Consequently, thousands of crops area died on fire and could not be cultivated. Among them, cafe trees exhibited the most serious effects. According to preliminary statistics, up to now, the whole Central Highlands had up to 95,000 ha of crops lacking irrigation water, of which over 7,000 ha has stopped production due to lack of water. Large-scale severe drought affected the productivity and product quality over 100,000 hectares of coffee; Some dead coffee areas could not be recovered. This is a difficult problem that Dak Nong is facing at the present. Thus, overcoming this issue, water crisis, with urgent and effective solutions could lead Dak Nong as well as other provinces to higher productivity of crop and better living for people. The application of technology to agricultural production has been implemented in many countries around the world and brought about significant effects. So far, many studies related to crop water requirements have been carried out for higher grade Coffee arabica, [1-6] however, the study on the installation and set up the smart water-saving irrigation techniques for coffee farm do not have

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much works focus on that. In particular, water issue on coffee plant is a big problem in Vietnam because of climate change effect in Vietnam.

Herein, we have studied the installation and set up the smart water-saving irrigation techniques for coffee farm in central highland in Vietnam that not only access to economical irrigation technologies but have not gone into depth to calculate the necessary irrigation water needs of plants as well as approached automatic and intelligent agriculture. The success of this study is therefore of great significance due to the applying this research to agriculture not only saves water for crops, contributes to climate change adaptation but also opens a new step in agriculture, agriculture 4.0.

## II. METHODOLOGY

***2.1. Document review method:*** Understanding the situation of water scarcity in the study area, economical irrigation methods that have been and are being applied in the investigating area and the world, domestic and international investigation into water-saving methods on crops.

***2.2. Field method:*** Field working in the study area to assess the potential of land, water resources; learning about climate characteristics, properties of plants and farming practices of the people.

***2.3. Collecting information method:*** Collecting crop and land data, hydro-meteorological statistics in the study area.

***2.4. Data analysis method:*** Using mathematical models to calculate the amount of irrigation water needed for plants and other analytical tools for data evaluation.

***2.5. Technology application method:*** Applying information technology and wireless network to the remote control of intelligent irrigation model; installing and using solar energy as energy for data transmission for irrigation systems.

**3. Results and discussion**

The smart-economical irrigation model we have faricated that was conducted for about 96 5-year-old coffee trees which divided into 6 rows of the irrigated plot. A sprinkler irrigation system was installed at an altitude of about 0.5 m with a high injection pressure (180 l/h), a spray radius of about 3 m, ensuring to supply water for 4 opposite coffee stumps. A system of Soil Moisture Sensor was remotely controlled through the plant's wilting point, which assists not only to calculate and determine the right amount of irrigation water at the right time but also precisely and necessary for plants in the drought regions. **(Fig. 1)**

***3.1. Establish a smart-saving irrigation model***

Smart-economical irrigation model is designed with an irrigation pump system (including reservoir, pump, piping and nozzles), a control device system (central equipment, soil moisture sensor boxes), solar cell systems and soil moisture sensors.

The sensor was plugged into the ground. These sensors are responsible for measuring the current soil moisture. In case the soil moisture is lower than the need for the tree (the optimal humidity range has been set), the sensor system will transmit data to the central processor, where the irrigation command is set. The pump is then turned on (manually or automatically) and trees are irrigated until the sensor registers the desired humidity value.

Besides, a camera is installed on the model to help users monitor the operation of the pump system, irrigation valves via smartphones; and the solar cell system is responsible for providing power for the system's data transmission. **(Fig. 2 and 3)**

*Fig.1: General irrigation model with rain-spray irrigation method in conjunction with soil moisture sensor for coffee plants (horizontally)*

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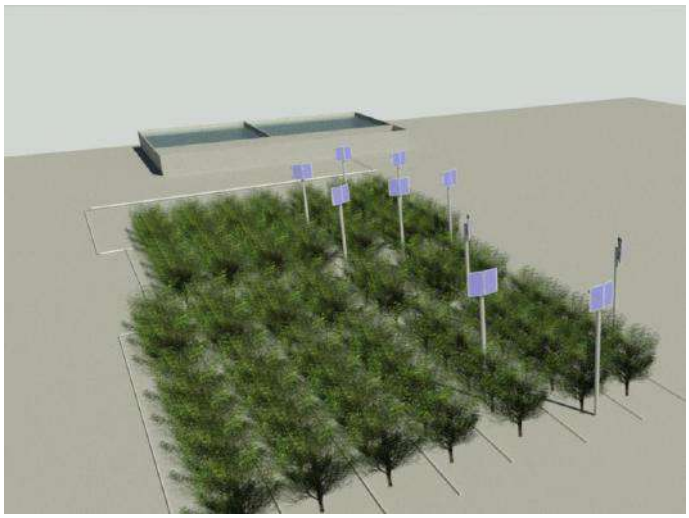

*Fig.2. General irrigation model with rain-spray irrigation method in conjunction with soil moisture sensor for coffee plants (vertically)*

*Fig.3. Smart watering system remotely controlled by humidity sensor system*

In this study, the CROP WAT 4.0 mathematical modeling method was employed to calculate the water demand for coffee plants. Based on information about soil properties, crop characteristics and climate in the study area, we calculated the irrigation water needs for coffee every month. Calculation results are shown in the following **Table 1**.

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*Table 1. The irrigation water demand for coffee plants*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 0.26 | 0.27 | 0.27 | 0.28 | 0.28 | 0.29 | 0.29 | 0.28 | 0.28 | 0.27 | 0.26 | 0.26 |
| T°C (2016) | 23.1 | 21.9 | 24.6 | 26 | 25.2 | 24.6 | 24.2 | 24.2 | 24.2 | 23.9 | 23.7 | 22.6 |
| MONTH | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| $ET_o$ (mm/day) | 4.96 | 5 | 5.35 | 5.73 | 5.63 | 5.74 | 5.69 | 5.49 | 5.49 | 5.26 | 5.04 | 4.9 |
| Growing phase: business period | | | | | | | | | | | | |
| $K_c$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $ET_c$ (mm/day) | 4.71 | 4.75 | 5.08 | 5.44 | 5.35 | 5.45 | 5.41 | 5.22 | 5.22 | 5 | 4.79 | 4.66 |
| $ET_c$ (mm/month) | 141 | 143 | 152 | 163 | 161 | 164 | 162 | 157 | 157 | 150 | 144 | 140 |
| P (mm/month) | 61 | 0.3 | 26 | 87 | 284 | 412 | 281 | 224 | 239 | 278 | 79 | 33 |
| Pe (mm/month) | 27 | -10 | 6 | 45 | 203 | 306 | 201 | 155 | 167 | 199 | 39 | 10 |
| I (mm/month) | 115 | 152 | 147 | 118 | -43 | -142 | -38 | 1.2 | -10 | -49 | 104 | 130 |
| I (mm/day) | 3.8 | 5.1 | 4.9 | 3.9 | -1.4 | -4.7 | -1.3 | 0.0 | -0.3 | -1.6 | 3.5 | 4.3 |
| N | 1.2 | 1.1 | 1.1 | 1.3 | 1.5 | 1.7 | 1.5 | 1.4 | 1.5 | 1.5 | 1.3 | 1.2 |
| I l/stump/month | 1042 | 1385 | 1335 | 1073 | -387 | -1293 | -348 | 11 | -93 | -441 | 948 | 1182 |
| I (l/stump/time) | 43 | 49 | 51 | 45 | -19 | -71 | -17 | 1 | -5 | -22 | 40 | 46 |

Where:

$ET_0$: Reference evaporation level

$ET_c$: Evaporation level of coffee trees

P: Actual rainfall

$P_e$: Effective rainfall

I: Irrigation water demand

***3.2. Design of smart and saving irrigation system with soil moisture sensor operates by solar energy and using wireless sensors to remote controller***

❖ **Installation of pumping and irrigation systems**

The irrigation pump system includes pumps, water lines, nozzles, flow valves, and water reservoirs. The model needs to calculate the water pipeline to optimize the efficiency of the irrigation system. [5-7]The design of pumping and irrigation systems are shown in Fig. 4 and 5.

❖ **Installation of central equipments**

Central devices are important for smart-economical irrigation. Central equipments are responsible for processing information, ordering irrigation and turning irrigation systems on and off. **(Fig. 6)**

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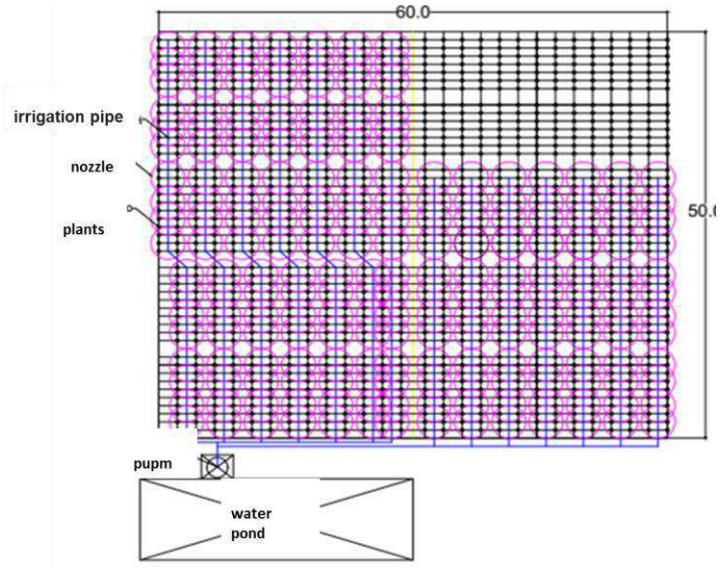


*Fig.4. Nozzles for watering coffee plants*

*Fig.5. Pumping system for coffee plants*

*Fig.6. The center control box*

❖ **Installing soil moisture sensors**

The moisture sensor is placed at a depth of about 80% of the roots. For coffee, roots are distributed mainly at a depth of 20 - 30 cm above the ground. However, the root system absorbs water most effectively at a depth of about 0 - 20 cm. [8-9]Therefore, the sensors are studied and installed at this depth. The sensor probe has a design length of about 15 cm, so during the installation, we must dig for more 5 cm deeper from the ground for the good position of the sensor, to ensure the entire probe is placed within the appropriate range (0-20 cm). **(Fig. 7 and 8)**


*Fig.7. Installing a soil moisture sensor*

❖ **Installation of solar cell systems**

The position of installing the solar power system is also used to determine the tilt angle of the solar cell so that when the system is fixed, it can receive the maximum total radiation intensity. In addition, tilting the solar panels has another meaning of self-cleaning. When it rains, due to the inclined surface of the battery, rainwater will clean the dirt on the cell, increasing the ability to absorb radiation of the battery.

❖ **Installation of the camera**

The camera has a role to help users monitor the smart-economical irrigation system. Therefore, the camera should be installed in a position that covers a large area of the study zone. Depending on the topographic, we can choose to arrange a dedicated camera support or make use of the tall tree trunks available to mount the camera in the area to be monitored.

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*Fig.8. Installing soil moisture sensor system*

*Fig.9. Installing a Pole Mounted Solar Panel*

### *3.3. Performance evaluation of smart-economical irrigation systems*

10 sensors were assessed on a sample of a coffee tree (1-year-old) with a height of 0.7 m, a root length of 0.35 m, a root depth of 0.5 m. The model was carried out on a 1000 $m^2$ land area with 10 sensors installed at different locations. Soil moisture measurements were conducted at different times on February 4, 2019 (ensuring a change in soil moisture) and characterized soil moisture with a handheld device to verify the accuracy of the sensor system. After conducting experiments on mounting sensors on a testing area of 1000 $m^2$, the sensor has operated stably. The sensor informs the controller when it is time to increase the humidity of the plant. The trial system for coffee trees initially gave positive results. Accurate and high repeatability of screen results, continuous monitoring of soil moisture values, bring into play the advantages of the system due to the system's automatic shut-off mechanism when the required threshold for each type of tree is reached.


*Fig.11. Spectrum Technologies standard sensor. Inc. of America*

We can save significant amounts of water and still provide the optimal amount of water for plants. The effect is higher than the current popular irrigation methods (traditional irrigation). After evaluating the accuracy and stability of the

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sensor system, we found that the sensors maintain a stable error of 2.5% compared to standard sensor Spectrum Technologies. Inc. of America. Therefore, it is possible to evaluate the smart irrigation system - economical with accuracy and high stability.

## III. CONCLUSIONS

The installation and set up the smart water-saving irrigation techniques for coffee farm in central highland in Vietnam have been studied in this work. The smart-economical irrigation model we have faricated that was conducted for 5-year-old coffee trees as well as the evaluation method the installed system. It can be seen that the process is simple and facile to install and set up. The success of the smart-economical irrigation model brings many economic benefits, with high applicability that was positive results; contribute to soil and water conservation, increase opportunities for sharing water and land resources in the community.

## ACKNOWLEDGMENTS

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# Evaluation of climate conditions in Remanso/BA and their relations with agricultural production in the Semiarid

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***Abstract*****—** *This paper aims to present the climatic conditions of the municipality of Remanso in the State of Bahia, taking into account the intrinsic relationship between climate change and agricultural production of tomato (Solanum lycopersicum) in the semiarid region, through data analysis of Standard Precipitation Index - SPI of about 30 years. The results showed that the tomato production system presents good prospects of obtaining positive profitability, considering the climatological indices. However, technical and managerial assistance and agricultural research actions, especially in the areas of fertilization, plant tutoring and irrigation, are necessary to promote improvement in productive efficiency.*
***Keywords*****— Climatology, Agriculture, Oscillations, Semiarid.**

## I. INTRODUCTION

Nowadays, the advance of science and technology is unquestionable, especially those dedicated to the study of food production in the world and its relations with present and future climatic conditions. However, despite all developments, climate is still the most important variable in agricultural production, affecting and determining the adequacy of food supplies through climate hazards and climate control over the type of viable agriculture in a given area.

In this sense, it can be said that climate parameters influence all stages of the agricultural production chain, including soil preparation, sowing, crop growth, harvesting, storage, transportation and marketing (AYOADE, 2004).

Tomato (Solanum lycopersicum) crops play an important role in the national economy, with a cultivated area of 54,931 hectares and a total production of 3,154,982 tons. It is one of the most prominent vegetables for the consumption of fruits (AGRIANUAL, 2007).

Based on these assumptions, this article aims to present the climatic conditions of the municipality of Remanso in the State of Bahia, taking into account the relationship between climate change and agricultural production of tomato (Solanum lycopersicum) in the semiarid region.

The methodological basis that underpins the research is based on the Standard Precipitation Index (SPI) with data of about 30 years, emphasizing tomato cultivation, available at the Center for Weather Forecasting and Climate Studies (CPTEC). and, National Institute for Space Research (INPE).

The results showed that the tomato production system presents good prospects of obtaining positive profitability, considering the climatological indices. However, technical and managerial assistance and agricultural research actions, especially in the areas of fertilization, plant tutoring and irrigation, are necessary to promote improvement in productive efficiency.

## II. THEORETICAL REFERENCE

### 2.1 The Influence of Climate on Agriculture

Each and every agricultural system is a man-made ecosystem that depends on the climate to function, similar to naturals systems. The climatic elements that affect agricultural production are the same as those that

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influence natural vegetation, including solar radiation, temperature and humidity. These climatic parameters and others that depend on them largely determine the distribution of crops and agricultural production within a climate zone, and it can be said that all crops have their climatic limits for economic production (AYOADE, 2004).

This same author argues that the ways in which the main climatic elements influence crop growth and yields occur in two ways: 1. Climate variables are interrelated in their influence on agricultural crops, and daily, seasonal or annual variations in climate element values are relevant in determining the efficiency of crop growth. 2. When considering the climatic environment in which crops grow, the microclimate around them is vitally important, as the prevailing climatic conditions within soils where seeds germinate and in the vicinity of the land where crops are grown grow, can be quite different from those that predominate in the air just above them (AYOADE, 2004, p. 262).

Thus, the influence of climate on agriculture tends to be perceived in different types of crops and by various climatic elements, such as solar radiation, temperature, humidity, wind. In addition to these can be added the climate hazards (frost, drought, hail and wind) which have a crucial influence on agricultural crops. But how do punctuated climate elements influence agriculture?

With regard to solar radiation, this is of vital importance because it is this energy that drives the agricultural system, determining the thermal characteristics of the environment, essentially air and soil temperatures during the day or photo period. In addition, the intensity of solar radiation is also an important factor since optimal light values for normal crop growth and development are generally around 8-20 kiloluxes (AYOADE, 2004).

In Ayoade conception (2004), the luminosity values (Table 1) for optimal flowering and fruiting, determined for some crops, are:

*Table 1: Lightness Values*

| **Crops** | **Brightness values** |
|---|---|
| **Pea** | 850 – 1.100 luxuries |
| **Corn** | 1.400 – 1.800 luxuries |
| **Barley and Wheat** | 1.800 – 2.000 luxuries |
| **Beans and Cucumbers** | 2.400 luxuries |
| **Tomatoes** | 4.000 luxuries |

Source: Ayoade (2004)

If there is not enough radiation the root system of the plants does not fully develop, and the foliage turns yellowish, tending to stem growing at the expense of the foliage. In addition, the crops themselves can be classified as “short day crops” and “long day crops” depending on the period in which they reach their optimum growth or maturation time.

Ayoade (2004) says that the crops that reach their optimal growth during the short days (about 10 hours of radiation) are as follows: beans, corn, cotton, cucumber, tomato and millet. These can be called “short day crops”. Already those that reach growth during the long days (about 14 hours of radiation) are mustard, clovers, oats, wheat and rye, and should be called “long day crops”.

The climate element temperature is of crucial relevance to agriculture, since air or soil temperature affects the plant's growth processes and all crops have minimum, optimal and maximum thermal limits for each of their stages of growth.

Both low and high temperatures can create serious risks to vegetables. When temperatures are below freezing point the living matter of cells can freeze and cell dehydration can occur, which can kill plants. At the same time, excess heat can destroy the plant protoplasm, where the drying effect on plants can lead to rapid rates of sweating and wilting (AYOADE, 2004).

Humidity is another very important climatic element for agriculture. Water plays an important role in plant growth and in the production of all crops, being the main constituent of plant physiological tissue and a reagent in photosynthesis. Thus, it can be stated that soil moisture is the significant source of water for the crop and the soil moisture state by the controlled by precipitation, evaporation rate and soil characteristics. In Ayoade view (2004, p. 267), “neither extremely high or low temperatures nor insufficient or excess water constitute favorable conditions for good agricultural performance”.

The role of humidity in agriculture is relevant in the tropics, mainly due to the action of high temperatures throughout the year, and also because evapotranspiration values are constantly high, however, precipitation is seasonal in large areas of the tropics (AYOADE, 2004).

The last climatic parameter is the wind that affects agriculture, being an efficient agent of plant dispersal. On the other hand, the wind can cause physical damage to the crops, favoring the high perspiration and consequent drying of the plant. In addition, erosion that the wind is capable of causing can ruin good quality agricultural land by removing the topsoil and damaging agricultural crops. In this way, extreme weather conditions are responsible for serious consequences for agriculture, as is the case with climate hazards from now on.

According to Ayoade (2004), crop development does not depend solely on weather conditions, but is also

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subject to a large number of climate hazards. Among these we can highlight the following:

Frosts - These occur when the air temperature in contact with the ground is below 0°C. Surface frost is particularly important in agriculture. Such bad luck is generally not common in the tropics, except in mountainous areas, but common in temperate areas; Drought - which poses a serious risk to agriculture in both temperate and tropical regions and is typified into four types: permanent, seasonal, contingent and invisible. In arid regions [as is the case of this study] permanent drought is the most common, where rainfall is not sufficient to meet the water needs of plants; Hail - These are small ice crystals [not a solid precipitation] that cause damage to crops in the field, occurring in temperate and tropical regions; Winds - which carry moisture and heat in the atmosphere and have some effect on agricultural production, influencing evapotranspiration rates and exerting direct pressure on crops (AYOADE, 2004, p. 270-275).

Based on these assumptions, it can be said that climate is a decisive factor in the development or not of agricultural crops, and the climate elements associated with climate hazards may contribute negatively to the advancement of agricultural production in the regions.

### 2.2 Agricultural Production in the Semiarid and the relationship with Climate Change

The study of the impact of climate change on the functional biodiversity of plants established in different ecosystems has been the target of many researchers at the international level. Recent changes in the patterns of climate variables, especially precipitation and evapotranspiration, have been associated with global warming, resulting from the increase in carbon dioxide in the atmosphere. In addition, CO2 in the atmosphere can directly influence the physiological, productive, water aspects and water use efficiency of agricultural production systems. However, these responses are not well defined, as they vary depending on the joint effect between: CO2 level and environmental factors, such as type of photosynthetic plant process, changes in plant architecture and mechanisms under new cultivation conditions (AINSWORTH; ROGERS, 2007).

Unsurprisingly, climate change influences plant biodiversity, especially with regard to the range of characters involved in the vital functions of these organisms, such as photosynthesis. Regardless of the degree of climate change, it promotes a response in the vital mechanisms of plants, especially those associated with the conditions appropriate to maintaining the establishment of individuals in any ecosystem. In contrast, the functional diversity of the plant species that make up the different vegetation types and, in most cases, is the result of the influence of the climatic factors of the environment where they are established, creating a very differentiated and specific stimulus-response system in certain biomes, as is the case of caatinga ecosystem in Bahia semiarid region (PIMENTAL, 2013).

In the conception of Silva, Souza and Azevedo (2013), the next 100 years indicate the possibility of significant climate impacts on various human activities and ecosystems, as well as natural disasters such as storms and droughts, which will be inevitable. The predicted increase in temperatures pointed by the IPCC (Intergovernmental Panel on Climate Change) will lead to changes in the behavior of world agricultural production, which may lead to the disappearance of some crops and modification of the world agricultural map.

Studies by Pereira et, al., (2002) conclude that from economic activities, agriculture is undoubtedly the one with the greatest dependence on weather and climate conditions. And atmospheric conditions affect the stages of agricultural activities, from soil preparation for sowing to harvesting, transportation, preparation and storage of produce.

Researchers such as Assad et, al., (2003) through the use of geoprocessing tools elaborated various climate scenarios for various crops and found that global warming will have a drastic impact on Brazilian agricultural production, and consequently will cause profound changes in Brazilian agricultural zoning.

Thus, global warming could endanger food security in Brazil in the coming years. This is the forecast of a study by researchers from Embrapa and Unicamp. In this study, it was found that rising temperatures may cause losses in grain crops in the amount of R $ 7.4 billion already in 2020, a break that could jump to R $ 14 billion in 2070, profoundly altering the geography of agricultural production in Brazil (SILVA; SOUZA; AZEVEDO, 2013).

### 2.3 Tomato Cultivation x Climate Conditions

Tomato is one of the largest market vegetables in terms of value and consumption in Brazil. However, the tomato is of Andean origin, preferring a dry climate, with high brightness and mild temperatures, and is therefore not a plant adapted to the Brazilian environment, either because of the climate, the incidence of diseases and pests (MELO, 2017).

By its origins, the tomato grows well in tropical conditions of altitude and the subtropical, fresh and dry, with plenty of light. However, the plant tolerates variations in weather factors well. With regard to

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temperature, the range of 20 to 25°C favors germination, while the range of 18 to 25°C helps the vegetative development, high nocturnal temperatures also contribute to the tomato growing faster. But beyond 32 ° C the flowers fall, fruit development is inhibited and hollow tomatoes are formed (EMBRAPA/SPI, 1993).

Flowering and fruiting benefit from daytime temperatures of 18 to 25°C and nighttime temperatures of 13 to 24°C. The permanence of temperatures above 28ºC impairs the firmness and color of the fruits, which tend to turn yellow due to inhibition synthesis of lycopene and other pigments that give them the typical red color (EMBRAPA/SPI, 1993).

Also according to Embrapa/SPI (1993, p. 10) "temperatures above 34°C cause respiratory disturbances and, when above 37°C, the fruits soften in the ripening phase". On the other hand, "temperatures near 0°C cause the leaflets to burn. With intense frost the fruits are burned and the plant can die". In addition, rainfall and high relative humidity, associated with temperature variations, favor the incidence of diseases and pests and make their control difficult, and hot and strong winds impair flowering and fruiting.

According to Geisenberg and Stewart (1986), tomatoes have critical climatic limits to their development (Table 2) and can be planted in summer or winter (Table 3).

*Table 2: Temperature limits for tomato development stages*

| | Temperature in (° C) | | |
|---|---|---|---|
| **Critical moments of development** | **Minimum** | **Optimal** | **Maximum** |
| **Germination** | 11 | 16 to 29 | 34 |
| **Vegetative growth** | 18 | 21 to 24 | 32 |
| **Fruit Pickings (night)** | 10 | 14 to 17 | 20 |
| **Fruit Picking (day)** | 18 | 19 to 24 | 30 |
| **Fruit ripening** | 10 | 20 to 24 | 30 |

Source: Geisenberg and Stewart (1986)

*Table 3: Critical Moments of Tomato Development in Summer and Winter*

| | Month of occurrence | |
|---|---|---|
| **Critical moments of development** | **Summer harvest** | **Winter harvest** |
| **Germination** | August | February |
| **Vegetative growth** | August to november | February to June |
| **Fruit Pickings (night)** | October to January | April to July |
| **Fruit Picking (day)** | October to January | April to July |
| **Fruit ripening** | November a janeiro | May to July |

Source: Geisenberg and Stewart (1986)

Thus the temperature ranges for acceptability of tomato cultivation are wide, however the ranges for developing an optimal tomato are narrow and not easy to find in all regions and all seasons. According to Embrapa/SPI (1993, p. 11) the best tomato planting season is the one that offers the following conditions for the whole plant cycle: "average temperatures ranging from 18°C to 25°C, low relative humidity of the air and low rainfall for a period of 5 to 6 consecutive months".

Moreover, some factors must also be taken into consideration when determining the best planting time, such as location of the region, topography and altitude, as these conditions influence the variation of temperatures and rainfall distribution. In adverse conditions, to reduce the risks, there is the option of installing the crop under plastic cover or in a greenhouse (EMBRAPA/SPI, 1993).

In addition to these factors, FAO also points out the water requirement, since tomatoes require 400 to 600 mm per cycle, considering cycles of only 90 to 120 days. However, in Brazil, to improve productivity, most tomato productions are irrigated (FAO, 2017).

## III. MATERIAL AND METHODS

### 3.1 Characterization

The municipality of Remanso, is located in the state of Bahia. It has an area of 4,684 km², and according to the 2010 census, Remanso has 38,957 inhabitants, today estimated at 41,008 people, with a population density of 8.3 inhab./km2, and a per capita GDP of R $ 7,496.64 (IBGE, 2019).

According to the IBGE (2019), temporary tomato cultivation produces a quantity of 25 tons, with a production value of R $ 27,000 per planted and harvested area of 1 hectare, with an average yield of 25,000 kg/ha.

### 3.2 Location

The municipality of Remanso is located at 405 meters altitude, having the following geographical coordinates: geographic coordinates: 9°36'16" south latitude and 42°6'6" west longitude, as shown in the map (figure 1).

It has a climate classified as warm semi-arid, with spring-summer rainfall regime, characterized by the scarcity and irregularity of rainfall, as well as the strong evaporation due to high temperatures. The average annual temperature is 26.3°C, with hot and humid summers and warm and dry winters. The month with the highest

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average temperature of 28.2°C is November, as well as the highest average maximum temperature of 34°C, while July is the coldest with a maximum temperature around 24.1°C and a minimum of 19 0.5°C. The average sunshine time is 2,860 hours per year, with air humidity around 45%.

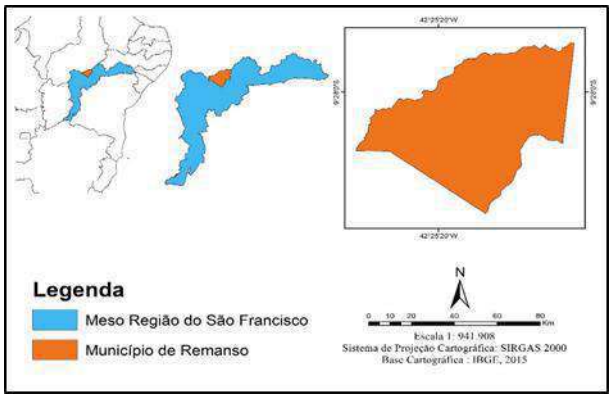


*Fig.1: Location map of Remanso Municipality/BA*
Source: PACHECO (2019)

### 3.3 Methodology

The methodology used in this study was based on the Standard Precipitation Index (SPI), often used to monitor conditions associated with drought and excessive rainfall. The RLS was developed by McKee et al. (1993), and is based only on the monthly precipitation product, in this case, produced by CPTEC/INPE, from data from various data sources in Brazil. The main feature of SPI is the ability to use monitoring of both wet and dry conditions at various time scales.

For drought monitoring from the SPI, only the negative index values are considered. Typical SPI values for characterizing a drought event are shown in the table below, based on the drought monitoring methodology used in the United States National Integrated Drought Information System, with five categories (Figure 2) that identify drought intensity.

| Category | Intensity | SPI Thresholds |
|---|---|---|
| D0 | Weak | -0,5 a -0,7 |
| D1 | Moderate | -0,8 a -1,2 |
| D2 | Severe | -1,3 a -1,5 |
| D3 | Extreme | -1,6 a -1,9 |
| D4 | Exceptional | -2,0 or less |

*Fig.2: Intensity categories of a drought event from the SPI*

Source: SPI (2019)

Thus, the Standard Precipitation Index - SPI data of about 30 years will be considered for analysis, since any research using climatological data should consider a minimum analysis time of three decades.

## IV. RESULTS AND DISCUSSIONS

To ensure a high-quality product, diagrams and lettering MUST be either computer-drafted or drawn using India ink.

Tomatoes, sourced from South America, are grown almost worldwide, and their global production has doubled in the last 20 years. One of the main factors for the expansion of culture is the growth of consumption. Between 1983/85 and 2003/05, world per capita tomato production grew by 36%, from 14 kg per person per year to 19 kg, according to data from the United Nations Food and Agriculture Organization (FAO/UN). Of the more than 120 million tons of tomatoes produced in the world, only 4.5 million are exported in nature.

According to FAO, the country's position has been achieved due to increased productivity. Currently, Brazil occupies the 3rd place in this ranking, behind only the United States and Spain. The spread of irrigation techniques, the intensive use of inputs and the introduction of more productive hybrids with lower postharvest losses were some of the main factors that contributed to the increase in the productivity of the national tomato. The average yield of tomatoes in Brazil is approximately 58 t/ha. However, more techni-cal producers reach over 100 t/ha (CARVALHO; PAGLIUCA 2007).

Based on these assumptions, the data obtained through the SPI will be analyzed based on Table 1, showing periods of incipient, moderate, severe and extreme rainfall (Figure 1).

Generally, any of the rainfall patterns can significantly damage tomato or any other cultivar, since each crop has its limits to withstand incipient or extreme rainfall.

*Table 1 - Patronized Precipitation Index (SPI) Values and Drought or Moisture Categories*

| SPI | CATEGORIA |
|---|---|
| **0 – 2,00** | Extremely humid |
| **1, 5 to 1,99** | Severely humid |
| **1,00 to 1,49** | Moderately humid |
| **0,1 to 0,99** | Incipient Moisture |
| **0 to -0,99** | Incipient Drought |
| **-1,00 to -1,49** | Moderately Dry |
| **-1,50 to -1,99** | Severely Dry |
| **0 to -2,00** | Extremely Dry |

Source: *MacKee at al*. (1993, 1995)

An example of this is what the Embrapa/SPI (1993) document says, which points out that recently the tomato crop has been growing significantly in greenhouses or under plastic cover, in order to protect the plants from the cold and the rain. This technology has allowed farmers from Rio Grande do Sul, Santa Catarina and Paraná to

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harvest tomatoes in the winter and those from São Paulo, Minas Gerais and Rio de Janeiro during the rainy season.

In this sense, the graphs below show the rainfall frequency indices in the surveyed region.

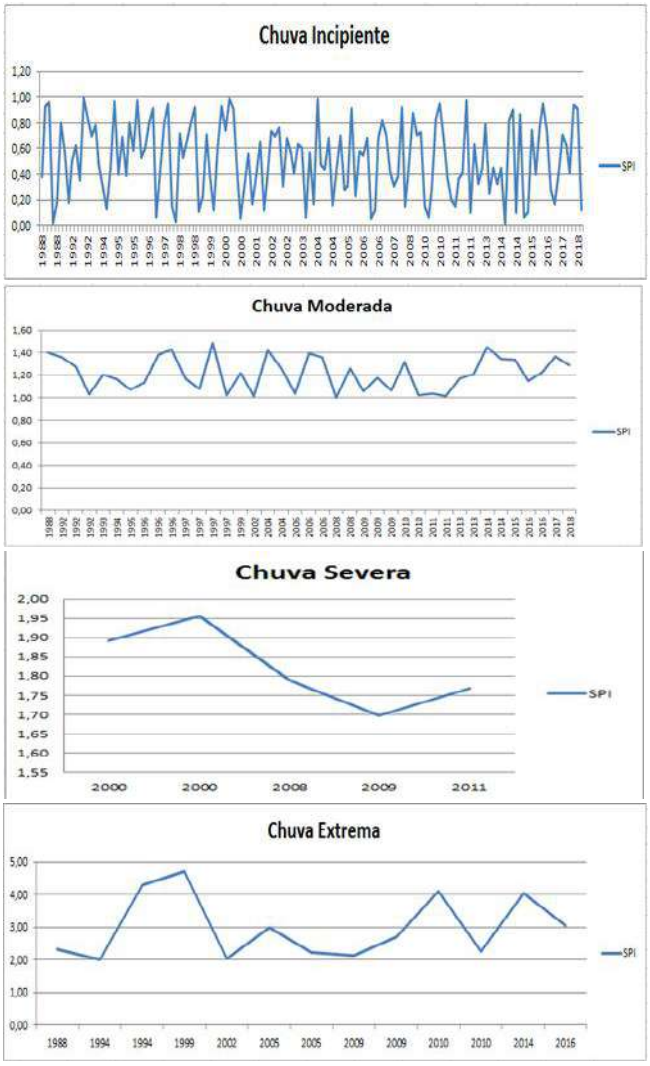


*Fig.1: Rain Frequency*

Source: SPI (2019)

The graphs above show the rainfall frequency distribution from 1988 to 2016, where it is possible to see extremely humid periods, even severely dry periods. In the incipient rainfall graph there is an annual variation between 0.0 and 1.0 (moderately humid), and in the moderate rainfall graph the variations range from 1.0 to 1.40 (severely humid). The severe rainfall graph for the period 2000-2011 has a frequency ranging from 1.70 to 1.96, thus representing periods ranging from severely humid to extremely humid. Finally, the extreme rainfall graph ranges from 2.0 to 4.8, indicating periods with very high humidity levels.

Taking into account the frequency distribution of rainfall found in Remanso and the favorable conditions for tomato production (10 hours of solar radiation, 20ºC to 25ºC for the germination period, 18ºC to 25ºC for plant development, etc.), it is It can be affirmed that it is only possible to grow it during the period with incipient and moderate rainfall, since it could not withstand severe or extreme rainfall and with high humidity, because it would run several risks, because the tomato is of Andean origin, having preference for dry climate, high brightness and mild temperatures.

For drought periods, the data show incipient drought, moderate drought and severe drought (Figure 2). No extreme drought was detected during the analyzed period.

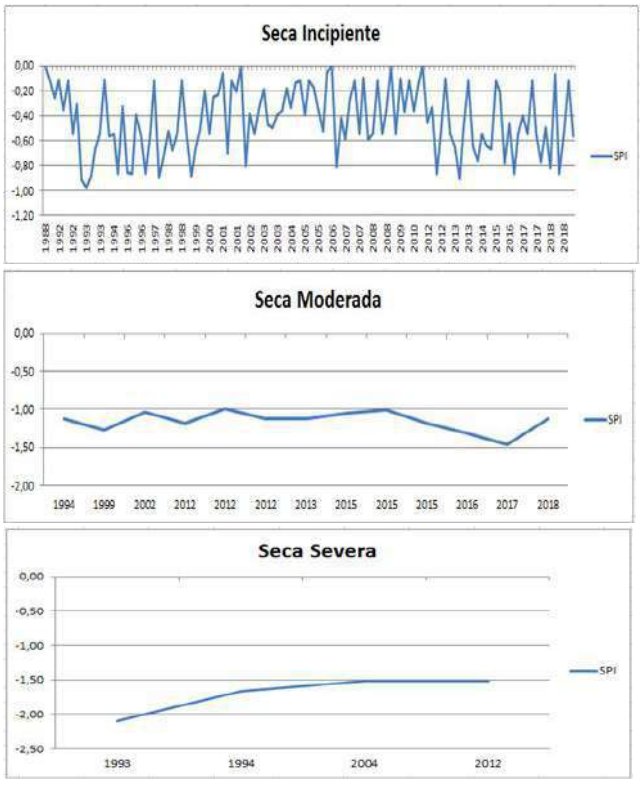


*Fig.2: Drought Frequency*

Source: SPI (2019)

Regarding the frequency of droughts in the surveyed period is noticeable in the first graph the annual variation between 0.0 and -1.0 (moderately dry), with incipient drought in the surveyed region. In the second graph there is a frequency between -1.0 to -1.50 (severely dry) with a so-called moderate drought. And the third graph shows a range between -1.50 to -2.20 (exceptionally dry), called severe drought.

This distribution of drought frequency in the Remanso region suggests that during these periods there was a higher rate of solar radiation, high day and night temperatures, low rainfall and low humidity, indicating a good period for tomato cultivation, although with Some observations: High solar radiation, high day and night temperatures, low rainfall and low humidity are favorable for tomato production, however, it should be noted that

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temperatures above 34ºC will cause respiratory disturbances greater than 37°C causes fruit softening in the ripening period.

The following graphs will be shown per quarter (2 months due to tomato flowering). Figure 3 below shows the monthly data, which will facilitate the correlation of production by period.

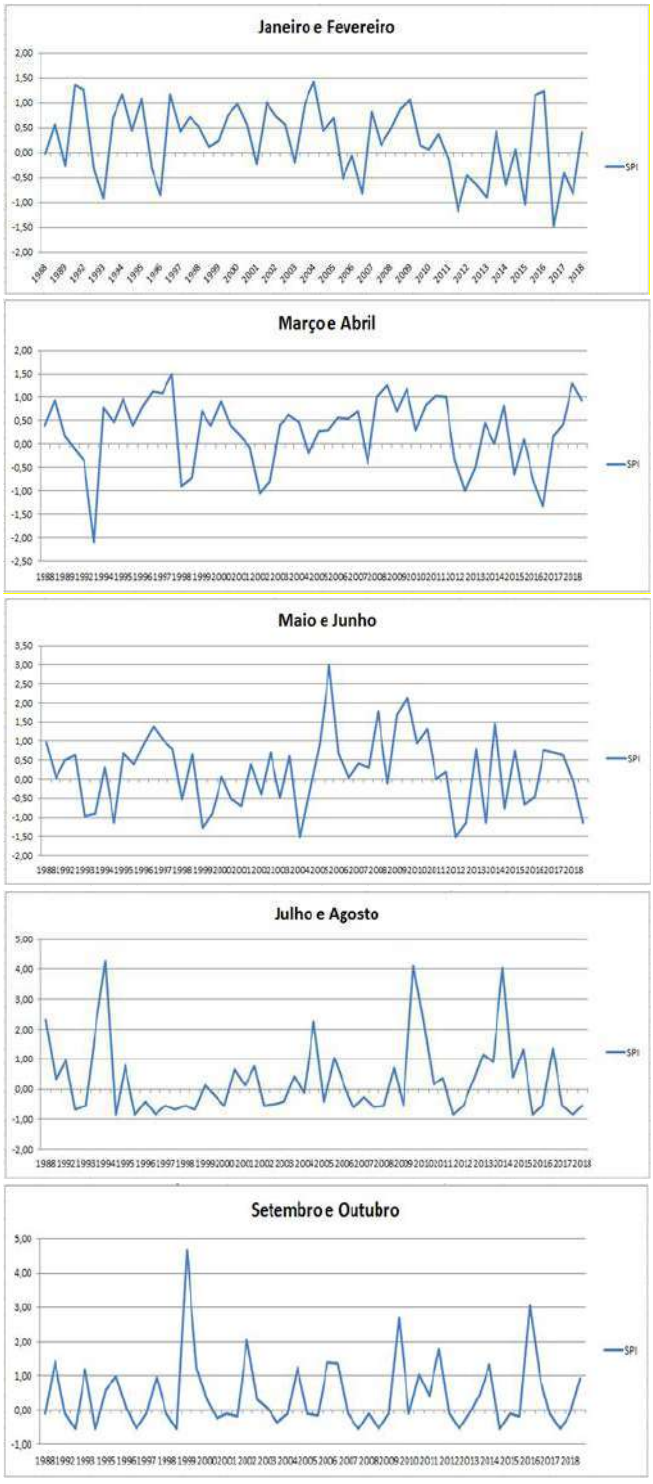



*Fig.3: Annual frequency of rainfall per two months*
Source: SPI (2019)

In this sense, the data indicate, by period, the following frequency of rain/ drought:

a. January and February - Rates range from -2.2 (exceptionally dry) to 1.5 (severely humid).
b. March and April - Rates range from -1.5 (severely dry) to 1.5 (severely wet).
c. May and June - Rates range from -1.5 (severely dry) to 3.0 (extremely humid).
d. July and August - Rates range from -1.0 (moderately dry) to 4.2 (extremely humid).
e. September and October - Rates range from -0.8 (moderate drought) to 4.8 (extremely humid).
f. November and December - Rates range from -1.7 (extreme drought) to 2.0 (severely humid).

Observing the frequencies described above, it can be stated that in January, May and November there are indices considered severely dry or extreme drought. February and April have severely humid indices, and June, August, October and December indices considered extremely humid. However, the months of July and September are classified as moderately dry or moderately dry, and March is exceptionally dry or extremely dry.

From these findings, it is possible to state that the best months for tomato cultivation in the surveyed area are the months that are severely dry, moderately dry or exceptionally dry, given that the tomato can withstand high insolation rates, low rainfall, and low humidity.

However, the month of November is severely dry, where temperatures vary from 28ºC (good for tomatoes) to 34ºC (bad for tomatoes, which from 32ºC causes the flowers to fall and the fruits become hollow). Already in July there is a moderately dry frequency, where temperatures vary in Backwater from 24ºC (great for tomato cultivation/ germination and flowering) to 19.5ºC (also good for tomato), with air humidity in around 45% (which can also be considered essential for the tomato, as there is no possibility of rain here) (EMBRAPA/SPI, 1993). However, as stated by Ayoade (2004), crops are subject to climate hazards, the influence of the region's

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location, topography and altitude (since Remanso has more than 400 meters of altitude), as these conditions influence the variation of temperatures and the distribution of vegetation rainfall and do not depend solely on weather conditions.

## IV. CONCLUSION

Discussing the assessment of climatic conditions and the relationship with agricultural production in the Semiarid is not an easy task. For this reason, a cut was made between 1988 and 2016 and delimited a single municipality of the Semiarid to discuss such themes.

The present work aimed to present the climatic conditions of the municipality of Remanso in the State of Bahia, taking into account the intrinsic relationship between climate change and agricultural production of tomato (Solanum lycopersicum) in the semiarid region, through data analysis of the Standard Precipitation Index – SPI of about 30 years.

The main results indicate that the region is favorable to tomato cultivation, however in certain periods, respecting the limitations of altitude, temperatures, humidity, insolation and climatic hazards and/or climatic oscillations. In addition, the data show severely humid periods (considered inappropriate for tomato cultivation) and extremely dry periods (also harmful to cultivation). However, moderately dry and severely dry periods are possible to practice such cultivation, always observing the diurnal and nocturnal temperature indices, the humidity indices and the tolerable precipitation averages.

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# Orthodontic Relapse - Orthodontic Treatment with Invisalign: Case Report

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***Abstract—*** *Contemporary dentistry has been developing new, increasingly improved treatment modalities, materials and techniques that aim to modify disharmony dental elements, providing the patient with the required aesthetic aspect without compromising function. Thus, the Invisalign™ system has been the device of choice for various types of malocclusion and in certain situations have superior results compared to conventional orthodontics, since the movements are minimally planned. The present study aimed to evaluate the results of the Invisalign™ system treatment in a patient with relapse after conventional orthodontic treatment. A 34-year-old female patient had a slightly open bite, crowding of the antero-inferior segment, slightly rotated to mesiobuccal, anterosuperior diastema and buccal incisors, and the main complaint of recurrence after two conventional orthodontic treatments. It was observed that tooth movement occurred entirely in the upper and lower arch. The open bite was corrected, the crowds were dissolved through wear and improvement of the arch shape and the anterior superior diastema was completely closed. It is concluded that the present case report presented satisfactory and effective results in relapse treatment after orthodontic treatment with Invisalign™ system.*

***Keywords—*** ***Relapse, Clear Treatment, Clear Aligners, Invisible orthodontics.***

## I. INTRODUCTION

Technological evolution has made patients increasingly demanding for aesthetic solutions in order to reestablish the loss or morphophysiological corrections of dental elements. It is in this context that in recent years there has been a growing increase in orthodontic treatment that provides a natural and harmonious result, avoiding the visual discomfort caused by traditional treatment (CHRISTOU et al., 2019).

In this evolution, polycarbonate and ceramic lingual brackets and removable aligners emerged, which pleased patients, especially adults, because of the greater facial aesthetic requirement and who hardly adhere to conventional treatment (HIRANI; PATEL; PATEL, 2016).

In the late 1990s, the Invisalign™ system (Align Technology, Inc., Santa Clara, California) became an alternative treatment for practitioners in the face of the aesthetic demands of patients and the comfort of removable polyurethane, cordless or transparent aligners. other metal accessories (DJEU; SHELTON; MAGANZINI, 2005).

With the advent of three-dimensional digital imaging techniques, Align has added to the Invisalign™ system computer-aided design / computer-aided manufacturing (CAD/ CAM) technology, enabling the precision manufacturing of transparent removable devices for serial exchange and thus allow a sequence of tooth movements necessary to obtain the correction (KRAVITZ et al., 2009).

Invisalign™ aligner treatment offers a 3D computer simulation made from an addition silicone molding. It is made a virtual model, ClinCheck, which allows the professional and patient to view on the computer and track the movements from beginning to end of dental treatment. This results in a sequence of aesthetic aligners, which are custom, clear, removable blanking-like plaques that perfectly fit the anatomy of the dental arches, completely enveloping all teeth. Exchanges are periodic, inducing orthodontic movement (WEIR, 2017).

InvisalignTM treatment has been an increasingly present alternative in the orthodontist's clinical daily life due to the numerous advantages it provides, such as: low visibility treatment with clear aligners, as it can be confused with natural teeth, low possibility of injury to the teeth. oral cavity, such as gingivitis, caries or periodontal disease, full access to teeth for hygiene, no change in speech, reduced chair time, faster and more spaced consultations as aligners are received at once (BRÄSCHER et al., 2016).

InvisalignTM is indicated for patients with mild to moderate crowding and / or diastema (1-6 mm), dental

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(non-skeletal) arch atresia, relapse of orthodontic treatment, moderate malocclusion, deep bite problems and especially malocclusion II (TURPIN, 2005).

Orthodontic recurrence can be defined as the tendency of teeth to return to their pretreatment position, and this occurs mainly in the lower canines and lower incisors. Thus, even after removal of the appliance, treatment continues with the use of restraint, which can be mobile, usually to the upper or fixed teeth, glued behind the lower teeth (YU et al., 2013).

However, previous reports in the scientific literature have shown, after 10 years of orthodontic treatment completion, only 30% to 50% of orthodontic patients effectively maintain the satisfactory alignment initially obtained, reducing to 10% at 20 years. Faced with orthodontic recurrence, it is necessary to reevaluate the patient's periodontal, physiological and psychological conditions in order to establish strategies to effectively manage the problem (YU et al., 2013).

Thus, the present study aimed to evaluate the results of the Invisalign™ system treatment in a patient with relapse after conventional orthodontic treatment.

## II. CASE REPORT

A 34-year-old female patient sought treatment at a private clinic. Initially, clinical evaluation and panoramic radiography, lateral radiograph, posteroanterior teleradiography, 3D computed tomography and extraoral and intraoral photographs were performed.

It presented a slightly open bite, crowding of the antero-inferior segment, slightly rotated to mesiobuccal, diastema in the anterosuperior region and buccalization of the upper incisors (Figure 1). The main complaint was relapse after two conventional orthodontic treatments.

The patient was offered treatment with Invisalign™ removable aligners, as the patient did not want to use a conventional appliance.

*Fig.1. Initial images: a) Smile before treatment; b) front view; c) Right lateral view; d) Right side view.*

The clinical chart listed the teeth to be moved, those that would receive the attachments, resin increments to aid tooth movement and sent for planning preparation.

**Treatment Summary Invisalign™ - Comprehensive Treatment**

Active aligners stage U: 1-7, L: 1-10
Passive aligners stage U: 8-10
Overcorrect aligners stage U: 11-13, L: 11-13
Attachment templates were provided for stage U: 2, L: 2

**Treatment Needs**

Interproximal wear/0.2 mm slice on some teeth between 4.3 e 4.2, 4.2 e 4.1, 4.1 e 3.1, 3.1 e 3.2, 3.2 e 3.3 (Figure 2).

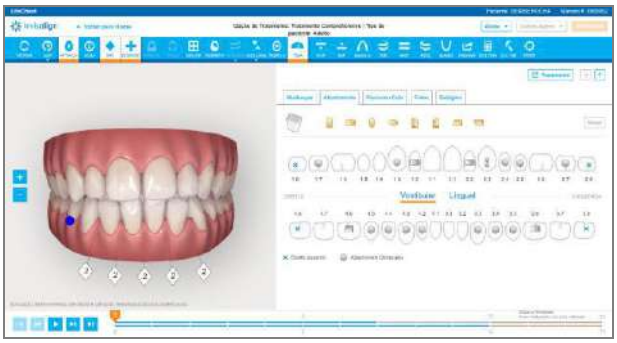

*Fig.2. Invisalign™ virtual planning.*

**Dental movement assessment**

Tooth 2.7: extrusion movement (value - 0.8 mm)
Tooth 3.7: intrusion movement (value - 0.8 mm)
Tooth 1.7: extrusion movement (value - 0.8 mm)
Tooth 4.4: extrusion movement (value - 0.5 mm)
Tooth 4.7: intrusion movement (value - 0.7 mm)

**Protocol and Follow Up**

**1 -** Treatment was initiated with an intraoral scan, iTero Element™ Scanner (Align Technology, Inc., Santa Clara, California) (Figure 3a-c);

**2 -** Then, the ClinCheck, virtual movement planning, analysis and conference of the orthodontist were performed to approve the treatment and then receive the aligners (Figure 2);

**3 -** In the first consultation, the first pair of aligners was delivered, the patient received all instructions for use;

**4 –** After 7 days, the attachments were installed with the aid of the template using IPS Empress™ Direct resin (Ivoclar Vivadent Clinical), color A1 (1.7, 1.3, 1.2, 2.2, 2.3, 2.4, 2.5, 2.7, 3.6, 3.5, 3.4, 3.3, 4.2, 4.3, 4.4, 4.5 and

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4.6). Then, 0.2 mm interproximal / slice wear was performed on some teeth: between 4.3 and 4.2, 4.2 and 4.1, 4.1 and 3.1, 3.1 and 3.2, 3.2 and 3.3. Soon after the installation of the attachments and wear, a sequence of 4 aligners was delivered (change every 7 days);

**5 -** After 35 days, the attachments were evaluated if they were healthy and found to be well adapted. In this consultation were given 3 more aligners;

**6 -** After 21 days, again treatment evaluation provided 2 more aligners. During this period, teeth alignment was observed, with no need for correction;

**7 -** The case was treated and concluded with 10 pairs of aligners for a period of 70 days;

**8 -** Upper and lower fixed restraint was performed on the patient.

## III. RESULTS

The treatment initially proposed to the patient consisted of 10 aligners, and the changes every 7 days. Throughout the treatment, the attachments were well fixed and interproximal, slice wear were performed as planned.

The patient was instructed to use the appliance for 22 hours a day, removing it only for cleaning and feeding. The office visits occurred at intervals ranging from 7, 21 and 35 days. In the consultations, intraoral photos were taken, guidance on the need for cooperation regarding the use of the device and professional monitoring of the dental response through virtual planning.

After the use of all aligners, according to the planning, it was observed that tooth movement occurred entirely in the upper and lower arch. The open bite was corrected, the crowds were dissolved through wear and improvement of the arch shape and there was complete closure of the anterior superior diastema (Figure 3d-f and Figure 4).

There were no significant facial changes, but there was a slight improvement in the chin contour and patient profile.

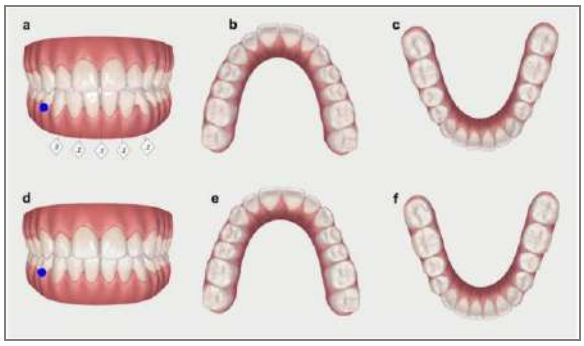

*Fig.3. Intraoral scans. Initial scan simulation: a) Front view with interproximal wear (IPR) markings; b) Occlusal view of the upper arch; c) Occlusal view of the lower arch. Final scan simulation: a) Front view; b) Occlusal view of the upper arch; c) Occlusal view of the lower arch.*

*Fig.4. Final images: a) Smile after treatment; b) front view; c-d) Right lateral view; d-e) Left side view.*

## IV. DISCUSSION AND FINAL CONSIDERATIONS

Improving the appearance of a smile in a more natural and aesthetic way is one of the main reasons why there has been a growing demand for faster and more effective dental treatments based on each patient's specific and individual needs (CHRISTOU et al., 2019).

Faced with aesthetic demands, dentistry has been developing new treatment modalities, materials and techniques, increasingly improved, which aim to modify dental elements in disharmony giving the patient the aesthetic aspect required without compromising the function (BLATZ et al., 2019).

Orthodontic treatments in recent years have evolved and occupied an important space in contemporary orthodontics. In this scenario, invisible aligners have emerged as alternatives to conventional orthodontic appliances in order to provide clinical results similar to metal brackets and in addition to meet, the aesthetic needs of the patient (WEIR, 2017).

The Invisalign™ system has been the device of choice for various types of malocclusion and in certain situations have superior results compared to conventional orthodontics because the movements are minimally planned (TEPEDINO et al., 2018).

The present case report presented satisfactory and effective results in the treatment of relapse after orthodontic treatment with Invisalign™ system. These findings are related to the correct evaluation of the patient's indication and collaboration to achieve the desired results.

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According to the manufacturer, orthodontic treatment with the Invisalign™ system can effectively perform large dental movements. However, despite the efficiency recommended by the treatment, its clinical potency still remains controversial among professionals (PAPADIMITRIOU et al., 2018).

Some previous studies report successful clinical evidence in the results, while others, in contrast, argue for significant limitations, such as malocclusions with more than 5 mm spacing and agglomeration, anteroposterior skeletal discrepancies greater than 2 mm, discrepancies between centric ratio, teeth rotation above 20 degrees, anterior and posterior open bites, teeth extrusion, teeth inclination above 45 degrees, teeth with short clinical crowns and missing teeth arches (WOMACK, 2007; KRAVITZ et al., 2009).

It is evident that some movements are still challenging in treatment with the system and, under many conditions, there is a need to combine ancillary treatments to achieve the desired result, as also in conventional orthodontics, as biomechanics is no different (LI; WANG; ZHANG, 2015).

Given this context, it is necessary to emphasize that in order to obtain a successful orthodontic treatment, professionals need to carry out careful planning, with appropriate therapeutic approach, based on up-to-date and highly reliable scientific evidence. Patient opinion also plays an important role in assessing the possibilities and limitations of each treatment modality for better aesthetics associated with immediate placement of the prosthesis.

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# Analysis of failure in extubation of patients admitted to the intensive care unit of a regional hospital in the southern region of Tocantins.

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***Abstract*****—***Introduction: Mechanical ventilation (MV) is one of the forms of treatment of serious patients in the intensive care unit (ICU). Since most patients who undergo removal from ventilatory support, i.e., extubation, are successful. However, a proportion of these have the inability to manage spontaneous breathing after removal of the artificial airway. Objective: To analyze the failure in the extubation of patients hospitalized in the intensive care unit of a Regional Hospital in the Southern Region of Tocantins. Methodology: The research was carried out through a quantitative, descriptive cross-sectional study with documentary survey conducted in the medical records and analysis of conducts/evaluations performed by on-call physiotherapists on the day of the extubation of patients in the ICU, from October 1, 2018, to March 6, 2019. Patients aged ≥ 14 years, with any pathology and extubated in the hospital ICU were included. Results: Of the nineteen patients followed by the study, fifteen (78.95%) achieved success in extubations and four (21.05%) failure in extubations. Of the 15 patients who succeeded in extubations, only 1 patient (6.67%) died, while the 04 patients who did not succeed in extubations, half (50%) died. Conclusion: This result of failure in extubation resulted in the hospital sector greater financial impact, as well as in health indicators, among them, the increase in the mortality rate and length of stay of hospitalization. Future studies with longer time and for greater reliability are recommended to use in all extubation processes a specific protocol with greater adherence of the health team to perform pre-extubal tests.*

***Keywords*****—Airway Extubation, Intensive Care Unit, Ventilator Weaning, Respiratory Insufficiency.**

## I. INTRODUCTION

Mechanical ventilation (MV) is one of the forms of treatment of serious patients in the Intensive Care Unit (ICU). Being a life support resource, performed by means of a machine that can replace the patient's ventilatory activity in whole or in part. In other words, it aims to restore oxygen demand and thus decrease the respiratory workload of patients who currently present ineffective pulmonary ventilation [1].

Ventilatory support can be offered through invasive mechanical ventilation (IMV) and noninvasive ventilation (NIV), and currently, artificial ventilation is obtained with the application of positive pressure in the airways, and the difference between them is in the form release of pressure. In the IMV, a prosthesis is used that is introduced into the airway, that is an oro or nasotracheal tube or a tracheostomy cannula. In NIV, a mask connected between the patient and the artificial ventilator is used [2].

Among the reasons leading to prosthesis placement are acute respiratory failure (ARPA), coma patients, patients with decompensated chronic obstructive pulmonary disease (COPD) and cases of patients with neuromuscular disease [3] [4].

When the patient is connected to the ventilatory prosthesis, it should be monitored constantly in order to

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identify the appropriate time for weaning of IV, because early withdrawal increases the chances that the patient will not support spontaneous ventilation [1] [4] [5] [6].Another strategy adopted to reduce the prolongation of IVF is to prevent respiratory and peripheral muscle weakness, that is, preventing hypotrophy [7] [8]

The physiotherapist plays an important role in the multidisciplinary team in the critical patient within the ICU, acting both in patients without the need for ventilatory support, in order to avoid motor and respiratory complications, and in those who are under the aid of MV and in the follow-up of patients who are fit for extubation, assisting in the prevention of complications [9].

The first phase of removal of the ventilatory support is called discontinuation of the ventilatory support. After the time of withdrawal is defined, the decision to be performed is initiated6 [6] [10]. Extubation is defined as withdrawal of artificial airway, leading the patient to spontaneous ventilation [11] [12] [13].

A large part of the patients who are submitted to removal of ventilatory support, that is, extubation presents success [14] [15], however, a proportion of these are unsuccessful, that is, the patient is unable to manage spontaneous breathing after removal of the artificial airway, requiring return to MV within a period ranging from 24 to 72 hours after a planned extubation [16] [17].

Failure may be associated with several factors, including the imbalance between respiratory muscle capacity and ventilatory work, the inability to protect airway and management of respiratory secretions, airway obstruction changes in mental status, hypoxemia, muscle weakness and failure in spontaneous breathing test (SBT) [18] [19] [20] [16]. Furthermore, the failure of extubation may be related to the prolongation of ICU stay associated with increased risk of mortality and higher frequency of tracheostomy [21].

Therefore, this study aimed to analyze the failure in the extubation of patients admitted to the intensive care unit of a regional hospital in southern Tocantins.

## II. MATERIALS AND METHODS

This is a quantitative, descriptive cross-sectional research with a documentary survey conducted in the medical records of extubated patients and in the analysis of conducts/evaluations performed by on-call physiotherapists on the day of extubation of patients in the ICU of a regional hospital in southern Tocantins between October 1, 2018, and March 6, 2019, after approval by the Research Ethics Committee of Gurupi-UnirG University, under protocol 2,915,971.

The inclusion criteria adopted were individuals of both sexes, aged ≥ 14 years, having any pathology and having been extubated in the ICU of the aforementioned hospital, between October 1, 2018, and March 6, 2019. Patients who were not admitted to the ICU, children, and neonates were excluded, having been extubated outside the mentioned period and extubated and readily reintubated patients because they had the need for orotracheal tube exchange.

Some data were extracted from the analysis of the medical records of patients hospitalized in the established period. The following information were considered: characterization of the patient, through the diagnosis, date and time of intubation, use of sedative, date and time of extubation, form of extubation, date and time of reintubation, date, and type of ICU output and causes of intubation.

The other data were extracted from the analysis of tests performed by the physiotherapist on duty for the evolution of the extubation process. From this, the following information was extracted: in the pre-extubation tests contained the SBT, cuff leak test, peak flow, Tobin index [9] [13] and evaluation of the leukogram. Already post-extubation, the criteria evaluated were accidental extubation, inability to protect the airway, management of respiratory secretions, laryngeal edema, laryngospasm, mental state changes, Glasgow coma scale, failure of breath test and use of NIV.

The researchers were informed of the probable daily extubations, through the coordinator of the physiotherapy sector of the ICU of the Regional Hospital of Gurupi-TO. As soon as they were aware, they attended the respective sector for data collection before, during and after the extubation were, and this were was performed by the on-duty physiotherapist. Data after extubation were collected at four different moments, the same being immediately after extubation, one hour later, two hours after and seventy-two hours after extubation.

The information obtained through the medical records of each patient and through the conduct of the on-call physiotherapist with regard to the pre- and post extubatory were individually typed into a database, organized from an electronic spreadsheet, this is used to analyze the failure in the extubation of patients in the ICU related.

Data tabulation, significance test, and tables were performed from the tab in Microsoft Excel® 2010 and use of the Statistical Package for the Social Sciences (SPSS®) program to perform the estimates. The Student t-test was performed to test the hypothesis of the work regarding the

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high incidence of failure, and the one established in all cases was 5% (P≤0.05).

## III. RESULTS AND DISCUSSION

The database that comprises the sample of this research was collected in an ICU of a Regional Hospital in Tocantins, between the period from October 1, 2018, to March 30, 2019, with information from 19 patients, of these 12 men and 07 women, aged between 14 and 83 years of age.

The cost of treatment evidenced per day was between R$ 7.729,72 to R$ 189.378,14, and the length of hospitalization between 02 days and 49 days, as can be observed in Table 1 that presents descriptive analysis of the variables of patients successfully in extubations with minimum value, maximum, average and standard deviation.

*Table 1. Descriptive analysis of the variables of patients successfully in extubations, aged (years), length of hospitalization (days) and total cost in days.*

| Variable | Minimum | Maximum | Average | Standard deviation |
|---|---|---|---|---|
| Age | 14 years | 78 years | 41,40 | 23,442 |
| Length of stay | 02 days | 49 days | 18,07 | 12,826 |
| Total Cost | R$ 7.729,72 | R$ 189.378,14 | R$ 69.825,13 | R$ 49.569,03 |

The characteristics of patients with failure in extubations that were consequently reintubated are presented in Table 2. The age was between 19 and 83 years, with a mean of 47.25 and standard deviation of 26,862 for more and less. For length of hospitalization, the minimum of days hospitalized was 13 and the maximum of 31, mean of 22 and standard deviation of 7,348. Regarding the hours for reintubation, the minimum was 02 hours and a maximum of 72 hours, mean of 37.50 and standard deviation of 31,472.

*Table 2. Characteristics of patients with failure in extubations and reintubated, aged (years), length of hospitalization (days), hours of reintubation and total cost in (days).*

| Variable | Minimum | Maximum | Average | Standard deviation |
|---|---|---|---|---|
| Age | 19 | 83 | 47,25 | 26,862 |
| Length of stay | 13 | 31 | 22,00 | 7,348 |
| Time for reintubation | 02 | 72 | 37,50 | 31,427 |
| Total Cost | R$50.243,18 | R$118.810,66 | R$85.026,92 | R$ 28.400,80 |

When comparing the data in table 1 with 2, it is observed that a higher age group can contribute to failure in extubations. This result was also verified by Teixeira et al [5] in his study in which he may conclude that advanced age was considered a predictor of extubation failure since most intubated individuals were over 70 years of age. When we observed the length of stay among patients who were successful in extubations and those who did not obtain it, we can observe an increase in the mean and minimum length of hospitalization of patients with failure in extubations. This finding was also evidenced in the study by Epstein et al [22], where it was observed that reintubation was responsible for an average of twelve days longer of MV when compared to successfully extubated patients. The average calculation of the costs of each ICU patient, participants of this research, was based on the results of the research: Hospital ICU bed cost analysis that found all the average elements spent per ICU bed, with the daily cost per bed being quantified at R$ 3.864,86 [23].

When comparing the expenses of patients successfully in extubations and those with failure, a significant increase in values can be observed. This generates the provider system greater burden, thus causing a high financial impact on the system. The same was observed in Seymour study *et al* [24] in which it was found that the increase in the duration of care with the patient after extubation failure doubled the total hospital cost and the cost per day when compared to patients who did not require reintubation.

Table 3 presents the diagnosis and causes of OTI. According to the data, several patients presented more than one pathology both in the diagnosis and causes of OTI. Among the diagnoses, polytrauma was the one with the highest occurrence, with 05 patients, of these 04 successfully in extubations and 01 with failure in extubations. For causes of OTI, the lowering of the level of consciousness was the one that presented the highest incidence for both groups, with 12 patients, being verified in 09 patients successfully, and in 03 patients, with failure.

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*Table 3. Causes of orotracheal intubation and result of extubations.*

| Variable | Total | Success | Failure |
|---|---|---|---|
| **Diagnostics** | | | |
| Polytrauma | 05 | 04 | 01 |
| Brain skull trauma | 03 | 02 | 01 |
| Pneumonia | 02 | 01 | 01 |
| Acute respiratory failure | 02 | 01 | 01 |
| Acute myocardial infarction | 02 | 02 | 00 |
| Alcoholic encephalitis | 01 | 01 | 00 |
| Heart ailure | 01 | 01 | 00 |
| Acute lung edema | 01 | 01 | 00 |
| Chronic alcoholism | 01 | 01 | 00 |
| Convulsive crisis | 01 | 01 | 00 |
| Syncope to clarify | 01 | 00 | 01 |
| Firearm injury | 01 | 01 | 00 |
| Cardiorespiratory arrest | 01 | 01 | 00 |
| Subdural hematoma | 01 | 01 | 00 |
| Hepatic abscess | 01 | 01 | 00 |
| Diabetes Mellitus | 01 | 00 | 01 |
| Eclampsia | 01 | 01 | 00 |
| Pleural effusion | 01 | 01 | 00 |
| Chest Trauma | 01 | 00 | 01 |
| Stroke sequels* | 01 | 01 | 00 |
| Appendectomy | 01 | 01 | 00 |
| **OTI Cause **** | | | |
| Lowering level of consciousness | 12 | 09 | 03 |
| Acute respiratory failure | 09 | 07 | 02 |
| Respiratory surgical intervention | 01 | 01 | 00 |
| Cardiorespiratory arrest | 01 | 01 | 00 |
| Hepatic abscess | 01 | 01 | 00 |
| Seizure | 01 | 01 | 00 |

* Brain Stroke; ** Orotracheal intubation.

When analyzing the result of the present study, it was observed that the lowering of the level of consciousness was the one that presented the highest incidence of causes of orotracheal intubation. Freitas *et al* [25], corroborate the present data by showing that 51,1% of cases of orotracheal intubation were due to the lowering of the level of consciousness. The same study still infers that the initial diagnosis of admission most frequently were respiratory complications 61,9%.

Table 4 presents the result of the type of output of the patient hospitalized in the ICU. Of 19 patients analyzed sixteen (84,21%) were discharged, and of these two (10,53%) failed extubation. Three patients (15,79%) died, one (5,26%) successfully in extubations and two (10,53%) with failure in extubations. Thus, from the total sample, 03 patients died, one who succeeded in extubation and two who did not succeed in extubation.

*Table 4. Result by output type*

| | Success | % | Failure | % | Total | % |
|---|---|---|---|---|---|---|
| High | 14 | 73,68 | 02 | 10,53 | 16 | 84,21 |
| Death | 01 | 5,26 | 02 | 10,53 | 03 | 15,79 |
| Total | 15 | 78,94 | 04 | 21,06 | 19 | 100,00 |

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When analyzing these results, it can be observed that there was a higher incidence of deaths in patients who were unsuccess- ful in extubations when compared to those who succeeded. Epstein findings *et al* [22] corroborate this result, after concluding in their study that patients undergoing reintubation were more likely to progress to death in the hospital or spend more time in the ICU. Also, according to these authors, extubation failure is an independent predictor of death and need for transfer to a long-term care facility.

The pre-extubatory tests used in this study were: SBT, Cuffleak test, Expiratory Flow Peak and Tobin Index, as shown in Table 5. By tabulating analysis, it can be observed that there was a case of accidental extubation. The Peak Flow test can be highlighted with 13 cases evaluated, and all obtained aptitude results and in 06 cases the test was not performed. The Tobin Index test presented the lowest adherence rate by the health team, in 17 cases the aforementioned test was not performed, in only 02 cases performed, there was a result of fitness. The results of the other tests were favorable to the fitness of patients to be extubated.

The opportunity of extubation should be evaluated in view of the risks involved both in early withdrawal and in superfluous stay of the cannula. Therefore, the decision on the appropriate time to perform extubation has to be based on accurate, objective and reproducible criteria. Thus, when the health team does not, it assumes the risk of failure which can significantly impact the patient's life [26].

*Table 5. Extubation tests.*

| Extubatory Tests | Performed | Unrealized | Able | Accidental extubation |
|---|---|---|---|---|
| Spontaneous Breathing | 16 | 03 | 16 | 01 |
| Test Cuffleak | 17 | 02 | 17 | 01 |
| Peak Flow | 13 | 06 | 13 | 01 |
| Tobin Index | 02 | 17 | 02 | 01 |

Table 6 presents the causes of reintubation, use of NIV without success, fitness in SBT and leukogram levels. For the causes of reintubations, laryngeal edema was the most verified with 50% of the cases. For NIV, 75% of the patients used the therapy and were still submitted to reintubation. For spontaneous breathing testing, 75% of patients were considered fit. And for leukogram, half of patients (50%) presented ascendant results in the examination.

*Table 6. Causes of reintubations, use of NIV, SBT and leucogram of patients with failure and submitted to reintubations.*

| Variable | Absolute value | % |
|---|---|---|
| **Causes of reintubations** | | |
| Change in mental state | 1 | 25% |
| Laryngeal edema | 2 | 50% |
| Management of respiratory secretions | 1 | 25% |
| **NIV*** | | |
| Yes | 3 | 75% |
| No | 1 | 25% |
| **Spontaneous Breathing Test** | | |
| Not fit | 1 | 25% |
| Fit | 3 | 75% |
| **Leucogram** | | |
| Up | 2 | 50% |
| Descendant | 1 | 25% |
| Normal | 1 | 25% |

***** Noninvasive ventilation.

Among the causes of reintubation, already mentioned above, 50% of the cases were due to laryngeal edema. In line with this result, Freitas et *al* [3] affirm that laryngeal edema is an important cause of failure in extubation, that is, this condition increases the need for reintubation. De Backer [27], it also contributes to studies by stating that laryngeal edema is a factor that contributes to extubation failure, thus leading to reintubation in about 15 to 38% of

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cases. However, Souza *et al* [15], in the study comparing the pre-extubation cuff leak test with three SBT methods, they stated that the absence of escape does not necessarily mean that there will be extubation failure and that patients with negative leak test are safely extubated, suggesting that failure in the specificity of the test.

The alteration of mental status and secretion management in this study were also crucial factors that contributed to reintubations. Similar fact was found in the study by Salam et *al* [18], since they observed cumulative increase in the risk of extubation failure, reaching 100% among patients with low cough power, accumulation of secretions and low level of consciousness. In another study, Khamiees et *al* [28] showed that patients with moderate to large volume of secretions are 8 times more likely to fail extubation when compared to patients with little or no secretion.

Conti and Soroksky *et al* [29] [30] propose that ventilation with noninvasive positive pressure (NIV), in addition to improving gas exchange and clinical evolution in different types of acute respiratory failure, reduces the risk of nosocomial pneumonia, the need for intubation and mortality. This perception is present in Rahal study *et al* [31] because there was a reduction in the incidence of nosocomial pneumonia, reduced mechanical ventilation time and ICU admission, which contributes to a higher probability of survival. However, in this study, 75% of patients who used NIV therapy after extubation to reverse signs of respiratory distress and/or denaturation were unsuccessful and were unfortunately submitted to reintubation.

For the spontaneous breathing test, in this study, 75% of patients with failure in extubations were considered fit when submitted to the test. Andrade *et al* [32], in a study conducted with the ph yto to verify whether or not the SBT is a predictor of extubation success in preterm neonates, does not corroborate the findings of this research. Therefore, in the aforementioned study, it was possible to verify that the group that performed the SBT previously obtained a significant result associated with the success of extubation when compared to the control group. However, in Chavez study *et al* [33], of the patients who were able to successfully complete the SBT, the extubation failure index was 7,8%, while for those who failed, half needed to return to invasive ventilatory support.

In this study, half (50%) of patients with failures submitted to reintubations presented an ascending result in the leukogram, that is, presence of leukocytosis. Lima [6], in his study entitled: Respiratory rate as a predictor of weaning failure of mechanical ventilation, states that, of the reintubated patients, 40% had important leukocytosis, that is, above 15.000, which could characterize a process underlying inflammatory, a new infection or persistence of the current disfavoring the weaning process of mechanical ventilation.

*Table 7. Student's T-Test.*

| Variables | t* | sd** | p-value | Average difference | 95% confidence interval | |
|---|---|---|---|---|---|---|
| | | | | | Bottom | Top |
| Age | 7,897 | 18 | 0,000 | 42,632 | 31,29 | 53,97 |
| Length of stay | 6,969 | 18 | 0,000 | 18,895 | 13,20 | 24,59 |
| Output type | 9,798 | 18 | 0,000 | 0,842 | 0,66 | 1,02 |
| Sex | 3,240 | 18 | 0,000 | 0,368 | 0,13 | 0,61 |
| Cost per day | 6,969 | 18 | 0,000 | 73.025,512 | 51.011,70 | 95.039,31 |
| Result | 8,216 | 18 | 0,000 | 0,789 | 0,59 | 0,99 |

* Student T; *Difference, *P≤0.05.

After this descriptive exposure, it can be concluded that of the 19 patients followed by the study, 15 (78,95%) achieved success in extubations and 04 (21,05%) failure in extubations. Of the 15 patients who succeeded in extubations, only one patient (6,67%) died, while the 04 patients who did not succeed in extubations, half (50%) died.

The causes of OTI were: lowering of the level of consciousness and acute respiratory failure. For patients who presented need for reintubation, the most verified complication in these patients was laryngeal edema, occurring in half (50%) of the cases.

## IV. CONCLUSION

In this study, it was possible to observe that extubation is inserted in the weaning process of MV, it is complex and likely to fail because it depends on several clinical and physiological factors that may indicate the possibility of failure or not extubation. The failure of the procedure generates high impacts on the health and

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financial indicators of the in-hospital sector, including the increase in the mortality rate, length of stay of hospitalization and higher frequency of tracheostomy.

Future studies with longer time and for greater reliability are recommended to use in all extubation processes a specific protocol for the performance of the procedure.

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# Endodontic Treatment of the first Maxillary Molar with 7 Root Canals: Case Report

Eduardo Fernandes Marques, Deise Mikaely de Sousa Silva, Diana Rodrigues Frota, and Larissa Bitencourt

***Abstract*****—** *The anatomical complexity of the root canal system is an ongoing challenge for the endodontist. The morphology of the permanent maxillary first molar contains numerous variations regarding the number of roots and canals. Thus, the success of endodontic treatment is related to the domain of anatomy. The aim of this study is to present a case report on a maxillary first molar with seven root canals.A 17-year-old female patient, melanoderm, was seen at the multidisciplinary clinic for a routine examination. In the clinical examination, a extensive carie was found in element 14. Radio graphically, radiolucent area was observed circumscribing the root apexes of this dental element. The following steps were performed. Anesthesia with 2% lidocaine, access surgery, absolute isolation and irrigation with 2.5% sodium hypochlorite. With the aid of ultrasonic vibration with an E7D insert at a frequency of 30 kHz for 20 seconds, connected to a piezoelectric device, the pulp chamber floor was refined. After this procedure it was found, through the exploration of a 10 K file and magnification with operative microscope, atypical anatomy with extra canals: mesiobuccal canal 1, mesiobuccal canal 2, vestibular mesio 3, distobuccal 1, distobuccal 2, palatine 1 and palatine 2.Cervical third preparation was performed with the aid of a Logic 25/05 rotary instrument, confirmation of working length with foraminal locator, apical third preparation and intracanal medication insertion: calcium hydroxide. Soon after the consultation, a computed tomography was requested to confirm the root canals. In the second session, after removal of intracanal medication, rotary files were recapitulated, 2.5% sodium hypochlorite irrigation, final irrigation with agitated EDTA with 25 IRRS ultrasound insert and thermoplastic obturation.The dental element was restored and a new CT scan was requested for follow-up. In this context, it can be concluded that the dental surgeon must be aware of the anatomical diversity, thus avoiding failures. The patient remains asymptomatic and dental element performing its functions.*

***Keywords*****— Endodontics, Anatomy, Anomaly.**

## I. INTRODUCTION

Endodontic treatment enables the maintenance of the dental element in the stomatognathic system through chemical-mechanical preparation and obturation of root canals (Ulin et al., 2019). However, the failure of this therapy may be related to persistentor secondary infections through untreated roots (Alkadi; Alsalleeh, 2019).Variations in the root canal system may contribute to the failure of endodontic treatment, especially in multiradicular teeth. Among these, the maxillary first molar has been studied due to its variation internal anatomy (Martins et al., 2019).

The upper first molars exhibit a frequent root anatomy of3 roots and 3 or 4 root canals. In addition, the roots may be ovoid, which considerably interfere with root canal visualization and detection specially during radiographic procedures (Zurawski et al.,2018). However, variations in its morphology are reported in the literature, such as the case of an upper first molar with two palatal roots and the roots fused buccal lesions, or the presence of two palatine roots and two totally independent vestibular roots (Venumuddala et al., 2017).

Studies have shown that the occurrence of the third canal in the mesiobuccal entrance exams are between 1.3% and 0.1% (Deepa et al., 2015; Sharma et al., 2016). However, Lee et al., 2011 and Kim et al., 2012, described the occurrence of two root canals at the distobuccal root in 1.9%. Some studies have shown upper molars with palatal roots with two canals in 2% to 5.1% of cases (Nayak et al., 2015; Badole et al., 2014).

Mamoun (2016) reports that the use of the operating microscope combined with ultrasound in the access surgery, help in the identification of the root canals. In this way, minimizing the non-identification of root ducts. Second Rover et al. (2017) the microscope and refinement of the pulp chamber walls and floor with ultrasound inserts are

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fundamental for the location of thesecond canal in the mesiobuccal root in the upper first molars.

Radiographic interpretation of an endodontic pathological conditionis an integral part of the diagnosis and prognostic determination in endodontics (Jang et al., 2019). The limitations of conventional radiography createdthe need for the acquisition of three-dimensional images, called tomographycone-beam volume (TVCB), which is a non-invasive and viable method for identification of conventional, complex and atypical anatomy (Amin et al., 2019).The aim of this study is to make a case report about a first molarsuperior with seven root canals.

## II. CASE REPORT

**Clinical Procedures**

A 17-year-old female patient attended the dental clinic of Ceulp / Ulbra-To (Brazil) for the endodontic treatment of element 26. the treatment was asymptomatic. Clinical examination showed no symptoms in the cold sensitivity test and negative percussion test. Radiographic examination revealed extensive coronary caries and radiolucent area circumscribing the mesiobuccal and distobuccal roots (Figure - 01).

Anesthesia was performed with Lidocaine 1: 200000 (Dentsply / Sirona, Tulsa Oklahoma, USA), tooth prophylaxis with straight white CA Brush (Microdont, Socorro - SP) and Herjos prophylaxis paste (Vigodent, Rio de Janeiro - RJ), removal of caries with low rotation spherical drills (Dentsply / Sirona Tulsa Oklahoma, USA), coronary opening with diamond burs 1014 and 3082 (KG Sorensen, Barueri - SP) and E7D pulp chamber floor refinement (Helse, São paulo, Brazil).

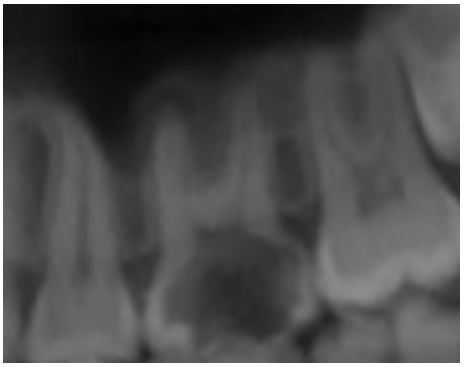

*Fig.1 –Initial Radiography*

Absolute isolation was made with rubber sheet (Madeitex, São José dos Campos - SP), Ostby insulation arch (Prisma, São Paulo - SP) and various isolation clamps (KSK, Rio de Janeiro - RJ) and field disinfection. treatment with 0.2% chlorhexidine (Pharmacy Manipulation Formula A, São Paulo-SP).

Initial exploration was performed with K file # 10 (Dentsply / Sirona Tulsa Oklahoma, USA) and the use of the operating microscope for root canal identification and atypical anatomy with extra channels were detected: mesiobuccal canal 1, mesiobuccal canal 2, mesium vestibular 3 (A), distobuccal 1, distobuccal 2 (B), palatine 1 and palatine 2 (C) (Figure 02).

*Fig.2 - Mesiobuccal canal 1, mesiobuccal canal 2, labial vestibular canal 3 (A), distobuccal canal 1, distobuccal canal 2 (B), palatine 1 and palatine 2 (C)*

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**Instrumentation Technique:**

It was performed with the Logic motor and rotary system (Easy, Belo Horizonte - Brazil), followed by the preparation of the cervical third with 25/05 Logic file (Easy, Belo Horizonte - Brazil) crown - apex direction respecting the anatomy of the canal, always maintaining a minimum distance of 5mm from the apical limit on radiography. Next, Root ZX foramen locator odontometry (J Morita, Kyoto - Japan) was performed, obtaining the real length of each root canal. Foraminal patency was performed with the rotary file 25/01 Logic (Easy, Belo Horizonte - Brazil) 1 mm beyond the actual tooth length, defined by an electronic foraminal locator. File patency check (10 or 15). Subsequently, a 5/25 file instrumented 1mm short of the actual length of each root canal.

Irrigation with 2.5% sodium hypochlorite (Pharmacy Manipulation - Formula and Action - São Paulo - SP), Lüer Slip 10 mL plastic syringe (Advantive, Nanchanc Jangxi - China) and disposable needle were performed throughout the instrumentation. x 0.55 (BD, Curitiba - PR). 30 mL of solution per experimental unit were used. The needle was introduced throughout the instrumentation process until it reached 2 mm below the working length. At the end of preparation, the canals were dried with capillary tips (Ultradent Products, Inc., South Jordan, Utah, USA) coupled with a high-power sucker and absorbent paper cones (Tanari, Manacapuru - AM). Immediately afterwards, intracanal medication - calcium hydroxide was introduced and provisional restoration with glass ionomer was performed. The patient was asked for a computed tomography to evaluate the root canals (Figure 03).

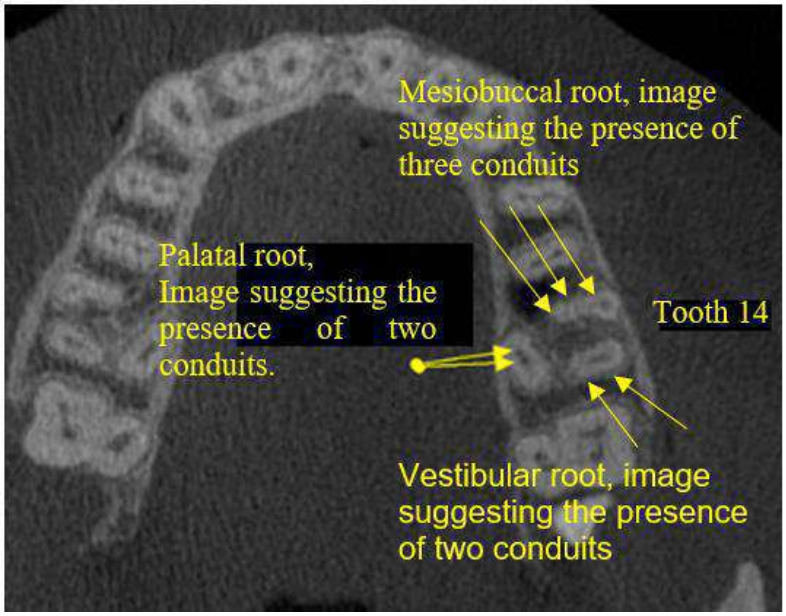


*Fig.3 - Computed tomography for root canal evaluation*

In the second session, after removal of intracanal medication, recapitulation of rotary limes and irrigation with 2.5% sodium hypochlorite. Final irrigation was performed with 3 mL of 17% EDTA (Pharmacy Manipulation - Formula and Action - São Paulo - SP). First, 1 mL of 17% EDTA was introduced, followed by ultrasonic vibration with 25 IRRI S insert (VDW; Endo Ultrasonic Files, Endodontic Synergy, Munich, Germany) at a frequency of 30 kHz. The ultrasound insert was connected to a piezoelectric ultrasound operating at 30 kHz (CVDent 1000; CVD Vale, Sao Jose dos Campos, SP, Brazil), set at power level 3, over a period of 20s. This process was repeated 2 more times. After this process, 5 mL of sodium hypochlorite was irrigated (Pharmacy Formula & Action, São Paulo – SP). The canals were dried with capillary tips (Ultradent Products, Inc, South Jordan, Utah, USA) coupled to a suction high power and absorbent paper cones (Tanari, Manacapuru - AM).

After manipulation of the endodontic cement the channels were filled by the Continuous Condensation Wave technique (Buchanan, 1994) following the principles of the Schilder technique (1967) using the Touch'n Heat equipment. For this purpose, M and FM accessory cones (Tanari, Manacapuru - AM) were selected. These were calibrated using an endodontic caliper (Dentsply / Sirona, Tulsa

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Oklahoma, USA) and adjusted to the working length. The Thermoplasticizer of the Touch'n Heat apparatus was cut, plasticized and condensed by gutta percha within the canals until 5 mm of gutta percha remained. This phase of the shutter is called Down Packing. Thereafter, thermoplasticized gutta percha was introduced to perform the Back Fill.

Definitive restoration with composite resin or glass ionomer cement was performed after treatment and final radiography was performed with radiographic positioner (Indusbello, Londrina - PR) (Figure 04). New tomography was performed for endodontic treatment analysis (Figure 05).

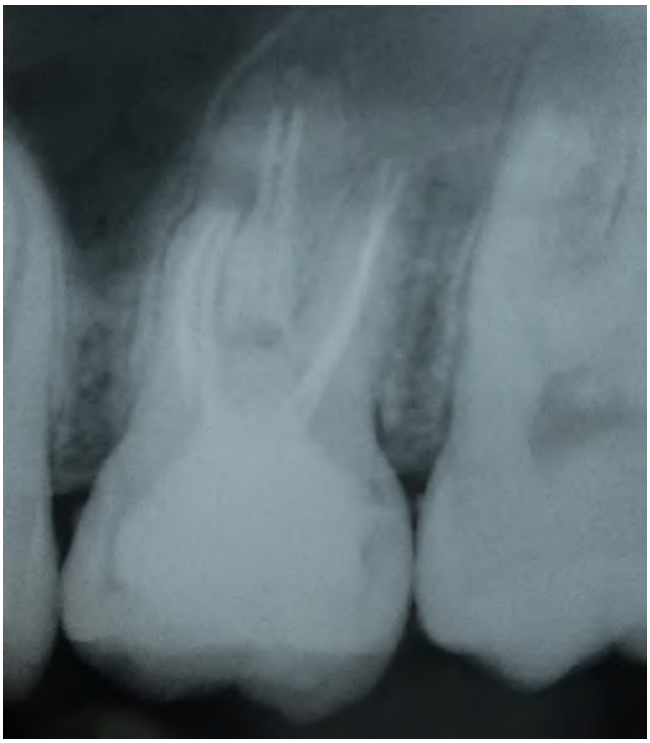

*Fig.4 – final radiography.*

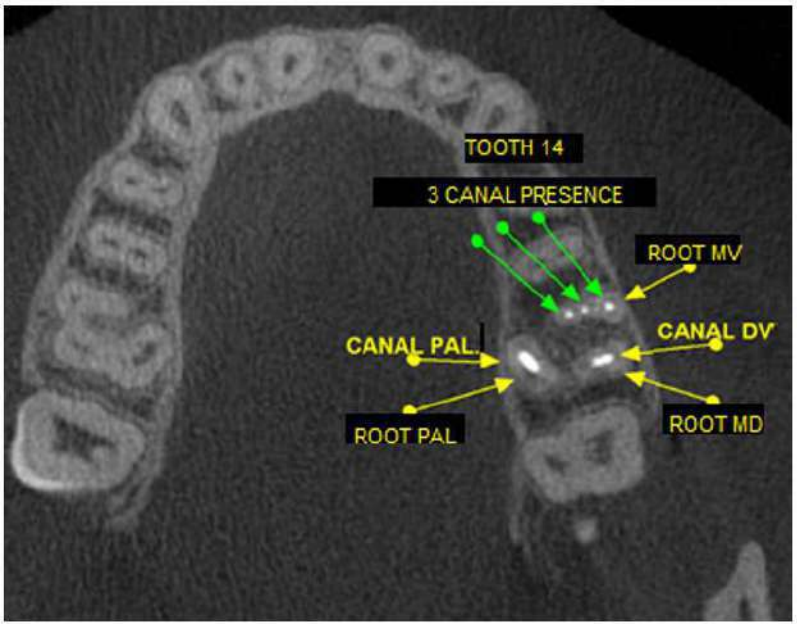


*Fig.5 - Tomography was performed for endodontic treatment analysis.*

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## III. DISCUSSION

Although the endodontic therapy remains viable and successful, cases of failure can be observed due to the complexity of root canal anatomy and variations found in root morphology (Chung et al., 2019).

Fernandes et al. (2019) reported that the upper first molar, in 92% of the cases, has two root canals in the mesiobuccal root, one in the distobuccal root and one in the palatal root. However, Guo et al (2014) report the prevalence of the second root canal in the mesiobuccal root can be reduced by the influence of the age of the individual. This can happen as a result of the structural changes that the dental element over the years. Continuous deposition of secondary dentine, leading to dentin and pulp recession sclerosis (Milcent et al., 2019). Thus, the canals become obliterated because there is a reduction in pulp volume, making the location of the second mesiobuccal canal, if present. In the present study, however, the patient was young, 17 years old, with 7 root canals, 3 in the mesiobuccal root, 2 in the distobuccal root and 2 in the palatal root. This type of anatomy was also found in a patient of 26 years in a study by Badole et al., 2014.

Sinha et al (2016) reported that in 2.4% of cases there may be 5 canals: 2 canals in the mesiobuccal root, 2 in the distobuccal root and 1 in the palatal canal. However, Zheng et al., 2010 observed that the incidence of six canals is 0.31%, with two canals being observed in the mesiobuccal root, two in the buccal root and two in the palatal root. In the present study, two were also found in the buccal root and two in the palatal root, but 3 in the mesiobuccal root, in agreement with the study by Badole et al (2014). However, Kottoor et al. (2011) published a study of an 8-canal upper first molar: 3 on the mesiobuccal root, 3 on the distobuccal root and two on the palatal root.

One of the difficulties in access surgery is the location of root canals. Currently, the operative microscope combined with ultrasound inserts help in the identification of these canals (Rover et al., 2017). de Oliveira et al (2019) clinically evaluated the impact of a dental operating microscope on the clinician's ability to locate a second canal in the mesiobuccal root 2. In teeth treated without the use of the dental operating microscope, only 26.67% of In these cases, the mesiobuccal canal 2 was located; however, when used, 77.78% of the cases were identified. They concluded that the use of the operating microscope significantly improved the identification of extra canals in the maxillary first molars. In the present work it was very useful to use this technology to put in the mesiobuccal root to have 3 root canals. According to Deepa et al (2015) and Sharma et al (2016) the occurrence of the third canal in the mesiobuccal root is between 1.3% and 0.1%.

Computed tomography can provide the clinician with additional information on the different root canal configurations for successful root canal treatment. Kashyap et al (2017) observed through computed tomography that 72.5% of the maxillary first molars had 4 root canals, and in 76.5% 2 canals in the mesiobuccal root. Kottoor et al. (2011), Sinha et al (2016) and Kim et al (2012) used computed tomography in their studies and reported that this type of exam was crucial in identifying extra root canals. In the present study, computed tomography was requested soon after the first consultation, to certify the identification of root canals and to verify the existence of others that could exist. After completion of the endodontic treatment, another tomography was requested to verify root canal filling.

## IV. CONCLUSION

It can be concluded from this study that the dental surgeon must be aware of the anatomical diversities, thus avoiding failures. The patient remains asymptomatic and dental element performing its functions.

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# Bayesian Spam Filter for Wolaytta

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***Abstract*****—** *The increasing volume of spam has become a serious threat not only to the Internet, but also to society. This paper presents a C++ code to implement a spam filtering based on the use of Bayesian spam filtering for Wolaytta text. Our experiments indicate that using this approach to filter spam e-mails is a good approach for languages like Wolaytta.*

***Keywords*** *—* ***Spam filter, Naïve Bayesian classification, Wolaytta.***

## I. INTRODUCTION

With the advancement in electronic and computer technology there is an explosive growth in the use of computers for processing information. In today's computer-connected society, among the existing forms of communication email has become the fastest and most economical form of available communication.

According to recent surveys, 60% of all e-mail traffic is spam [1]. In this way a great amount of bandwidth is wasted and the e-mail systems are overloaded. Due to the above serious problems, measures must be taken to deal with the spam phenomenon. The best such measure has proven to be spam filtering.

This paper demonstrates the use of Bayes' formula in filtering spam messages of Wolaytta text. Achieving the goal for local languages like Wolaytta would also provide novel knowledge about cognition, understanding, and mechanism of spam filtering with the possibility of considering some of the features of the language.

## II. BAYESIAN PROBABILITY

Bayesian probability is one of the major theoretical and practical frameworks for reasoning and decision making under uncertainty [2]. The historical roots of this theory lie in the late 18th, early 19th century, with Thomas Bayes [2] and Pierre-Simon de Laplace [3]. It was "forgotten" for a long time, and began to be re-appreciated in different application domains, during various periods of the 20th century. Hence, Bayesian probability was never developed as one single, homogeneous piece of scientific activity. Bayesian concepts, methods and solutions for different applications became known for decades under various names: the Bayesian approach to uncertainty reasoning, Bayesianism, the Bayesian framework, the Bayesian paradigm, plausible inference, and Bayesian reasoning

### *A. Bayes' Formula*

In basic terms, Bayes' Formula allows us to determine the probability of an event occurring, based on the probabilities of two or more independent evidentiary events [4]. Mathematically, the general formula is represented as: **P(Ej|F)**

$$P(Ej|F) = \frac{P(F|Ej)P(Ej)}{\sum P(F|Ei)P(Ei)}$$

Assuming that the variables a and b are the probabilities of two evidentiary events, the probability would be equal to:

$$\frac{ab}{ab + (1-a)(1-b)}$$

For three evidentiary events a, b, and c, the formula expands so the probability is equal to:

$$\frac{abc}{abc + (1-a)(1-b)(1-c)}$$

In this fashion, the formula can be expanded to accommodate any number of evidentiary events. The Bayes formula lets us combine the probability of multiple independent events into one number with a range of 0.0 to 1.0. Here the Bayes' formula is used to figure out the probability that a message is spam based on the words appearing in it.

The block diagram below in figure 1 shows how the spam filter module is designed. The goal of the filter program is to filter spam messages as it occurs as a legitimate mail message. The program takes data to train the train_data_table, a table which is used to store words (tokens) that appear in spam and non-spam messages along with their frequency both in spam and non-spam messages. It also has columns that hold calculated values of probability and spamicity. The filter:

I. Parses each word in sample spam and legitimate (non-spam) messages. These messages are used to train the filter with possible tokens that appear in spam message.

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II. For each token it uses its frequency both in spam and legitimate messages. The frequency is then used to calculate the probability of each token being as it being appears in spam and legitimate messages.
III. The calculated probability then yields the spamicity.

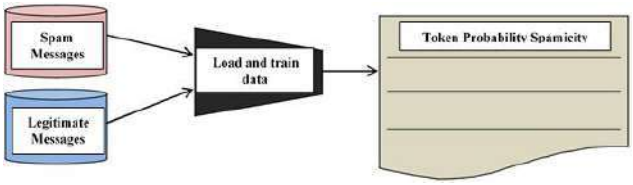


*Fig. 1: Spam Filter Module*

The first thing we need to do is to provide the filter with a couple of spam and legitimate messages. This will allow the filter to train itself the difference between spam and non-spam messages. When we humans accidentally read a spam message, we almost immediately recognize it as spam because of certain key words (such as "viagra" and "mortgage") or phrases (such as "Get your free porn here!"). Instinctively, we know that a message containing these words or phrases is spam because of our experience in dealing with junk mail. The opposite is true as well. We can almost instantly look at a message from our mother (containing phrases such as "When are you going to get married so I can have grandchildren?") or our boss (containing phrases such as "Less computer solitaire and more work if you want a paycheck this Friday") and know they're not spam.

## III. WOLAYTTA LANGUAGE

Wolaytta is an Omotic language family which is a branch of the Afro-Asiatic language phylum spoken in the Wolaytta Zone and some parts of the Southern Nations, Nationalities, and People's Region of Ethiopia [6]. The term 'Wolaytta' is used as the name by which the people refer to themselves, their region and their language. The Wolaytta language is written in the Latin alphabet. It is one of the languages known as it has complex morphology.

## IV. THE SYSTEM (BAYESIAN FILTER)

The system developed here implements the Bayes' filter. It is named 'Wolaytta_Spam_Filter'. To develop the system, I used C++ programming language that I am familiar with. The system uses a single table (vector) to store tokens that are supposed to be both in spam and non-spam messages. The messages are written in Wolaytta.

### *A. Training Data*

The more we train our filter the more it will become accurate. We "train" the filter by showing it a bunch of mail messages, and telling it whether the message is spam. Whenever we show a message to the filter, it finds every word in the message and stores it (along with how many times it occurred) in a database.

To train the system I translated the most familiar spam messages occur in English to Wolaytta text and give the system the text in .txt file format. This due to the problem of inaccessibility of any written text for this language in Examples of the spam and non-spam messages used for the training 'Wolaytta_Spam_Filter' are listed below.

*Table I: Sample Spam and Non-Spam messages of Wolaytta*

| **Spam and Non-Spam messages** |
|---|
| **Spam Messages** |
| 1. Tanni kehini nena sikio gishawu tannara gayitanawu koiko hachi tawu silikia shocha. Ta nena dossiyoo gishsha ta neyoo kittido ta pootuwan beada ne tana dossiko tayoo neeni silkkiyaan tani neeko yaada nenaara gayttana. |
| 2. Dvyaa Lotoriyaa gakanadani koiko tayo nenni birra bankirra yedana mala tomooseyis. Hega otanawu ne koiko tanni niyo esuwara polissada nena America bitta yedana. Nena dvyaa qaaday gakkido gishaw, ne bankkiyaa payduwaa nussi issi agnnaa gakkanaashin eesuwan xaafa. Ne hegaa xaafa simishiin nu neyoo nena ekkida giya woraqataa yedana. |
| **Non Spam Messages** |
| 1. Tani issi shanne uddppu xeetane eudpu tamanu marotetaa layttan yeletasi. Hega gioge ta layitai hae eshattamapee aleissi gioga. La Taddalla aymala deay waanada xayadii? Ne ossoy aymalee? Ne naati ubbayka saroo? Ne siiqo machchiyaa aymalee? Taani neeko mata wodiyaan yaana. Hegee gakkanaashin saro dea. |
| 2. Ha gidooni intte ooso keettay oosanchchasi oorata oosuwan qadaa kessidogaa kessidoogaa siyaasi shiinawude gakkanawu takii? Ubbankka neesi wontto silkkiaa shoccana. Saro taka |

For training purpose, the filter takes tokens both form spam and non-spam messages. For this project I used 4 spam and 4 non-spam messages for training purpose. The messages listed above only show the content of the messages.

Here I used Wireshark, a network analysis tool, for capturing the actual messages as if it is sent through E-Mail. While sending the E-Mail Wireshark uses http protocol and hence, I extracted the content of the messages from the raw packets. During spam filtering the main focus is on the actual message content so that other parts of the

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message such as Header parts are not important to be listed here in training data. As a result, the header and body fields along with their values are not included in the message texts listed above.

All title and author details must be in single-column format and must be centered.

The messages are hence used to populate the filter table. The probabilities are calculated using an easy probability formula used to compute the probability value. In order to calculate the probability of each token the filter use the frequency of the token as it appears on spam and non-spam messages. The values of the calculated probabilities are used to compute the spamicity of a given token.

This probability value assigned to each word is commonly referred to as spamicity, and ranges from 0.0 to 1.0. If spamicity value for a given word is greater than 0.5 then the message containing the word/token is likely to be spam, while a spamicity value less than 0.5 indicates that a message containing the word is likely to be ham (non-spam). A spamicity value of 0.5 is neutral, meaning that it has no effect on the decision as to whether a message is spam or not.

Some spam filtering applications use a separate table for spams and non-spam messages. Here I used a common table for both spam and non-spam messages. This approach is easy for reading the values that correspond to a particular token. A count of messages used for training is also kept on the database to calculate the probabilities.

*Table II: Sample Spam and Non-Spam messages of Wolaytta*

| Token | Spam frequency | Non-spam frequency | Pr(spam) | Pr(non-spam) | Spamicity |
|---|---|---|---|---|---|
| **Tanni** | 4 | 0 | 1 | 0 | 1 |
| **Kehini** | 1 | 0 | 0.25 | 0 | 1 |
| **Nena** | 3 | 0 | 0.75 | 0 | 1 |
| **Aleissi** | 0 | 1 | 0 | 0.25 | 0 |
| **Hega** | 1 | 1 | 0.25 | 0.25 | 0.5 |
| **Nyio** | 2 | 0 | 0.5 | 0 | 1 |

The implementation of the filter to create the above train database uses the following structures:

```
typedef struct token_table
{
        string word;
        int id;
        int non_spam_freq;
        int spam_freq;
        float ps;
        float pns;
        float spamicity;
}token_table;
```

The "token_table" is a structure used to hold tokens parsed for spam and non-spam messages. Non-spam and spam fields store integer values that tell the number of appearances of a word in spam and non-spam messages. These values are used for finding the probabilities of each word that exists within the messages.

Once the Bayesian filter has the list of tokens in the table, it searches the spam and non-spam tokens databases for these tokens. These databases of tokens are created and updated whenever the Bayesian filter is "trained" on a new message. This implies training only requires messages that are supposed to be spam and non-spam.

If a token from the message is found in the databases, the Bayesian filter calculates the token's spamicity based on the following variables:

I. The frequency of the token in spam messages that the filter has been trained on
II. The frequency of the token in ham messages that the filter has been trained on
III. The number of spam messages the filter has been trained on
IV. The number of ham messages the filter has been trained on

The algorithm used to calculate a token's spamicity from these pieces of information is as follows:

$$\text{Ham probability} = \frac{\text{Token frequency in ham messages}}{\text{Number of ham messages trained on}}$$

Equation 1

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$$\text{Ham probability} = \frac{\text{Token frequency in ham messages}}{\text{Number of ham messages trained on}}$$

Equation 2

If either Ham probability or Spam probability are greater than 1.0, it sets them equal to 1.0.

$$\text{Spamicity} = \frac{\text{Spam probability}}{\text{Ham probability} + \text{Spam probability}}$$

Equation 3

The structure used to store the tokens along with their structure members are shown below:

```
typedef struct train_Data

{

        vector<token_table> trainTable;

        int non_spam_word;

        int spam_word;

}train_Data;
```

The fields 'spam_word' and 'non_spam_word' are integer variables used to store the number of spam and non-spam messages used to train the train database. The vector holds tokens along with the fields specified in 'token_table'.

First messages in non-spam category are loaded and then messages in spam category. These processes are handled by function:

loadTrainDataSpam()

loadTrainDataHam()

after the tokens in spam and non-spam messages are parsed and populated along with their frequency in spam and non-spam messages. The next step is calculating the probability and spamicity of each token. The function which calculates these values is:

calculateProbability()

This function takes the values populated by the previous function, *loadTrainDataSpam()* and *loadTrainDataHam()*.

These three functions use the formulas listed above, Equation1, Equation2 and Equation3.

Loading training messages involves adding the parsed tokens in to the train_table. For such functions I used the function:

add_token_ham(token)

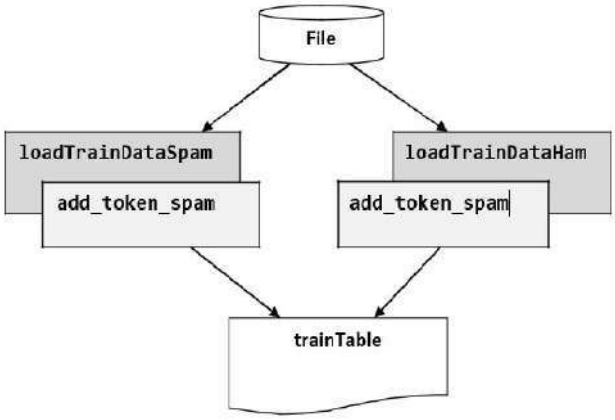


*Fig.2: Filter processing*

Next, I'm gone to let the filter try to decide if a message is spam or not, based on what we've told it about what spam looks like and how it differs from non-spam. Let's pretend a mail message is sent to the filter, which looks like this:

"Tanni kehini nena sikio gayitanawu koiko hachi tawu silikia shocha"

The filter scans through the message, creating a list of every word it knows about (in other words, every word in the message that's also in the token databases). Once the filter has the list of words it knows about, for each word it calculates the probability that the word appears in spam based on the frequency data in the token databases.

## V. Testing and Evaluation of the New System

This section provides the performance assessment of the spam filter followed by testing the adequacy of the system.

The filter takes as input a directory with email messages (both spam and non-spam) for testing the filter specified by the user. In order to use the program and test some messages a user requires:

I. A directory\folder with spam messages used to train the filter
II. A directory\folder with non-spam messages used to train the filter
III. A directory\folder with messages (both spam and non-spam) for testing the filter

The program continues well and shows all train database and the result for the tested messages. It filters the message as spam and non-spam and shows the result as follows:

*Fig 3: Processing Spam File*

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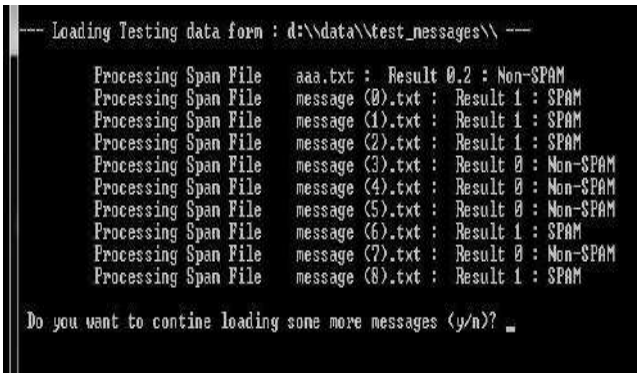


Most of developers of this system train and evaluate their system with thousands of messages. But for this case due to unavailability of Wolaytta text, I translate some messages and try to evaluate on the texts that I trained the system and with some more. To evaluate the filter's performance, I performed the following test case:

The inbox contains 10 email messages: 5 spams and 5 non-spams.

- Total number of email messages: 10
- Total number of non-spam messages: 5
- Total number of spam messages: 5
- Total number of email messages classified as non-spam: 5
- Total number of email messages classified as spam: 5
- Total number of non-spam messages classified as spam messages: 0
- Total number of spam messages classified as non-spam messages: 0
- Accuracy: 100%

This doesn't show precisely the accuracy of the system as if it is trained with small number of training sets and small number of testing sets of data.

## VI. CONCLUSION

As we have experienced, most of the email messages that are sent for us daily are spam. According to different researchers among the existing different techniques used for text classification, Bayesian analysis filters spam with high accuracy.

Here I tried to develop a Bayesian spam filter using C++ programming language. I read different articles to understand the Bayesian filtering technique and I developed a system that is capable to do filtering messages as spam and non-spam. What we need to do on the system is to train once and we are done. After training the filter, it becomes capable of filtering spam with high accuracy as shown in the evaluation section.

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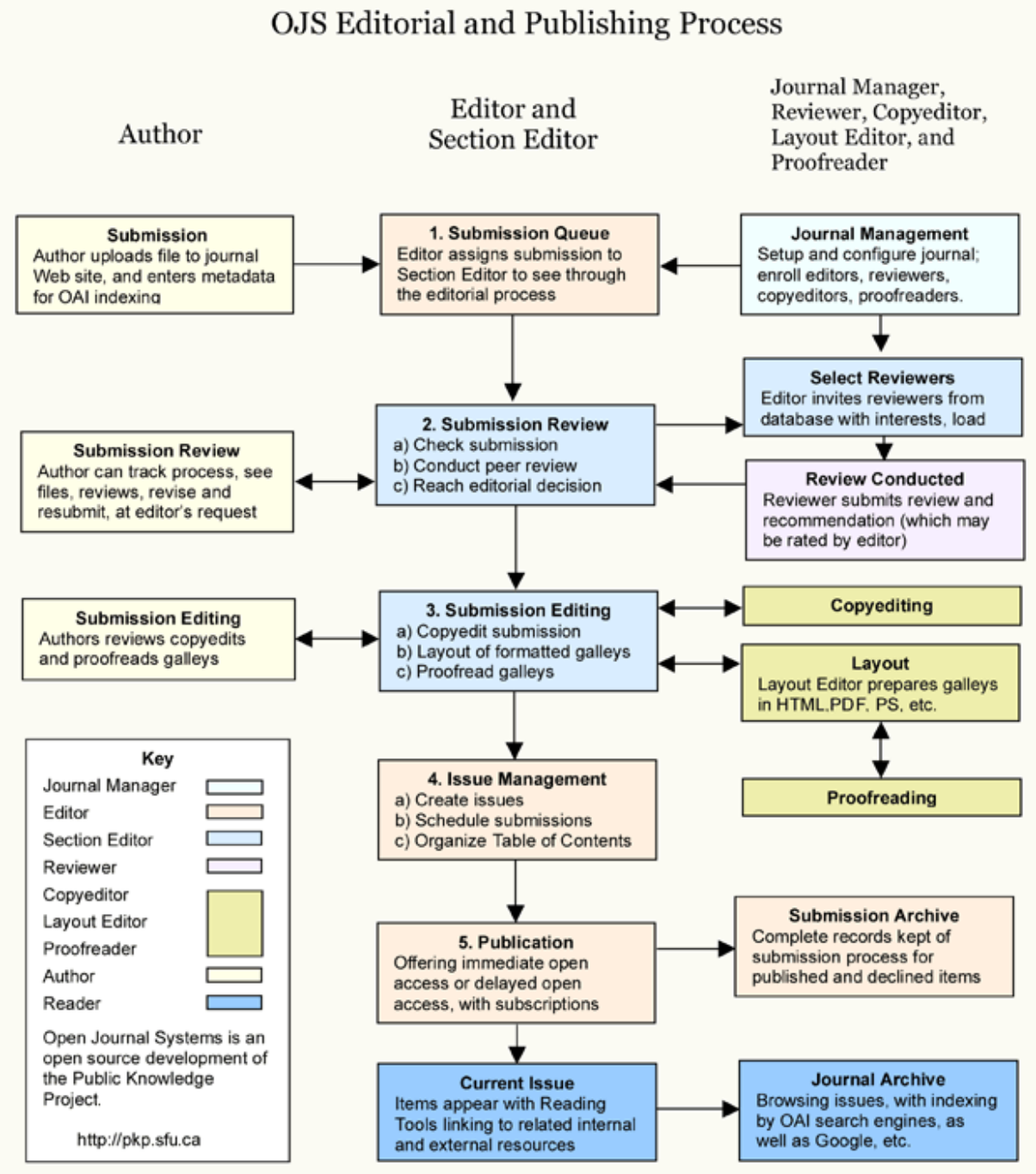


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