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FOREWORD

I am pleased to put into the hands of readers Volume-8; Issue-6: 2021 (June, 2021) of **"International Journal of Advanced Engineering Research and Science (IJAERS) (ISSN: 2349-6495(P) | 2456-1908(O)",** an international journal which publishes peer-reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers. Now journal has also been indexed in **Qualis (Interdisciplinary Area) (Brazilian system for the evaluation of periodicals, maintained by CAPES).**

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

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

With warm regards.

Dr. Swapnesh Taterh
Editor-in-Chief
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Viability of *Bacillus subtilis* immobilization using silica gel for self-healing of cement based materials

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Abstract— *Cracks in concrete's structure may lead it to lose some properties, such as compressive strength. The use of self-healing concretes by the addition of bacteria is a way of sealing these cracks. In this work, 10^5 cells/ml of Bacillus subtilis showed favorable to this application. In the analysis of Dispersive Energy Spectroscopy coupled to Scanning Electron Microscopy, the Bacillus subtilis bacteria showed $CaCO_3$ precipitants in mortars samples. By means of the analysis of optical microscopy, the closure of 0.4 mm induced crack was severe observed during 168 days. Furthermore, an increase in compressive strength was observed by the immobilization of Bacillus subtilis on silica gel, by the addition of only silica and only to the bacterium.*

I. INTRODUCTION

The second most consumed material worldwide is concrete, losing only to water. It is also the most used material in civil construction, which implies in its high consumption and, consequently, in an increase in the consumption of its components, such as cement (Instituto Brasileiro do Concreto, 2009). The durability of concrete is highly related to its permeability, which can provide an easy path for the ingress of potentially harmful liquids and gases that, consequently, causes loss of mechanical properties (Xu & Yao, 2014).

The risk of accidents caused by concrete degradation is recurrent. There are records of several landslides, such as a bridge in Genoa, Italy (2018) and viaducts in São Paulo (2009), Belo Horizonte (2014), Fortaleza (2016) and Brasília (2018). Data indicate that one in five bridges or viaducts needs renovation (Gomes, 2018).

In addition to this concern, there is also the economic issue. In the work of Medeiros, Andrade & Helene (2011), expenses with maintenance of concrete are presented in developed countries and it can be seen that the cost of repairing these structures is equivalent to the cost for a new construction. Furthermore, it can be impossible to repair affected structures that are in continuous service, such as tunnels and highways (Xu & Yao, 2014).

One way to protect the concrete against this deterioration and increase its durability is to seal cracks and pores that allow degrading elements to enter the material. Nowadays, a wide variety of products are available to provide this protection, among which are: types of coverings, water repellents and pore blockers. However, these means have some disadvantages, such as a difference in the coefficient of thermal expansion, degradation over time, cost for constant maintenance, and these materials may contain solvents that contribute to environmental pollution (Muynck, Cox, Belie & Verstraete, 2008). The use of self-healing concrete is environmentally friendly and prevents future repairs (Huynh, Imamoto & Kiyohara, 2019). This concrete can be made by incorporating calcium carbonate precipitating bacteria ($CaCO_3$) into its structure. This

precipitation is capable of closing cracks, decreasing the porosity of the material and being able to increase its compressive strength (Wang, Soens, Verstraete & Belie, 2014). Some types of bacteria can be added in different ways to the concrete and one of them involves its immobilization on silica gel, which protects the bacteria from the highly alkaline pH and from cement hydration (Wang, Tittelboom, Belie & Verstraete, 2012).

This article aims to analyze the self-healing of cracks, by $CaCO_3$ precipitation, in cementitious materials containing the bacteria Bacillus subtilis immobilized by silica gel, the immobilization of the Bacillus subtilis after the addition of silica to the mortars and the influence of these addition in the compressive strength property.

II. MATERIALS AND METHOD

The methodology used in the study is illustrated in Fig. 1. Each step will be discussed and further detailed below.
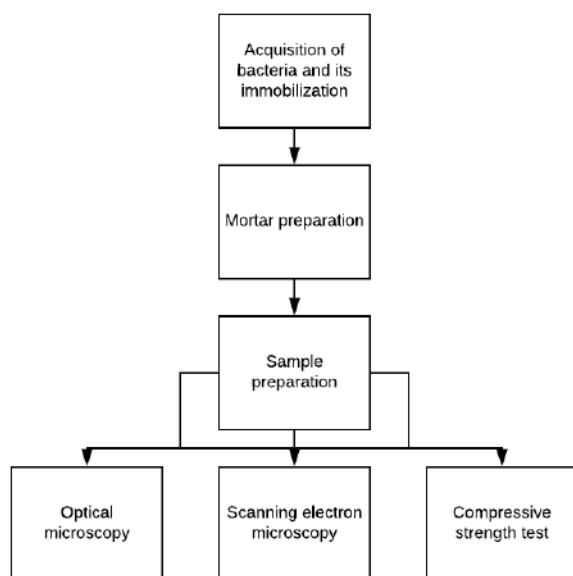
Fig. 1: Work methodology flowchart

2.1 Acquisition of bacteria and its immobilization

The bacterium Bacillus subtilis was supplied in association with State University of Londrina. The concentration used was 105 cells/mL in a saline solution.

For the growth of the bacteria that made up the mortar, they were inoculated in the LB (Luria-Bertani) culture medium, according to the parameters presented by Schwantes-Cezario, Nogueira & Toralles (2017).

To immobilize the bacteria, silica gel used was Aerosil® 200 from Evonik.

To prepare the silica gel for the immobilization, a mixture of 30 g of silica powder with 100 mL of water was prepared, as indicated in Tittelboom, Belie, Muynck & Verstraete's (2010) research. In order to verify the bacteria immobilization on silica gel, images were taken on Physis stereoscope.

2.2 Mortars preparation

Due to the fact that the mortar and concrete have similar compositions and the practical use of the mortar, the samples were made of this material. Quartz river sand, Portland cement of high initial strength (CP V – ARI, Brazilian denomination) and PVC molds were used to make the samples.

The mortar was composed of a cement-to-sand ratio of 1:3 (by weight) and a water-to-cement ratio of 0.50. Bacteria without immobilization and immobilized on silica gel were added during mixing mortar.

To check the quantity of materials used, calculations were performed relating the volume of the specimens to the mix proportion, using a mortar density value of 2.4 g.cm-³.

To prepare the mortars, four different mixes were made. Their compositions and names are shown in Table 1.

2.3 Sample preparation

The molds used were cut from a four-meter PVC pipe. The cuts were made by a bench saw by the company FUNDISA. Thirty-two molds were molded with dimensions of 50 mm in diameter and 100 mm in height. Eight specimens were produced for each composition. These samples were used for compressive strength tests.

For the first composition (C + S), the cement and sand were mixed, then, the water was added gradually. To receive the mixture, the molds of all compositions received an application of release agent.

Table.1: Mortars preparation – Compositions and nomenclature

Composition	Nomenclature	Cement (g)	Sand (g)	Water (mL)	Water (mL) with Silica gel	Water (mL) with Bacteria	Bacteria (cells/mL)
Cement, sand and water	C + S	942.48	2827.44	471.24	-	-	-
Cement, sand, water and silica gel	C + S + SG	942.48	2827.44	421.24	50	-	-
Cement, sand, water and bacteria	C + S + B	942.48	2827.44	-	-	471.24	1×10^5
Cement, sand, water, bacteria and silica gel	C + S + B + SG	942.48	2827.44	371.24	50	50	1×10^5

To mold the specimens, the NBR 7215 (Brazilian standard) was adapted: Portland cement - Determination of the compressive strength (ABNT, 1997). The placement of the mortar in the mold was made with the help of the spatula, in four layers of approximately equal height, each layer receiving 30 uniform strokes with the socket, homogeneously distributed. Finally, the top of the specimen was scraped.

For the second composition (C + S + SG), the same procedure was performed in relation to cement and sand. For the formation of silica gel, 10 ml of deionized water with 1.2 g of sodium chloride were added to 40 ml of the previously prepared solution and this mixture was taken to a magnetic mixer until the consistency was similar to a gel. The gel was placed after these materials. For molding, compaction followed the procedure described in NBR 7215/1997 (ABNT, 1997).

For the third composition (C + S + B), the amount of bacteria of 105 cells/mL was placed in the water that had been separated into the mixture, with an addition of 0.85% sodium chloride, to maintain the medium isotonic for the bacteria.

Afterwards, the molding followed the same procedure as the other two mortars.

For the fourth composition (C + S + B + SG), the amount of bacteria of 105 cells / ml and 0.85% sodium chloride were placed in the separate water for this composition. The procedure used in the preparation of silica gel in composition C + S + SG was repeated, but 50 ml of the water with bacteria was added to the solution.

A small sample of the water with bacteria was analyzed on the PHYSIS stereoscope to check if the immobilization in silica gel has happened.

At the end of each impression, a piece of film paper was placed over the sample so that water would not evaporate and cause porosity.

Twenty-four hours after the completion of the moldings, the specimens were placed in four buckets (one for each composition) containing water saturated with calcium oxide and remained this way until the test ages.

2.4 Optical microscopy

To perform the crack analysis, four samples were made with a crack in each one. A CAP was cut to serve as a template and the height obtained was approximately 2 cm. With the help of a spatula, a certain amount of the composition was placed and a few strokes were made with the socket until the mold was filled. Galvanized plates measuring 2 cm x 2 cm with a thickness of 0.43 mm were used to generate the crack in the mortar. The same procedure was performed for the four compositions.

The crack analysis was carried out on an optical microscope with attached camera Axio Scope.A1 at the ages of 2, 14, 28 and 168 days.

2.5 Scanning Electron Microscopy

Scanning Electron Microscopy (SEM) was performed at the Electron Microscopy and Micro Analysis Laboratory - LMEN, of the State University of Londrina, using the FEI Quanta 200 Microscope.

The samples for the analysis were taken from the compressive strength test performed on the seventh day of cure. The samples were then kept in water saturated with calcium oxide until they were taken to the laboratory (in order to be analyzed at the twenty-eighth day of cure) to be covered with gold. The sample size was approximately 0.5 cm x 0.5 cm x 0.5 cm.

2.6 Compressive Strength

The compressive strength test was carried out according to the NBR 7215 standard: Portland cement - Determination of compressive strength (Brazilian Standard), with the exception of the mold material and capping. The specimens were broken at the ages of 7 and 28 days, in the universal testing equipment, model WDW-100E. To smooth the surface, a piece of neoprene was used. Thus, there was a better distribution of the load application. Such application was carried out with a speed of 0.5 kN/s and a preload of 0.3 kN. For each composition, four specimens were tested at each age of analysis.

III.   RESULTS AND DISCUSSION

In order to verify whether the bacterium was immobilized on silica gel, the image taken on the Physis stereoscope was observed in Fig. 2.

It is known that it is possible to identify the spores in a stereoscope by bright points (Figueiredo, Pedro & Barroso, 1989). In the center and on the left side of the photo, it's seen two clusters of material that appear to form a network. This characteristic is the same that silica obtains when it becomes silica gel. Within these clusters, it is possible to observe bright spots, which may be the spores. It is possible that the silica gel was not yet fully formed and that is why you can see a bright spot without being involved in this material at the top of the image. In Fig. 2, bacteria are pointed out by arrows and silica gel by asterisks.

From this analysis, it is likely that the bacterium was immobilized by silica gel upon contact with the same.

3.1 Optical microscopy

In Fig. 3, it's seen the images taken from the cracks at 2, 14, 28 and 168 days after molding. A comparison is made between the cracks in the same composition.

In compositions C + S and C + S + SG, no crack closure was observed over the days, while in compositions
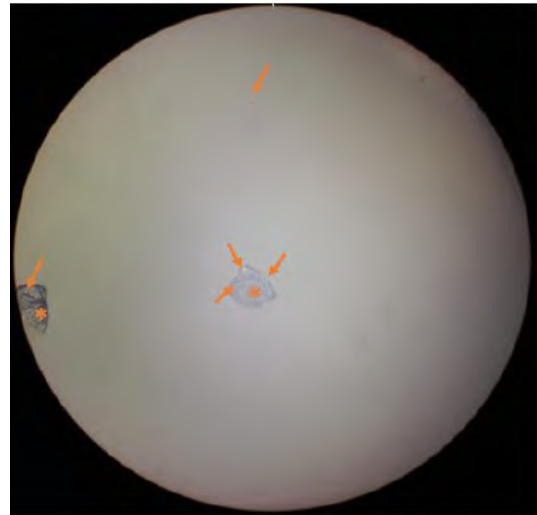
Fig. 2: Bacteria immobilized on silica gel. Bacteria are pointed out by arrows and the silica gel by an asterisk

C + S + B and C + S + B + SG, partial crack closure occurs at 14 days and certain regions close almost completely at 28 days. At 168 days, it can be seen that more regions have been closed and this may be an indication that, over time, the closure of cracks is increasingly greater.

Compositions C + S + B and C + S + B + SG contain $CaCO_3$ precipitating bacteria, which is probably why the fissure is being closed over the days.

Other researchers studied the healing of cracks by the addiction of bacteria.

Wang, Soens, Verstraete & Belie (2014) verified the incorporation of B. sphaericus spores microencapsulated by a polycondensation reaction over 8 weeks. In the bacterial series, the cracks healed from 48% to 80%, but the fissures weren't totally closed.

Rong et al. (2020) studied the effect of addiction of B. pasteurii, a type of urease-producing bacteria, on the self-healing of cement mortar. The most significant crack healing was verified at the end of 50 days and for cracks with a width of 0.2 – 0.3 mm.

In the studies of Luo, Qian & Li (2015), spore-forming alkali-resistant bacteria were used to analyze the factors affecting its crack repairing capacity. They verified that when the crack of age was more than 60 days, the crack healing ratio was very small, despite of this study in which the crack repair was significant noticed over the 168 days. After 100 days, bacteria alkalinitrilicus impregnated in expanded clay with a culture medium also showed favorable to healing cracks in the studies of Wiktor & Jonkers (2011).
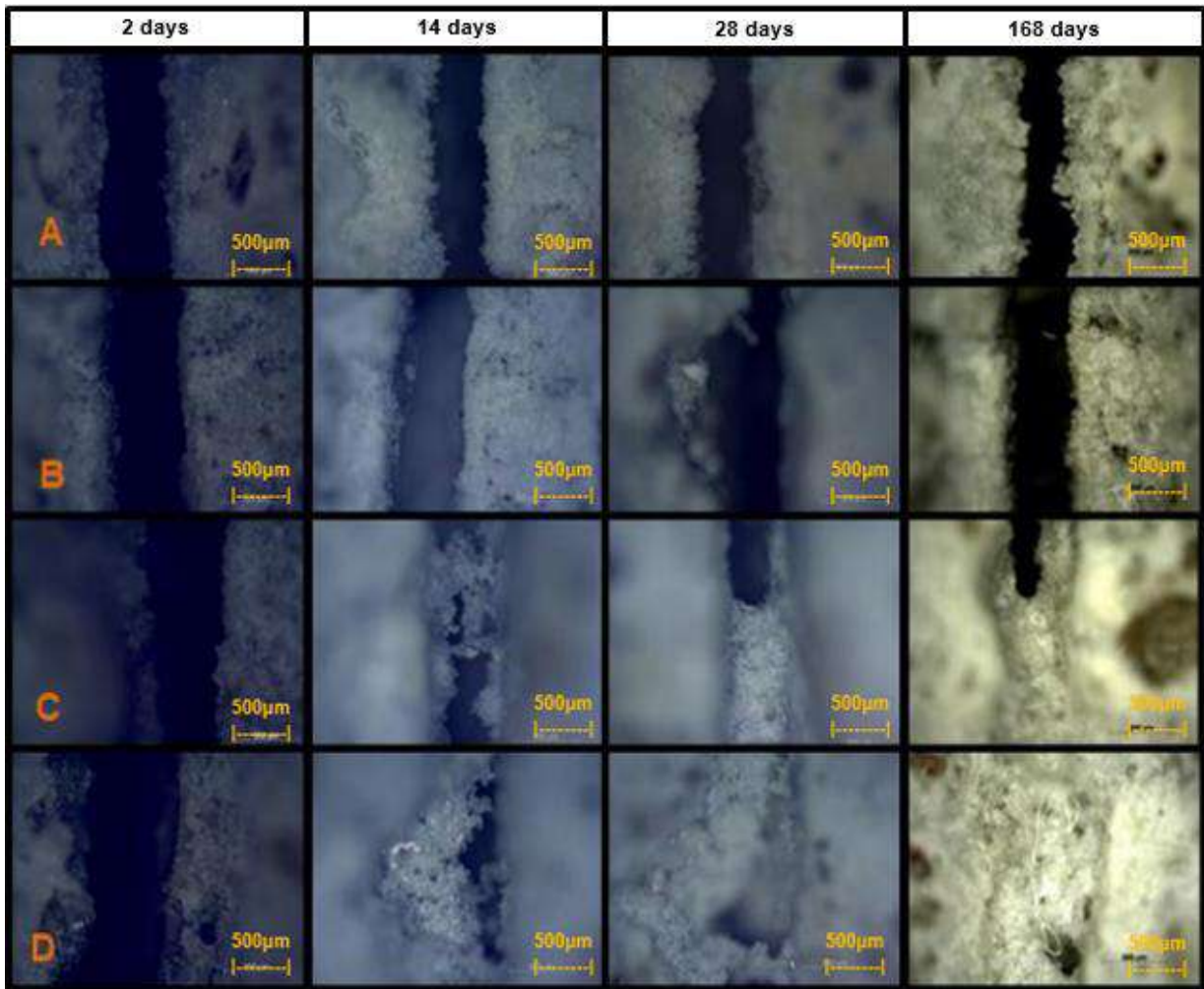
Fig. 3: Monitoring of cracks at 2, 14, 28 and 168 days for (A) composition C + S, (B) composition C + S + SG, (C) composition C + S + B and (D) composition C + S + B + SG

Liu, Xu, Lv & Xing (2020) studied the self-healing capacity of B. pasteurii carried by recycled aggregate. It was verified that specimens that were directly introduced bacteria without protective carrier had their cracks slightly decreased at 14 days of healing. However, this decrease wasn't observed at 28 days. The authors attributed that to the difficulty of bacteria to survive in high alkaline environment without protection.

In the addiction of B. subtilis in contact with urea and calcium chloride, Kalhori & Bagherpour (2017) verified the self-healing of cracks after 28 days. As mentioned before, the addition of calcium chloride as a source of calcium can be harmful to concrete's structure. The bacteria B. subtilis addicted without chlorides to mortar in this study also promoted self-healing of cracks at the first seven days of cure.

In reinforced concrete, the structure is protected by a thin oxide layer promoted by the concrete alkalinity. That layer can be destroyed by the carbonation of concrete or by the presence of chlorides. The destruction of that layer by chlorides causes pitting corrosion (Ormellese, Berra, Bolzoni, & Pastore, 2006). At the study of Tittelboom, Belie, Muynck & Verstraete (2010), calcium chloride was added with the bacteria immobilized by silica gel and analyzed. The influence of the calcium source is related only to the morphology of the crystals and not to its efficiency, therefore it was suggested alternative calcium sources. Considering the harmfulness of chlorides to the reinforced concrete and its influence limited only to the morphology, in this study there was no use of calcium chloride and the calcium source was limited to the water saturated with calcium oxide and calcium hydroxide from cement hydration reactions. As observed at the studies of Tan et al. (2020), for cementitious composites that do not carbonate prior to cracking, this calcium hydroxide is sufficient to provide an efficient level of healing. Besides that, the production of ammonium is concerning because of its detrimental effects on concrete. That production is

similar to an acid attack and it contributes to calcium hydroxide leaching (Kaur & Mukherjee, 2012).

At Tittelboom, Belie, Muynck & Verstraete's (2010) studies, the bacteria immobilized with silica gel was added to the cracks by the means of a syringe. Although their results can't be compared to the immobilization of bacteria with silica gel during mixing mortar, this mean of addiction was chosen because of its applicability. It would be more functional not to have to fill in the cracks with the bacteria immobilized when repairing a structure.

Thiyagarajan et al. (2016) concluded that the supply of nutrients plays a significant role in the bacterial activity in cement mortar. Alazhari, Sharma, Heath, Coope & Paine (2018) incorporated in mortars B. pseudofirmus encapsulated in expanded perlite with following nutrients: yeast extract and calcium acetate. The healing of cracks occurred after 165 days of analysis. Despite of what was done in this study, the addiction of nutrients may lead to a decrease in compressive strength of the concrete. This fact was observed when Joshi, Goyal & Reddy (2018) studied the effect of nutrient components of media on structural properties of concrete during biocimentation.

3.2 Scanning Electron Microscopy

From the Scanning Electron Microscopy (SEM), performed in the Microscope model FEI Quanta 200, the images of Fig. 4 were obtained. Coupled to the SEM, using the INCA software the performance of Dispersive Energy Spectroscopy (EDS) in certain regions were obtained (Fig. 4).

With the SEM analysis, it was possible to verify, for the first composition (C + S), the presence of one of the cement hydrations forms: the ettringite (needle shape), which is indicated by "ETT" in Fig. 4. In the EDS, the presence of calcium is observed, which is one of the components of cement hydration products and is present in ettringite.

For the second composition (C + S + SG), it is also possible to observe the presence of ettringite (also indicated by arrows), by microscopy and calcium, in the analysis made by EDS.

In the third composition (C + S + B), it is possible to identify $CaCO_3$ precipitation (indicated by "CC", a structure similar to that of vaterite, and also by observing the EDS, it is possible to verify the presence of the elements of calcium carbonate. Ettringite is also observed. Similar morphologies of $CaCO_3$ were seen in previous researches (Daskalakis et al., 2015; Dupraz, Parmentier, Ménez & Guyot, 2009; Ercole, Cacchio, Botta, Centi & Lepidi, 2007; Hammes, Boon, Villiers, Verstraete & Siciliano, 2003; Park, S. J., Park, J. M., Kim & Ghim,

2012). In the study of Muynck, Cox, Belie & Verstraete (2008), the treatment of mortar with bacteria and a calcium source resulted in the presence of a crystalline layer on the surface. The X-Ray Diffraction Spectroscopy results of that study indicated the presence of calcite and vaterite. The last one was related to the spherical particles.

In the fourth composition (C + S + B + SG), $CaCO_3$ precipitation is also observed, whose elements are also present in the EDS analysis. However, Ettringite is not seen in the analyzed region. In Fig. 4 (D), it's possible to see that the particles have a regular cubic shape and are homogenously distributed. Wang, Tittelboom, Belie & Verstraete (2012) studied the addiction of B. sphaericus (grown in a medium of yeast extract and urea) immobilized into silica gel and into polyurethane. In their study, the $CaCO_3$ particles from immobilized silica gel also had regular cubic shape, while the particles from polyurethane immobilization showed an irregular block shape. Observing another region in the same sample, another hydration product can be observed: CSH (hydrated calcium silicate). The presence of silica in this composition may have been a factor that influenced this structure. The CSH (indicated by "CSH") can be observed in the SEM of the fourth composition, for an increase of 4000 times, in Fig. 5.

3.3 Compressive Strength test

The data obtained for the compressive strength on the seventh and twenty-eighth day are shown in Fig. 6, as well as the average between the four specimens of each composition, the standard deviation and their error. According to some studies (Park, S. J., Park, J. M., Kim & Ghim, 2012; Pei, Liu, Wang & Yang, 2013; Schwantes-Cezario, Nogueira & Toralles, 2017), the compressive strength values obtained were between 20 and 65 MPa.

Lower compressive strength values (between 7 MPa and 10 MPa) than those of the references were expected due to the conditions of sample preparation and testing. To perform the analysis of the compressive strength graph, there are some factors common to all very important compositions to consider. The first is the surface of the specimens that were tested. Its irregularity does not allow a uniform load to be applied and this can significantly influence the compressive strength values. Small irregularities in the surface are enough to reduce the final strength. In order to minimize this problem, it is recommended to cover the bases of the specimens with a thin layer (less than 3 mm) of appropriate material, that is, capping. The most efficient material found is the neoprene pad confined by a metallic base that restricts the lateral deformation of the elastomer (Tres, Balz, Bieger &

Pedrozo, 2018). This material was used in this work, but it was not confined to the metallic base.
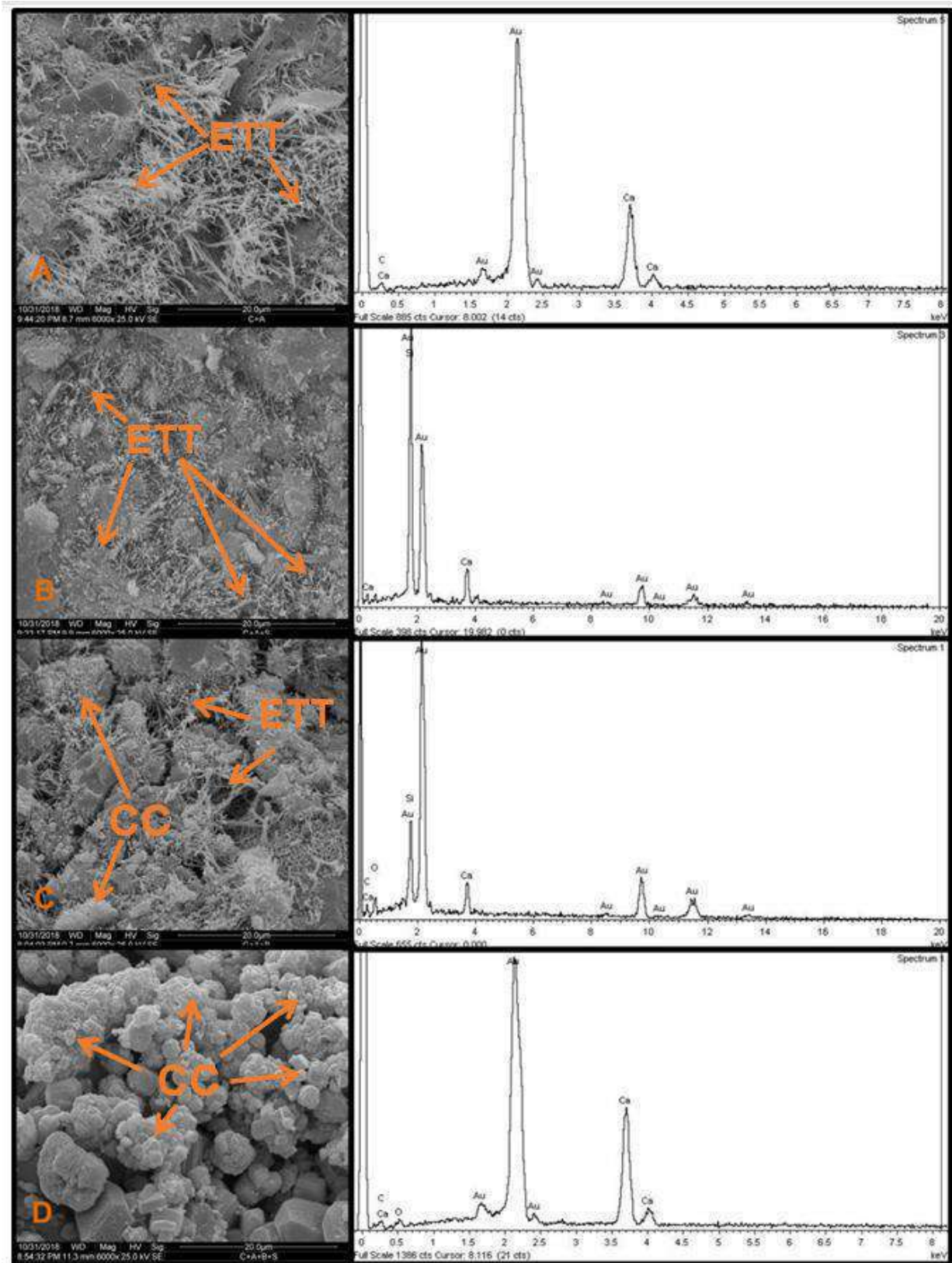
Fig. 4: SEM and EDS of (A) composition C + S, (B) composition C + S + SG, (C) composition C + S + B and (D) composition C + S + B + SG, 20 μm scale, 6000-fold magnification. Ettringite is indicated by "ETT" and CaCO₃ precipitation is indicated by "CC.
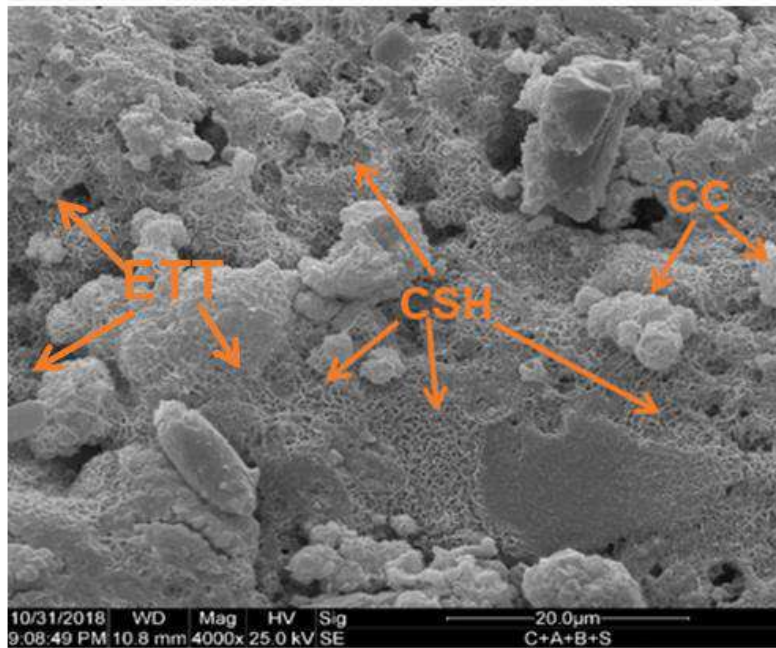
Fig. 5: SEM of the composition C + S + B + SG sample, 20 µm scale. Hydrated calcium silicate is indicated by "CSH" and CaCO₃ precipitation is indicated by "CC"

Other factors that may have influenced were noticed during the molding, which is done manually and consists of applying blows to a certain amount of material. The lack of experience and consistency during molding may have led to a non-standardization of these specimens, varying, for example, in the amount of material that received the blow and in the intensity with which these blows were applied. In addition, the molds were adapted. According to NBR 7215: Portland Cement - Determination of compressive strength (ABNT, 1997), the molds should be made of non-corrosive metal and were made of PVC pipe, due to the high cost. To remove the sample from the mold, it was necessary to cut them with a hand saw and part of the specimens were damaged.

Although the values themselves were lower than expected, there was an increase in the compressive strength values by adding only silica, only bacteria and bacteria immobilized on silica, for the two test ages. When carrying out the 7-day trial, in relation to composition C + S, the increase verified was 3.25% in composition C + S + SG, 11.18% in composition C + S + B and 13.90% in composition C + S + B + SG. Regarding the composition C + S + SG, the increase verified was 10.32% in the composition C + S + B + SG. In their studies, Schwantes-Cezario, Nogueira & Toralles (2017) found an increase of 10% when adding the bacteria to the composition of cement, sand and water. In this study, the increase found was 11.18%.

When carrying out the 28-day test, in relation to composition C + S, the increase verified was 14.22% in composition C + S + SG, 17.40% in composition C + S + B and 25.29% in composition C + S + B + SG. Regarding the composition C + S + SG, the increase verified was 9.69% in the composition C + S + B + SG.

When adding bacteria to the mortar, Park, S. J., Park, J. M., Kim & Ghim (2012) found an increase of 19.5% and Pei, Liu, Wang & Yang (2013), an increase of 15.6%. The increase found in this work was 17.4%.

The compositions that could be compared to the literature brought values of compressive strengths compatible with those already studied.

Regarding the addition of only silica gel and bacteria immobilized on silica gel, there are no comparisons in the literature, as the references used did not use the same methodology as this work and the results are restricted to the conditions in which the study was developed.

The increase verified by the addition of silica gel to the mortar can be explained by Pinheiro (2015). According to her, silica gel may have accelerated the hydration reactions of the cement, increasing its performance. The increase verified by the addition of bacteria to the mortar can be explained by the precipitation of calcium carbonate and, consequently, the closing of cracks and pores in the structural material. The greater increase verified by the simultaneous addition of silica gel and bacteria can be explained by the immobilization of the bacteria in the

silica grid. In this way, bacteria would be protected during cement hydration, acting more efficiently.
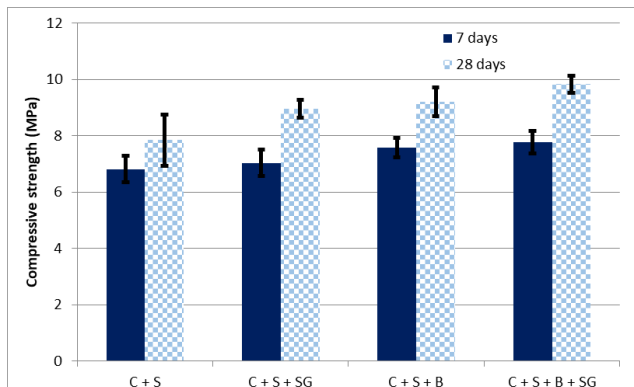
Fig. 6: Results of the compressive strength tests at 7 and 28 days

IV. CONCLUSION

In this study, the viability of B. subtilis immobilization using silica gel for self-healing of cement mortars was analyzed. By the means of the analyzes made from an Optical Microscopy to verify the closure of cracks, the analyzes made by Dispersive Energy Spectroscopy coupled to Scanning Electron Microscopy and the compression tests performed, some conclusions can be made:

• Bacillus subtilis bacteria were found to precipitate CaCO₃ in cementitious materials, which can be observed in the Scanning Electron Microscopy and Dispersive Energy Spectroscopy analyzes.

• The $CaCO_3$ precipitation influenced the 0.4 mm crack closure, which increased with the passing of the days and was verified using the optical microscope with attached camera. It is important to highlight that with the immobilization the complete closure of the crack was observed during the analyzed time.

• The immobilization of Bacillus subtilis bacteria on silica gel was observed, influencing the increase in resistance to compression (13.90% in the 7-day trial and 25.29% in the 28-day trial). This increase was also due to the addition of only silica (3.25% in the 7-day trial and 14.22% in the 28-day trial) and only bacteria (11.18% in the 7-day trial and 17.40% in the trial) 28 days). The highest values of compression resistance are related to the protection of bacteria from the high pH of concrete and from the cement hydration reactions.

ACKNOWLEDGEMENTS

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Study of the Variety of Pathologies Diagnosed by Hysteroscopy understanded between the Years from 2019 to 2020: Case Study

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Abstract— *Abnormal uterine bleeding is a frequent condition that can negatively affect the physical, emotional, sexual and professional aspects of women, reducing their quality of life and can lead to anemia. It is necessary to be aware of when patients have severe and acute bleeding, they need urgent treatment, with volumetric replacement and hemostatic substances. Often, situations arise that require prolonged treatment and others in which surgical treatment is necessary. Called endometrial ablation whose surgical technique is capable of destroying or resecting the endometrium, indicated in cases of abnormal uterine bleeding without improving with clinical treatment or with contraindication to it. It is an alternative to hysterectomy in the treatment of benign pathologies, being less invasive and less aggressive, with less morbidity and mortality and with considerable cost reduction. Objective: This study aims to analyze the main indications and procedures used for the study of varieties of pathologies diagnosed by hysteroscopy performed in service between the years 2019 and 2020. Methodology : This is a bibliographic, qualitative and descriptive review that will be carried out through books, reading and analysis of national and international scientific articles, course completion works through consultations in the electronic databases, Pubmed, Virtual Health Library, including electronic journals specialized in the area. For this, this research was divided into two moments that refer: the bibliographic research and case study, using the data collection technique through the results obtained from the patients' exams. Results: The results attested that the presence of endometrial polyps, followed by the atrophic endometrium, integrated the most frequent histological and hysteroscopic diagnoses. Polyps and functional endometrium prevailed in younger patients, while in older women, polyps and endometrial atrophy predominated, both through hysteroscopy and endometrial histology.*

I. INTRODUCTION

Currently, several studies have proven that the causes of vaginal bleeding from the uterus are diverse , where it can occur at any age, resulting from problems related to anovulation, benign or malignant anatomical lesions, pregnancy or hormonal disorders. In order to diagnose the cause of bleeding, it is necessary to perform tests such as endometrial biopsy, uterine curettage, transvaginal or abdominal ultrasound and hysteroscopy. Abnormal uterine bleeding (SUA) is

called changes in menstruation resulting from increased volume, duration or frequency, negatively affecting the physical, emotional, sexual and professional aspects of women, worsening their quality of life, at reproductive age, in peri and post-menopause and may even cause anemia.

Often, most women, with the exception of those with dysfunctional uterine bleeding, have benign conditions. However, l esões focal intrauterine, especially polyps endometrial and fibroid submucosal are con - ditions common gynecological, affecting 30 and 40% respectively in patients with abnormal uterine bleeding (SVIRSKKY; SMORGICK; ROZOWSK; Sagiv; FEINGOLD; HALPERIN et al. , 2008) .

It is believed that most women do not have the knowledge of the performed method called hysteroscopy, despite being a procedure widely performed in clinics and hospitals. This method is considered effective for the evaluation of the uterine cavity, either in cases of indeterminate bleeding or for the investigation of infertile patients. The hysteroscopy is very important because it detects and locates anatomical lesions such as polyps, fibroids, hyperplasia and carcinoma, and enabling the realization of directed biopsy. Through this, the doctor visualizes the inside of the uterus and the endocervical canal with an instrument called a hysteroscope that is introduced through the vagina and through the cervix.

The reason for choosing the theme becomes relevant and is justified by the researcher's curiosity and deepening in investigating the study of the use of the hysteroscope instrument, to verify with precision and effectiveness on the functioning of the uterus, problems and difficulties faced by women as : recurrent spontaneous abortions; excessive menstrual flow and suspected endometrial cancer and difficulties in getting pregnant, so that the surgical modality can be avoided.

The research becomes relevant, as it brings information and contributions to the specialized medical area, discussing and clarifying abnormal uterine bleeding and the success of the treatment. Informing that in situations of acute and intense bleeding, it is acceptable that the treatment be established, whose objective is to stop the bleeding and stabilize the patient's hemodynamics, delaying the investigation once the bleeding is controlled.

According to Goldstein (2010), he affirms that every symptomatic patient, over the age of 35 years, should be evaluated, or earlier, if he presents risk factors, specifically as: obesity and chronic anovulation. It is noteworthy that the realization of a tra - clinical ment alone is not enough to exclude intrauterine disorders and is

recommended to obtain material for examination endometrial pathology.

Within this view, the problem that will be investigated in this research will be the following: What are the main indications and procedures used for the study of varieties of pathologies diagnosed by hysteroscopy performed in service between the years 2019 and 2020?

R ESPONDING by this *study ,* as well as some of the *hypotheses* as possible support to the problem raised, it is believed that abnormal uterine bleeding encompasses a number of diseases and female hormonal changes, it is suggested to perform an assessment to detect the accuracy of ultrasound imaging transvaginal to diagnose possible intrauterine lesions, where hysteroscopy can become a reference standard and, therefore, it is believed that hysteroscopy is a non-invasive exam, requires training, considered low cost, easy access to the population, being a standard gold for the evaluation of the endometrial cavity.

The aim of obtaining answers to this question led to the formulation of the following general objective: To analyze the main pathologies and procedures used for the study of varieties diagnosed by hysteroscopy performed in service between the years 2019 and 2020. From this investigation, the specific objectives that this study was dedicated to: Describe the origin and historicity   of outpatient diagnostic hysteroscopy ; c ompreender the doprocedimento importance of hysteroscopy in women's health, talk about uterine intracavitary injury to pontar the indications and contraindications to perform the examination hysteroscopy; and finally, to analyze the pathological conditions diagnosed in service during the years 2019 and 2020; provide information to the population and the health team, especially the medical profession, about the importance of performing a hysteroscopic examination, in cases where a complementary diagnosis is necessary.

To this end, a survey of the bibliography of the publication of the last five (5) years was carried out **,** followed by a case study carried out through the evaluation of a diagnostic test in patients seen at the researcher's clinic, between the years 2019 and 2020, so that there would be a deepening until the dissertation was written. Among the various publications, those in Portuguese and English will be selected, internet articles that included in treatments or research on the variety of pathologies diagnosed by in-service hysteroscopy. Studies that do not deal with pathologies or that have low methodological quality will be excluded.

II.   THEORETICAL FRAMEWORKS

2.1 ORIGIN OF AMBULATORIAL DIAGNOSTIC HISTEROSCOPY

The first hysteroscopy was performed by Pantaleoni in 1865. He used a cystoscope that he had invented four years ago by Desormaux in Paris, and that the source of light was called alcohol. Panteloni in 1869 managed to isolate a polypoid lesion in a woman who was 60 years old and had postmenopausal bleeding, after which she cauterized the lesion with silver nitrate (MENGAGLIA; NETO, 2002).

Pantaleoni (1865) dilated the cervix in the 24-hour period with laminaria. In 1879, through the invention of the electric lamp by Thomas Edison, there were improvements in lighting that were incorporated into stethoscopes in the year 1898. In 1914, Heineberg (1890) experimented with the distension of the uterine cavity with water, to improve the visualization of the cavity and to cool the heat caused by the light source.

In 1925 Rubin introduced carbon dioxide (CO_2) as a form of distension, but several patients had pneumoperitoneum complications and the technique was abandoned. In 1934 Shoeder was responsible for developing a 10 mm endoscope with an optical system with the possibility of three-dimensional vision. In 1952, Forestier, Glandu and Vulmiere used cold light for the first time. It took place in 1957 Palmer reduced the diameter of hysteroscopes to 5mm. Around 1960 Hopkins rearranged the glass lenses so that minimal columns of air were between the longest bars on the glass. In 1970 Lindeman and Porto reintroduced CO_2 as a means of distension. Around 1979 Jacques Hamou invented the modern panoramic hysteroscopy, with thinner hysteroscopes, no longer considering cervical dilation or analgesia as necessary. Jacques Hamou is the father of modern hysteroscopy (MENGAGLIA; NETO, 2002). Diagnostic hysteroscopy does not require speculation or clamping or dilation of the cervix.

According to Mengaglia, Neto (2002) when performing the surgical hysteroscopy, it has the need for anesthesia, dilation of the cervix until Hegar candle No. 9 to perform the introduction of instruments. Hysteroscopiac surgery allows endometrial resection through large quantities in endometrial ablation and myomectomy procedures for submucosal fibroids, in addition to polypectomies, among others. Uses mono or bipolar current resectoscope and works with electrical energy.

Nowadays, led light is used, and the distention of the uterine cavity is usually performed with 0.9% saline from diagnostic hysteroscopies. The cervix has sympathetic and parasympathetic nerve endings, which makes it a site of pain when pinched, pulled or stretched. Modern diagnostic hysteroscopy no longer uses a speculum, nor does it clamp the cervix with Pozzi forceps. The technique used in the introduction of the hysteroscope is currently performed with a patient in a gynecological position without the need for anesthesia or sedation of the patient, when the vagina is then obliterated with the left hand, the hysteroscope irrigates the vaginal cavity with saline, the cervix is visualized and enters it under direct vision. When viewing the internal cervical orifice, the hysteroscope is rotated 90 ° and enters the uterine cavity. The internal cervical orifice has a lying oval shape and the hysteroscopes also have this shape, so there is a need for 90º rotation, so that the oval surfaces and fit, and the hysteroscope enters the uterine cavity. After being inside the cavity, in addition to the visualization of the tubular ostia and uterine walls, you can introduce biopsy micro-pieces or even micro-scissors. Diagnostic hysteroscopy is not limited to only analyzing lesions, but also the act of performing procedures such as sectioning synechiae and excision of small polyps, and endometrial biopsy, removing foreign bodies, among other things (BETTOCHI et al, 2002) ..

It is important to remember that the endometrium is devoid of nerve endings and can be used without causing pain, but the myometrium has nerve endings and the internal manipulation of the cavity always tries to avoid deepening any forceps. This technique, described without the use of a speculum, without clamping the cervix, is identified as vaginoscopy or hysteroscopy (BETTOCHI et al, 2002).

Among the endometrial pathologies in which hysteroscopy clearly demonstrates the gold standard of diagnosis, and often create the possibility of all the convenience of seeing and treating, there are endometrial polyps (CLARK, STEVENSON, 2017).

2.1 THE IMPORTANCE OF THE HISTEROSCOPY PROCEDURE IN FEMALE HEALTH

Experts recommend performing hysterosopia for more complex procedures for each complication in the pelvic region. When the transvaginal ultrasound scan procedure is performed, it makes it possible to detect endometrial pathology with high sensitivity, this being the first step to use a diagnosis in the screening of symptomatic postmenopausal women, but an endometrial pathology cannot be completely excluded. In this case, it must be completed by the hysteroscopic evaluation when there is an alteration or atrophy of the thickness of the endometrium, in order to be able to detect the cancer and its precursors at an early stage (MARELLO and BETTOCHI et al., 200 2).

When the woman has a uterine bleed that may appear within a year or after menopause, they need to be properly diagnosed prior to any treatment. Generally, 60% of women who experience postmenopausal bleeding do not see any pathological cause in the genital tract. According to Choo et al. (1995) the sampling of the endometrium presents an atrophic and rarely proliferative endometrium; where endometrial cancers are associated with postmenopausal uterine bleeding as a presenting symptom in 90-95% of cases. For the establishment of a gold standard of diagnosis, endometrial sampling under general anesthesia is confirmed by the endometrial sample .

Research data show that the curettage of the uterine cavity has a false negative rate between 2% and 10% in cases of focal injury. It is necessary that all women who experience postmenopausal hemorrhage should undergo a clinical examination and transvaginal ultrasound examination. When performing such a procedure, the endometrial thickness ultrasound shows a good precision in the distinction between normal and pathological endometrium and, thus, will contribute to the reduction of unnecessary exams in postmenopausal women (EPSTEIN and VALENTIN, 2004).

Emphasizes Garuti et al. (2001) that the procedure performed by hysteroscopy is much more accurate than transvaginal ultrasound due to its specificity being indicated for all patients with endometrial band greater than 4mm in thickness.

According to Garuti et al. (2001), such a procedure allows the direct visualization of the endometrium where it surpasses curettage in making an accurate diagnosis of pathologies in the uterine cavity. Hysteroscopy compared to other invasive methods has a great value in the diagnosis of benign diseases such as fibrocystic endometrial polyps and submucosal fibroids. When referring to oncologically suspicious hysteroscopic images , these should always be followed by endometrial sampling and lesion removal is indicated in all symptomatic patients, even those who may have a defined risk for endometrial cancer.

However, it is realized that hysteroscopy is an important part in the evaluation of S UA in patients postmenopausal, this happens when the uterine bleeding not presented as a final barrier so that you can view the endometrial cavity. When biopsy and direct visualization of the uterine cavity are associated, the cause of postmenopausal bleeding is identified with a high probability (LIBERIS et al., 2010).

Video hysteroscopy, where a thin optical fiber is introduced into the vagina into the uterine canal, transporting a light into the vagina, together with a gas (carbon dioxide) to distend it, being controlled by the automatic hysteroflator that allows protection and safety regarding absorption. of CO_2 by the patient. It is noteworthy that the gas can be replaced by the use of saline as a means of distention, being safer and allowing the performance of hysteroscopic surgery using bipolar electrosurgery in liquid medium ("see and treat" technique). The optics mentioned are inserted in a micro camera taking the image to a monitor allowing the specialist doctor to visualize the cervical canal with greater clarity and to identify the diseases existing in this location. Right after the exam, the patient can return to his normal life by performing his activities. At that moment of the exams, they are recorded, and photographed, and this procedure performed is called diagnostic hysteroscopy (C RISPI et al., 2012).

After examining the exams, if the doctor verifies a more serious illness, he will ask the patient for his hospitalization. So that a Surgical Hysteroscopy can be performed, which this treatment can be performed by the endoscopic route. This type of procedure allows to perform surgery through the cervix, without making any cuts or incisions, being the patient in a hospital environment, hospitalized, at most, 24 hours. Even though it is being performed in the same way as the Diagnostic Hysteroscopy, the Operative Video Hysteroscopy requires hospitalization and anesthesia, as the instruments used have large diameters, that is, more calibrated. This applied method reduces the risk of nosocomial infection and the patient's recovery is very fast (C RISPI et al., 2012).

For Goyal et al. (2015) to hysteroscopy has a percentage of 1% of surgical complications being stated ada for the removal of fibroids, r and taken polyps, removal of adhesions (scars) or septa (congenital disorder), ablation of Endometrium (alternative to hysterectomy) for reduction of bleeding, removal of foreign body, directed biopsy and finally, catheterization / tubal ligation.

2.3 INTRACAVITARY UTERINE INJURIES

Lesions of the mucosa, benign, of endometrial tissue covered by epithelium and of variable content of glands, stroma and blood vessels, are called endometrial polyps. It can affect patients in their menstrual period or post menopause. It is noticed that the great complaint of the patients is due to bleeding, in large irregular quantities or after menopause, which may be correlated with infertility. They are often considered asymptomatic, and for this reason, the actual incidence of endometrial polyps is unknown, some researchers estimate a prevalence of

around 20 to 55% in the female population (DEWAAY et al., 2012; BEM-ARIE et al., 2014).

According to the aforementioned authors, the classic image of the polyp on ultrasound is of solid echogenic structure, containing defined limits, deforming the uterine cavity and the endometrial echo. However, in day-to-day practice, the presence of localized thickening of the endometrial image is frequently found and, in post-menopause, an image of solid formation supplying the entire uterine cavity with small permeated cystic formations.

At hysteroscopy, presenting different shapes and sizes, endometrial polyps occupy practically the entire uterine cavity, being the only or multiple, pedicled or sessile. Because they are located inside the uterine cavity having insertion in the endometrium, they usually never reach the myometrium. It has a pinkish-gray, smooth and shiny surface and, sometimes it is possible to notice the presence of small cysts in the stroma. These do not have abundant superficial vascularization, being possible to visualize. Many scholars claim that the accuracy in the diagnosis of polyps by ultrasound ranges from 65.9% to 88.33%. (CRISPI et al., 2012).

The most common tumors found in the uterus are fibroids, which are nodules of a benign nature, composed of smooth muscle cells and fibrous connective tissues, with an estimated incidence of 50% of necropsy exams. Most women are asymptomatic and, after menopause, the fibroid grows in size and symptoms are rare. Because they are located inside the uterine cavity, they cause continuous bleeding causing infertility (FATEMI et al., 2010; GOYAL et al., 2015).

According to Loverro et al., (1999); Trojano et al., (2018) the endometrium, consists of the inner lining layer of the uterus, constituted by a basal lamina covered by glands and stroma. When the woman is in her reproductive phase, she is influenced by hormones and has a cyclic increase and then a decrease. When the woman enters the post-menopause phase, there is a reduction in estrogenic stimuli, and a non-proliferated endometrium is expected. The studies carried out demonstrated a limit value of thickness of 5 mm, in ultrasound evaluations, portraying safety to evaluate endometrial thickening in the post menopause regarding the possible risk of endometrial cancer, this being the greatest concern of the specialist with regard to the evaluation of the endometrial cavity. .

In the words of Fatemi et al. (2010) endometrial cancer is the malignant neoplasm of the female pelvis most commonly found in women in the United States and being the second most common in Brazil justifying the concern in the diagnostic accuracy for this disease.

When an ultrasound assessment of endometrial thickening is performed, thickness is considered the first value to be obtained. It is noteworthy that in post-menopause, endometriums greater than 5 mm in thickness should be investigated, and thicknesses that exceed 10 mm are related to malignancy. Echogenicity is an important endometrial evaluation, with regularity of the endometrial-myometrial interface and the presence of intracavitary fluid. Generally, when any suspicious footage is recorded, it usually presents large, heterogeneous and irregular echoes, subdivided by the uterine cavity and, occasionally, myometrium (MENCAGLIA and ALBUQUERQUE NETO, 2004).

At hysteroscopy, endometrial thickening consists of whitish material and in compact vessels with pseudopolypoid growth forming. grooves when having contact with the hysteroscope. Further, it is noticed that the cavity is reddish in color with cysts, craters, synechia, in addition to the appearance of hemorrhagic areas and hypertrophic vessels in the superficial path. Sometimes an abnormality is noticed when a striking polypoid aspect is present, expressing cerebroid tissue, which can be varied, with a softened to buttery fibroelastic consistency. The abnormal vascularization consists of vessels of different thickness whose shapes are spiral, being the most relevant aspect to be evaluated when it presents a certain abnormality (MENCAGLIA et al., 2004; DOTTO et al., 2003).

According to Shivalingaiah (2014); Wanderley et al., (2016) the ultrasound accuracy for an assessment of endometrial thickening ranges from 63.2% to 88.33%. Being that the anatomical variations of the uterus usually happen to be diagnosed, the verification of the infertility exam. Such incidence of investigation is usually around 6%; being that in infertile patients, the incidence varies from 14% to 74% It is noteworthy that these values may vary according to the sample and the type of population studied. This group consists of changes in the embryogenesis process (genital or Müller duct malformations). Mainly, when referring to intrauterine anatomical variations, where ultrasonography allows visualization of the cavity duplicity and rudimentary horns.

The procedure used with transvaginal ultrasound has great relevance in the preparation of these variations, presenting a good precision. The 3D image performed by transvaginal ultrasound is considered to provide accurate accuracy for the best examination in the evaluation of septate uterus. Therefore, hysteroscopy is based on the diagnosis of septum visualization, demonstrating the cavity divided into a single tubal orifice, in cases of unicornual cavity (BUTTRAM and GIBBONS, 1979).

Having an endometrium of less than 4 or 5 mm called endometrial atrophy, consisting of the performance of ultrasound in the post menopause, it is considered a very important diagnosis in the evaluation of the uterine cavity. With the endometrium below 4 mm, with no symptoms after ultrasound, a high negative predictive value (99%) for malignant diseases of the uterine body (MENCAGLIA and ALBUQUERQUE NETO, 2004) is shown.

As Mencaglia and Albuquerque (2004) affirm that the compliance for atrophy, by ultrasonography reaches 90%; because when performing hysteroscopy, an atrophic endometrium is represented by the whitish and pale color and the vascularization of the basal lamina of the endometrium is exposed. Uterine synechiae are seen as suspicious on ultrasound because they contain echogenic points in the intimacy of endometrial echo, which can be confused with polyps by less experienced technicians.

Generally, uterine synechiae are the result of infections, where they are classified as mild, moderate or severe, subject to the involvement of connective tissue structures and the extent of involvement of the cavity. When performing hysteroscopy, the evaluation may present a quarter of the affected uterine cavity and with thin adhesions on the wall; moderate, with one to three quarters of the uterine cavity affected, without adherence to the walls and with partial involvement of the ostia and fundus; and severe, when affected by more than three quarters of the cavity, adhered walls, ostia and elevated cavity causing changes (MARCH et al., 1978).

When carrying out an analysis of the relevance of endometrial lesions, the accuracy of the diagnosis is observed, where it is allowed to make an appropriate treatment and thus improve the prognosis. When a wrong diagnosis is made, it leads to an incorrect treatment, increasing morbidity and decreasing the patient's quality of life. The existence of costs and expenses for the patient in the health system. Therefore, an accurate diagnosis is necessary, reducing disorders, risks and costs for the health system (MARCH et al., 1978).

It is noteworthy that, after having presented in detail all the characteristics of each type of lesion to transvaginal ultrasound, its conformity, sensitivity and specificity, are not very clear and defined in the literature.

2.4 HISTEROSCOPY: INDICATIONS AND CONTRAINDICATIONS

2.4.1 Indications

Because it is currently considered by experts as the gold standard in the evaluation of the uterine cavity and diseases that are interrelated with this cavity, hysteroscopy is the most appropriate procedure to be used. This method makes it possible to carry out an evaluation of the uterine cavity, the functioning of the endometrium such as vascularization, thickness, presence or absence of mucus and any sign of infection; being the only one that allows a directed biopsy of suspicious areas or injuries. This method is recommended because it is also possible to treat possible injuries where some advantages classically related to the endoscopic approach have already been mentioned, such as lower morbidity and mortality, reduced hospital stay and lower cost (OSTHOFF L .; SOARES A .; KOCH HA, 2007).

According to the authors the information may be: Abnormal uterine bleeding, infertilidade, diagnóstico of suspected pathologies by other methods , L OCATION of foreign bodies into the uterine cavity

2.4.1 Contraindications

When the patient presents pregnant, you should not perform a hysteroscopy . To be noted the presence of uterine bleeding often and with great abun d Crone which may impair the view through the hysteroscope, and the recent or active infection. It is impossible to perform a safe procedure such as difficulties for biopsies, more frequent bleeding and fragility of the uterine tissues. It is identified as high risk of spreading or agra va ing in an infectious process, this is related to the execution of the procedure. When faced with such situations , each case should be prioritized , always considering the specific characteristics of the patient and also considering the experience of the entire medical team with the referred technique (FREITAS, F .; MENKE, CH; RIVOIRE, WA; PASSOS, E , P 2011).

III.   METHODS

3 .1 TYPE OF STUDY

T rata is a bibliographical research, qualitative and descriptive, which was used in books, reading and analysis of national and international scientific articles, completion of course work through consultation in electronic databases, Pumed, Library Virtual Health, including electronic journals specialized in the area and books , dissertations, scientific articles and also in university libraries with the purpose of structuring the entire textual body of the referred study.

According to Marconi and Lakatos (20 11), descriptive research can be defined as the exposure of a phenomenon as the researcher goes deeper into the research problem.

3 .2 SAMPLE AND SAMPLING CRITERION

From a universe of 188 patients who underwent video hysteroscopy at the clinic, 50 samples were selected that had clinical indication for investigation of the uterine cavity.

The sample is a part that was taken from the universe through which the characteristics of the universe are established or approximated, that is, the sample is a portion of the universe chosen according to some representativeness criterion (VERGARA 2011).

According to Fachin (2013), supported by representative samples, the observer can delimit the universe through sampling. The researcher choosing a sample that most faithfully represents the researched universe, can, through coherence, make analyzes of the population.

3 .3 DATA COLLECTION

The data collection of the 50 patients evaluated was according to age, number of reported pregnancies, hormonal medication in use and hysteroscopy indications. Then, the histopathological diagnoses of the material obtained by biopsy guided by hysteroscopy were evaluated, in order of frequency according to the age group

3 .4 DATA PROCESSING

This research first addressed the qualitative analysis of the data, through content analysis, and later the quantitative analysis through the verification of the results of the examinations performed by hysteroscopy .

According to Gil (2012), in the data analysis process, one can initially reduce, categorize and interpret them before composing the study. Also according to this author, data analysis can be done in two ways: qualitative and quantitative.

According to Marconi and Lakatos (2011), in the content analysis the researcher makes a detailed analysis of the acquired content in order to establish a correlation with the established conjectures.

According to Beuren (2008), content analysis is strongly linked to the objectives of the research project, so the researcher needs a critical sense about the subject in order to support the collected data.

The description of the patients was initially observed according to age, number of referred pregnancies, hormonal medication in use and hysteroscopy indications. Then. The histopathological diagnoses of the material obtained by hysteroscopic-oriented biopsy were evaluated, in order of frequency according to the age group.

After categorizing the data, based on the answers to the detailed studies and the examinations performed, it was possible for the researcher to interpret, categorize and quantify the results obtained.

All documentation of hysteroscopic findings was performed through records by written and individual operative reports and through color photos (four exposures per patient).

IV.   RESULTS

The results attested that of the 50 patients analyzed, 53 pathologies were obtained, as some patients in the exam had more than one diagnosis, but the women attended were discharged up to 24 hours after the procedure.

The frequent hysteroscopic and anatomopathological findings in some patients attested that the endometrial cavity had a large amount of hematic content inside it, with the removal of clots, and foci of diffuse acute endometritis were observed.

It was found through the videohysteroscopy report of a 67-year-old patient, with the atrophied pelvic canal, whose endometrial cavity is bulky, the polyp with fibrocystic characteristic in the posterior wall occupying 2/3 of the cavity, the atrophic endometrium with a thickness of 2mm , and the left tubal ostium was not seen, the right tubal ostium was visible and showed no abnormalities. As an auxiliary procedure, a biopsy of the material was performed.

In order to evaluate the association of the main endometrial findings found such as: normal endometrium, endometrial polyp, submucosal fibroid, endometrial hyperplasia, carcinoma, atrophic endometrium and dysfunctional pathology and the variables: oral contraceptive, parity, hormone replacement therapy, obesity, hypertension systemic arterial disease and diabetes mellitus, the statistical method of Multiple Correspondence Analysis was used. After performing this analysis, the findings of submucosal myoma and endometrial carcinoma were eliminated because they belong to groups with low numerical representativeness (1 1 and 3 cases, respectively). For the same reason, 14 cases out of the total (50) were limited because they belong to the group of association of findings (others).

V.   DISCUSSIONS

Data on age, endometrial cavity, endometrium, right tubal ostium, left tubal ostium and procedure used were recorded. After performing the diagnostic

hysteroscopy method completed in patients, it was possible to verify that all uterine anomalies which may negatively affect the receptivity of the endometrium and implantation. Upon becoming aware of this information, it was necessary to direct and carry out the appropriate treatment.

According to Lopes (2015), this method assesses *the* uterine cavity and definitively diagnoses the treatment of the pathology found, which is affecting female fertility, making it a painless, fast and free of complications procedure. Hysteroscopy is considered an accurate method to assess and treat uterine disease by improving conception rates in shorter periods of time.

It was evident that when performing hysteroscopic treatment of submucosal fibroids in some patients, they increased considerably, pregnancy rates in patients undergoing medically assisted procreation (PMA), where it was recommended to treat these fibroids with complete hysteroscopic resection in order to achieve a pregnancy. The growth caused by smooth muscle tissue and containing a variable component of connective tissue is called uterine fibroids (YELA DA, HIDALGO SR, PEREIRA KCHM, GABIATTI JRE, MONTEIRO IMU, 2011).

It was found that the adhesions showed present in 0.3% to 14% of infertile patients and may be associated with infertility due to obstruction of the orifices tubári the or a mechanical obstruction of the cervical canal. It may also be due to abortions that may have impaired the implantation and development of the placenta.

It is noteworthy that the final outcome of hysteroscopy diag - nóstica performed on patients is the sum of the endoscopic examination with the result of the pathological examination of endometrial biopsy.

Finally, ratings of 50 patients were performed with hysteroscopy followed by biópsi the hysteroscopic endometrial with caliper and compared to the compliance of endometrial biopsy blindly with the hysteroscopy for intrauterine lesions. There was no material considered insufficient, even though the material obtained by directed biopsy.

VI.   CONCLUSION

The general objective of this research was to analyze the main pathologies and procedures used for the study of varieties diagnosed by hysteroscopy performed in service between the years 2019 and 2020. As a research question: What are the main indications and procedures used for the study of varieties of pathologies diagnosed by hysteroscopy performed in service between the years 2019 and 2020?

As an answer to the proposed question and to the research objective, it is understood that a study demonstrated the pathologies diagnosed by hysteroscopy, the presence of endometrial polyps was found, followed by endomeritis and integrated the most frequent hysteroscopic diagnoses.

The study showed a high anatomo-endoscopic correlation for endometrial polyps, atrophic endometrium, submucosal fibroids and, however, low for endometrial hyperplasias. Therefore, it is not possible to affirm the existence of an association pattern in the studied sample, between the endometrial findings and the researched variables.

It is worth mentioning the existence of several therapeutic options available in the treatment of abnormal uterine bleeding, which must be used in a rational way so that their control can be allowed, and surgical procedures can be reserved for more specific situations, and thus avoid unnecessary surgical procedures .

Finally, it is perceived that hysteroscopy is a technological and scientific advance, both for diagnosis and for surgical treatment, which is essential nowadays.

For future research, it suggests detailed studies so that the expansion of knowledge in this area can happen, where more equipment with smaller and smaller diameters may appear, allowing less invasive and precise procedures, thus improving patient care and satisfaction.

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The work of art: appreciated on the perspective of psicanalise

A obra de arte: apreciada sobre a ótica da psicanalise

La obra de arte: apreciada en la perspectiva de la psicanalise

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Abstract— The intertwining between art and psychoanalysis began as soon as Freud elaborated his conception of the unconscious. It is a question of saying that the relationship was not bilateral. Contemporary artists to Freud found "in him" a way of dialogue, but the psychoanalyst did not have the same vision. He was fond of classical arts and sought not to issue opinions about the art of his time.

Resumo— O entrelaçamento entre a arte e a psicanálise começou tão logo Freud elaborou sua concepção acerca do inconsciente. Trata-se, aqui, de dizer que a relação não foi bilateral. Os artistas contemporâneos á Freud encontraram "nele" uma maneira de dialogar, mas o psicanalista não tinha a mesma visão. Era apreciador de artes clássicas e procurava não emitir opiniões sobre a arte de seu tempo.

Palavra Chave— Ciências Humanas; Inconsciente; Arte.

Resumen— El entrelazamiento entre el arte y el psicoanálisis comenzó tan pronto como Freud elaboró su concepción del inconsciente. Se trata de decir que la relación no era bilateral. Los artistas contemporáneos de Freud encontraron "en él" una forma de diálogo, pero el psicoanalista no tenía la misma visión. Le gustaban las artes clásicas y trataba de no emitir opiniones sobre el arte de su tiempo.

Palabra Clave— Humanidades; Inconsciente; arte.

Sigmund Freud sempre foi um investigador da mente humana e procurou estudá-la profundamente durante a sua vida. Sem dar-se conta, suas pesquisas ajudaram a formatar uma das manifestações artísticas mais fecundas do início do século XX. Mas, você sabia, caro estudante, que ele mesmo não gostava desse tipo de arte? Para ele, a

arte que merece ser elevada à categoria de obra de arte é a clássica. Resulta daí o fato de Freud não se referir, praticamente, à arte feita por seus contemporâneos, preferindo escrever e analisar alguns artistas cujas obras foram feitas alguns séculos antes. Leonardo da Vinci foi um deles. Veremos isso mais à frente.

Freud foi um colecionador de antiguidades e apreciador de obras clássicas. Com seus estudos, o mundo viu o homem descer de seu "pedestal", de ser o centro, de ser uno, para tornar-se fragmentado, perdendo a estabilidade e precisando de novos conceitos e novas formas de representação. Sua descoberta do conceito de inconsciente trouxe isso à tona. Essa revolução na maneira de ver e tratar o sujeito serviu de alicerce para que um novo tipo de arte ganhasse bases teóricas para se desenvolver.

Por algumas vezes, neste artigo, você encontrará o termo inconsciente. Freud o concebe de algumas diferentes formas, conforme a evolução da sua teoria. Já o psicanalista Lacan tem outra concepção, diferente das proposições de Freud. Grosso modo, podemos dizer, para simplificar, que inconsciente é a "parte mais profunda da estrutura mental humana, em que se dão processos psíquicos, impulsos e desejos, que escapam à consciência, porque estão censurados ou reprimidos. O inconsciente pode encerrar impulsos e desejos que nunca foram conscientes, isto é, nunca foram percebidos pela pessoa, ou então que, tendo chegado ao nível consciente c em algum momento, foram censurados e voltaram ao inconsciente. Do conflito entre esses impulsos e a repressão que a consciência exerce sobre eles é que nascem as neuroses e as psicoses". em algum momento, foram censurados e voltaram ao inconsciente. Do conflito entre esses impulsos e a repressão que a consciência exerce sobre eles é que nascem as neuroses e as psicoses".

O mundo estava em movimento e se transformando, principalmente a partir da Primeira Guerra Mundial. Com o aparecimento da fotografia, com as descobertas Freud foi um colecionador de antiguidades e apreciador de obras clássicas. Arte pela Psicanálise do impressionismo, com a revolução cezanniana do espaço visual, que quebrou as leis da perspectiva, novas expressões artísticas surgiram. Nesse sentido,

> em nome de um novo cânone estético, que se afirma por uma negação virulenta de todos os vigentes e pela busca de uma expressão revolucionária que irromperia do inconsciente, alguns artistas se aproximarão das ideias de Freud. (RIVERA, 2005, p. 8).

Assim, a arte surrealista não nasce da psicanálise, mas encontra nela um material teórico fértil para alçar voos mais altos. Nesse novo tipo de arte, há uma negação de tudo o que é racional e uma valorização do racional, do espontâneo e da livre expressão. Alguns artistas anteriores já haviam já haviam se desvencilhado da arte acadêmica europeia ou das grandes escolas de arte, como, por exemplo, Picasso, que se aproximou da arte africana. Outros se aproximaram da arte dos loucos. É nesta perspectiva que Rivera (2005, p. 11) escreve: "a busca de uma pureza artística, de se retomar a arte em suas origens – ingênuas, loucas ou primitivas – integra em seu ideal revolucionário a noção de inconsciente [...]" Essa noção de inconsciente faria oposição ao intencional, ao racional, "e permitiria, portanto, uma irradiação de imagens supostamente livres das amarras das convenções e exigências estéticas." (RIVERA, 2005, p. 11).

Vários foram os artistas que se inspiraram nas teorias freudianas. André Breton, um dos grandes nomes da arte moderna, por exemplo, no texto Que é surrealismo?, de 1934, fala do parentesco entre psicanálise e surrealismo:

> [...] Baseada nessas descobertas [de Freud], desenha-se enfim uma corrente de opinião a favor da qual o explorador da mente humana poderá levar mais longe suas investigações, já que estará autorizado a levar em conta não apenas as realidades sumárias. A imaginação está talvez na iminência de retomar os seus direitos. Se as profundezas do nosso espírito ocultam forças estranhas, capazes de aumentar as da superfície ou de lutar vitoriosamente contra elas, é de todo interesse captá-las, captá-las primeiro, para em seguida submetê-las, se possível, ao controle da nossa razão. Os próprios analistas só têm a ganhar com isso. Mas é importante observar que nenhum meio é designado a priori para a conduta dessa empresa; que, até segunda ordem, ela pode passar por ser tanto do domínio dos poetas como dos cientistas; e que seu sucesso não depende dos caminhos mais ou menos caprichosos que serão seguidos. (BRETON, 1999, p. 418-9).

> Contudo, Freud não aceitou as criações artísticas a partir da

psicanálise. Na verdade, Freud dizia que não compreendia a arte moderna. Nesse tocante, o psicanalista não acreditava haver possibilidade de uma conjunção entre o surrealismo e a psicanálise. Chegou a dizer, em frente à obra Metamorfose de Narciso, de Salvador Dalí, que, na pintura clássica, procurava pelo inconsciente e, na moderna, o consciente. Isso foi um grande choque para os pintores surrealistas.

Isso nos permite dizer que a psicanálise significou muito mais para o surrealismo do que as obras de arte surrealistas para a psicanálise, ao menos para Freud. Isso já não aconteceu com Lacan que, primeiro, teve contato com a pintura surrealista e, depois, com as teorias freudianas. Diz-nos Rivera (2005, p. 24) que o jovem Lacan,

> [...] no início da década de 1920, cedo se interessou pelo dadaísmo e reconhece a influência surrealista que sofreu sua obra. Ele conheceu André Breton e o também poeta Philippe Soupault antes de começar a ler Freud. Elisabeth Roudinesco, a respeitada psicanalista e historiadora da psicanálise francesa, chega a considerar a teoria lacaniana como uma síntese, em partes iguais, de três grandes tendências: o freudismo, a psiquiatria e o surrealismo.

Ao contrário de Freud, que se servia das obras de artistas clássicos para aplicar sua hipótese psicanalista, Lacan nutria-se das concepções artísticas para poder pensar sua teoria. Lacan, por exemplo, viu, na obra de Holbein, uma maneira de refletir a função escópica.

Será que podemos analisar a vida de um artista a partir de sua obra? Você, provavelmente, já escutou alguém dizer: "nossa, que cores fortes! Acho que quem pintou este quadro estava em bom astral!" ou: "Que cores frias! O pintor devia estar triste ao pintar esta tela com tons acinzentados!". Sem dúvida, muitos espectadores veem na obra traços do sentimento e caráter do artista. Independente de emitir um juízo de valor de ser isso o mais correto a fazer ou não, o nosso objetivo, aqui, é mostrar a retomada freudiana de obras de Leonardo da Vinci e, por consequência, uma análise da sua vida.

Entre os textos que escreveu, o que Freud considerou mais belo foi aquele no qual interpretou a imagem Santa Ana, a virgem e a criança, de Leonardo da Vinci, e apresentou um pintor perseguido por uma recordação da infância. Eis a recordação:

> Parece que já era meu destino preocupar-me tão profundamente com abutres; pois guardo como uma das minhas primeiras recordações que, estando em meu berço, um abutre desceu sobre mim, abriu-me a boca com sua cauda e com ela fustigou-me repetidas vezes os lábios. (FREUD, 1980, p. 76).

Antes de entrar mais detalhadamente na análise freudiana, convidamos você a conhecer um pouco mais da vida de um dos maiores artistas que a humanidade já teve. Da infância de Leonardo da Vinci, sabe-se muito pouco. Nasceu em 1452, em Vinci – próximo a Florença, Itália. Seu pai, Piero, não o aceitou como filho e somente o reconheceu anos depois. Isso porque era filho ilegítimo. Sua mãe era uma camponesa chamada Caterina e havia indícios de que casara com outro homem após Leonardo ir morar com o pai. A esposa de Piero era a Dona Albieri, que não teve filhos. Por conta disso, Leonardo da Vinci teve uma boa educação. Viveu, então, em companhia de sua mãe, nos anos iniciais. Já na juventude, e não se sabe em qual data precisamente, aprendeu com Verrochio, seu grande mestre, todas as artes ligadas ao desenho. Freud mostra, em seu texto, essa precariedade de informações sobre a infância de Leonardo da Vinci, mas, mesmo assim fez sua análise psicanalista a partir desses poucos dados:

> [...] a culpa não está nos métodos falhos e inadequados da psicanálise, mas na incerteza e na natureza fragmentária do material com ele relacionado, e que a tradição nos legou. Portanto, somente o autor deverá ser considerado responsável pelo fracasso, por ter obrigado a psicanálise a exprimir sua opinião abalizada, apoiando-se em material tão insuficiente. (FREUD, 1980, p. 122).

Apesar disso, Rivera (2005, p.32), que leu o texto de Freud, tem o entendimento de que, "na obra de Da Vinci deve haver, supõe o pai da psicanálise, algo que dê testemunho de sua recordação infantil". Sobre a recordação infantil, Freud a associou com o sexo oral e, assim, a cauda do abutre tocando o lábio, seria, por analogia, o pênis tocando a boca de Leonardo da Vinci. Sendo fantasia ou descrição real do artista, essa recordação deu subsídios, mesmo que precários, para o psicanalista

analisar uma possível homossexualidade de um dos maiores artistas de todos os tempos.

Observe a adaptação feita por Malraux que, tomando a imagem em preto e branco, faz um contorno no manto sugerindo e acentuando a hipótese de Leonardo ter elaborado, mesmo que, de forma inconsciente, um abutre. Malraux insiste que a imagem deve ser olhada como que "de viés" para a identificação do animal, pois ele está todo torcido na composição. A cabeça termina nas costas da Virgem. Outro detalhe que Freud assinala é o fato de Santa Ana e a Virgem possuírem quase a mesma idade na imagem. Isso foi associado às duas mães que Leonardo da Vinci possuiu: a mãe verdadeira e a madrasta.

Arte pela Psicanálise De toda sorte, "A tentativa de Freud", afirma Merleau-Ponty (2004, p. 139), "de decifrar o enigma a partir do que se sabe sobre a significação do vôo das aves, sobre os fantasmas de fellatio e sua relação com o período de aleitamento, certamente levantará protestos". Sem dúvida, a análise de Freud sobre Leonardo da Vinci e sua recordação da infância não foram bem aceitas. Vejamos, porém, o que Clark escreveu:

> Suas conclusões foram rejeitadas com horror pela maioria dos estudiosos de Leonardo, e não há dúvida de que os processos de uma mente poderosa e complexa não podem ser deduzidos de uma simples frase nem explicados por um único sistema de psicologia. [...] No entanto, ele nos ajuda a conceber o caráter de Leonardo com sua insistência sobre sua anormalidade. Devemos ter isto em mente ao examinar superficialmente suas primeiras obras. Depois, não esqueceremos isso facilmente. (CLARK, 2003, p. 51).

Que sua Lembrança da infância possa ser uma fantasia em que o abutre represente uma alusão à sua sexualidade e que a cauda do abutre tocando os lábios seja a representação do órgão sexual masculino e, por conseguinte, um possível desejo reprimido de Leonardo da Vinci ou o fato de o abutre representar sua mãe, como mostram os hieróglifos do antigo Egito (segunda hipótese da análise freudiana), parece-nos especulação partidária de alguém que se propõe a analisar a arte apenas sob um único ponto de vista.

Leonardo da Vinci foi um dos maiores gênios que a humanidade já teve. De fato, até seus contemporâneos a ele atribuíam grande talento e genialidade. Em um fragmento do Tratado da pintura, chegou a dizer: "quero fazer milagres". Considerado uns dos maiores homens de todos os tempos, devido a sua superabundância de talentos,

seus historiadores dizem que ele era muito belo na aparência e no físico; tinha uma voz magnífica e encantava a todos que o escutavam; tinha um talento invejável para a Matemática; e uma mente extremamente aguçada para a investigação científica. Evidentemente, sem contar com seu talento para as artes e, sobretudo, para a pintura. A história nos mostra que pintou poucos quadros – talvez pela multiplicidade de talentos que possuía – e raramente dava por concluída uma obra.

Uma das obras mais intrigantes e de maior prestígio, entre todas as outras pinturas do mundo ocidental, é, sem dúvida, a Monalisa. Presente no museu do Louvre, já foi roubada por um operário que lá trabalhava e também já serviu de adorno no quarto de Napoleão. Alguns especuladores dizem que é um autorretrato de Leonardo da Vinci. Outros ainda consideram que era a tentativa de o pintor resgatar ou imortalizar o sorriso de sua mãe. Muitos mistérios se acercam em torno desse retrato.

Freud (1980, p. 102) assim analisa o sorriso da Monalisa e o de outras pinturas de Leonardo da Vinci:

> [...] então as mulheres sorridentes nada mais seriam senão a reprodução de sua mãe Caterina, e começamos a suspeitar a possibilidade de que este misterioso sorriso era o de sua mãe – sorriso que ele perdera e que muito o fascinou, quando novamente o encontrou na dama florentina.

Talvez os psicanalistas estejam certos em relação à infância de Leonardo da Vinci. Talvez não. Nunca saberemos ao certo. O que realmente conta é que foi um grande artista e muito acrescentou para o desenvolvimento da arte com suas técnicas renovadoras e suas pesquisas sobre a natureza para as ciências. Seus estudos despertam a atenção e o interesse de vários estudiosos, de variadas áreas do conhecimento, produzindo significações que se desdobram a cada momento, cada vez mais e mais... ad infinitunn.

A arte, para Jacques Lacan, produz um sentido diferente daquele causado em Freud. O pai da psicanálise procurou ver traços do artista na obra de arte e, por exemplo, viu, no sorriso das mulheres pintadas por Leonardo da Vinci, uma Talvez os psicanalistas estejam certos em relação à infância de Leonardo da Vinci. Talvez não. Nunca saberemos ao certo. Uma representação do sorriso materno. Já, para Lacan, esse sorriso era algo estranho, provocativo e, até, por que não considerar, perturbador. Essa é a produção de sentidos que a obra causa em Lacan. Mais do que analisar as obras e os artistas, Lacan queria aprender com elas.

Uma das obras tomadas pelo psicanalista foi " Os embaixadores" do pintor Hans Holbein, de 1533. A pintura mostra um objeto estranho que se impõe obliquamente na parte inferior da tela e que a atravessa, como se fosse pintado posteriormente, algo que parece não fazer parte da obra. As imagens da obra são construídas à maneira clássica: "os dois personagens estão hirtos, duros, dentro de seus ornamentos de ostentação. Entre eles, toda uma série de objetos que figuram, na pintura da época, os símbolos da vanitas." (LACAN, 2008, p. 87). Ao prestarmos mais atenção na obra – senão esse detalhe nos passaria despercebido – vemos o rasgo obscuro que perpassa o plano inferior do quadro e que rompe a plasticidade da obra.

O pintor, para produzir tal efeito, fez uso da técnica da anamorfose (uso invertido das leis da perspectiva). Assim, ao olharmos de viés para o quadro, veremos uma caveira aterrorizante. Sobre esse detalhe, assinala Lacan (2008, p. 88):

> [...] Holbein nos torna aqui visível algo que não é outra coisa senão o sujeito como nadificado – nadificado numa forma que é, falando propriamente, a encarnação imajada do menos-fi $[(-\varphi)]$ da castração, a qual centra para nós toda a organização dos desejos através do quadro das pulsões fundamentais.

Nessa análise, vemos alguns conceitos centrais na teoria lacaniana: pulsão, castração e desejo. Em nosso texto, não nos aprofundaremos nesses conceitos por serem demasiadamente extensos e complexos, o que nos tomaria muito tempo e também por não serem relevantes nesse momento.

Lacan (2008) assinala que Holbein nos instala num solo inseguro, que nos incomoda, que nos abala, que nos descentraliza e nos insere num lugar onde precisamos nos reelaborar e nos atualizar constantemente. Sobre a obra, Lacan (2008, p. 91) afirma: "Esse quadro não é nada mais do que é todo quadro, uma armadilha de olhar. Em qualquer quadro que seja, é precisamente ao procurar o olhar em cada um de seus pontos que vocês o verão desaparecer." Assim, o que pertence ao olhar escapa do empreendimento daquilo que a visão ordinária vê. Essa vitória do olhar sobre o olho, pois ver é função do olho e o olhar é tido como objeto da função escópica, "tem uma estrutura de reviravolta, além de ser considerado como um olhar fendido, rasurado e manchado em razão da esquize, da fenda entre o olho e o olhar"; o olhar "como objeto [...] em lugar do Outro, que é ponto da falta, da angústia e do estranhamento" (GUIMARÃES, 1995, p. 105). Desta

forma, o olhar deixa de ser uma mera atitude, um ponto de vista, uma maneira de ler a imagem, para ser um objeto, algo estranho e que é objeto da pulsão escópica. Lacan (2008) desloca o olhar, que era do lado do sujeito, e o coloca do lado do objeto. Assim, entre o sujeito e a imagem, há o olhar, há o quiasma, há o que não se deixa capturar. O olho é o sujeito consciente, o cogito cartesiano, o sujeito do conhecimento. O olhar, por sua vez, representa o sujeito do inconsciente e do desejo. Se há falta, então há desejo. "[...] de todos os objetos nos quais o sujeito pode reconhecer a dependência em que está no registro do desejo, o olhar se especifica como inapreensível." (LACAN, 2008, p. 86). O olhar deixa de ser uma mera atitude, um ponto de vista, uma maneira de ler a imagem, para ser um objeto, algo estranho e que é objeto da pulsão escópica. Lacan (2008) desloca o olhar, que era do lado do sujeito, e o coloca do lado do objeto.

Em nossa vida cotidiana, há uma reversibilidade do olhar: ao mesmo tempo em que vemos, somos vistos por aquilo que vemos (mesmo os objetos!) e, nessa relação, também percebemos que somos vistos. Em nossa vida cotidiana, há uma reversibilidade do olhar: ao mesmo tempo em que vemos, somos vistos por aquilo que vemos (mesmo os objetos!) e, nessa relação, também percebemos que somos vistos. Ao postular tal teoria, a partir da obra de Holbein e de um texto do filósofo Merleau-Ponty (O visível e o invisível), Lacan (2008) nos chama a atenção para uma terceira forma de olhar: algo que atravessa a reversibilidade do olhar/ser-olhado e que não sabemos direito o que é. Ele chama isso de esquize do olhar: é algo que é estranho, que nos escapa, que atravessa o ato de ver, que não se deixa apreender e que é vazio. Parece difícil de entender isso? Pois bem, alguns pintores, como Paul Klee, constantemente comentaram, em seus textos, que percebiam que eram olhados pelas coisas. Klee falava que as árvores ficavam olhando para ele. O fato de nós olharmos e alguém nos olhar é simples. Todos conseguem entender. Porém, saber que um objeto nos olha parece ser algo mais complexo e estranho. Em todo caso, tanto Lacan quanto Merleau-Ponty consideram a reversibilidade do olhar. Só que ambos também certificam que há algo mais além dessa reversibilidade: algo que foge, que escapa, que é estranho e que nos permite ver o vazio entre duas coisas. Correlativamente, podemos ver isso também na linguagem verbal. Entre um signo e outro, entre uma palavra e outra, há um vazio, um silêncio. Silêncio que permite haver um entrelaçamento entre as palavras e, por consequência, possibilita a comunicação entre as pessoas. Holbein igualmente nos mostra algo parecido: entre o olhar que olha e que é visto, algo existe e que não sabemos ao certo o que é. Nesse sentido, a obra de arte contribuiu para Lacan pensar o mistério da visão.

CONSIDERAÇÕES FINAIS

Todo aquele que se propôs, alguma vez, a se expressar por meio da pintura, da escultura, da escrita de um poema ou de outra atividade artística, sabe que a obra ultrapassa os limites racionais da intenção do autor. Aquilo que escapa é o que permite à obra não ter um sentido único e determinado, mas que a deixa causar inúmeras significações cada vez que é retomada.

Se todas as significações estão na própria obra ou se estão na mente do espectador não sabemos ao certo. Mas é fato que obras de arte causam significações diversas e, por conta disso, ora causam um deleite, ora provocam o espectador de forma perturbadora e enigmática.

Vimos que a psicanálise leu as obras de artes de algumas maneiras e as continuará lendo. Inúmeros livros e textos foram produzidos a partir desse entrelaçamento. Para Freud, foi de uma forma; para Lacan, foi de outra. Talvez o que importa é não admitirmos que os sentidos delas se esgotem em determinada teoria. Nesse contexto, a obra é aberta e precisa da retomada do espectador para dar-lhe continuidade.

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Vibration of Orthotropic Rectangular Plates Under the Action of Moving Distributed Masses and Resting on a Variable Elastic Pasternak Foundation with Clamped End Conditions

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Abstract

This work investigates the vibration of orthotropic rectangular plate resting on a variable elastic Pasternak foundation under the action of moving distributed masses. The governing equation is a fourth order partial differential equation with variable and singular co-efficients. The solutions to the problem are obtained by transforming the fourth order partial differential equation for the problem to a set of coupled second order ordinary differential equations using the technique of Shadnam et al[11] which are then simplified using modified asymptotic method of Struble. The closed form solution is analyzed, resonance conditions are obtained and the results are presented in plotted curves for both cases of moving distributed mass and moving distributed force.

Keyword

Variable bi-parametric foundation,orthotropic, foundation modulus, critical speed,flexural rigidity,shear modulus resonance, modified frequency, clamped end conditions

1 Introduction

The problems related to thin structural bodies (rods, beams, plates,and shells) with other bodies have widespread application in various fields of science and technology. The physical phenomena involved in the impact event include structural responses, contact effects and wave propagation. The problems associated with these are always topical issues in the field of applied mechanics. Since these problems belong to the problems related to dynamic contact interaction, their solution is connected with cumbersome mathematical tasks. To this end , several researchers had worked and some are still working on the dynamic behavior of orthotropic rectangular plates. Ambartsumian [1] examined the five fundamental differential equations describing the equilibrium of an orthotropic plate with a cylindrical anisotropy for the case when all radial planes crossing the axis of anisotropy are the planes of elastic symmetry. Sveklo [2] suggested the contact theory for two anisotropic bodies under compression according to which the contact pressure is distributed over an elliptical contact region. The same structural effects are also true of the concrete slab in a composite girder bridge, but the steel orthotropic deck is considerably lighter, and therefore allows longer span bridges to be more efficiently designed. Awodola [3] studied the effect of plate parameters on the vibrations under moving masses of elastically supported plate resting on bi-parametric foundation with stiffness variation.Szekrenyes [4] investigated the interface fracture in orthotropic composite plates using second order shear deformation theory. Yan [5] proposed elastic orthotropic models and used these in the nonlinear analysis of concrete structures subjected to monotonic or pseudo dynamic loading. Since these models can appropriately describe the strain softening behavior of concrete beyond the peak stress and show good agreement with the strength envelope obtained from experimental results Hu and Yao [6] studied the vibration solutions of rectangular orthotropic plates by symplectic geometry method. In the same vien, Alshaya, Hunt and Rowlands [7] examined stresses and

strains in thick perforated orthotropic plates. Gbadeyan and Dada [8] found the natural frequency of rectangular plates traversed by moving concentrated masses. Awodola and Adeoye [9] investigated the behavior of simply supported orthotropic rectangular plate by applying the technique of variable separable. Adeoye and Awodola [10] studied the dynamic behavior of orthotropic rectangular plate with clamped-clamped boundary conditions by making use of the technique of Shadnam Due to inability of researchers to solve orthotropic plates problems by analytical methods, this work aims at solving the governing equation by analytical solution and also considers the effect of the flexural rigidities in both x and y directions.

2   Governing Equation

The dynamic transverse displacement $W(x, y, t)$ of orthotropic rectangular plates when it is resting on a bi-parametric elastic foundation and traversed by distributed mass M_r moving with constant velocity c_r along a straight line parallel to the x-axis issuing from point y=s on the y-axis with flexural rigidities D_x and D_y is governed by the fourth order partial differential equation given as

$$D_x \frac{\partial^4}{\partial x^4} W(x, y, t) + 2B \frac{\partial^4}{\partial x^2 \partial y^2} W(x, y, t) + D_y \frac{\partial^4}{\partial y^4} W(x, y, t) + \mu \frac{\partial^2}{\partial t^2} W(x, y, t) - \rho h R_0$$

$$\left[\frac{\partial^4}{\partial x^2 \partial t^2} W(x, y, t) + \frac{\partial^4}{\partial y^2 \partial t^2} W(x, y, t) \right] + K_0 (4x - 3x^2 + x^3) W(x, y, t) + S_0(-13+$$

$$12x + 3x^2) \frac{\partial}{\partial x} W(x, y, t) - S_0(12 - 13x + 6x^2 + x^3) \left[\frac{\partial^2}{\partial x^2} W(x, y, t) + \frac{\partial^2}{\partial y^2} W(x, y, t) \right] \quad (2.1)$$

$$- \sum_{r=1}^{N} \left[M_r g H(x - ct) H(y - s) - M_r \left(\frac{\partial^2}{\partial t^2} W(x, y, t) + 2c_r \frac{\partial^2}{\partial x \partial t} W(x, y, t) + c_r^2 \right. \right.$$

$$\left. \left. \frac{\partial^2}{\partial x^2} W(x, y, t) \right) H(x - c_r t) H(y - s) \right] = 0$$

where D_x and D_y are the flexural rigidities of the plate along x and y axes respectively.

$$D_x = \frac{E_x h^3}{12(1 - \nu_x \nu_y)}, \quad D_y = \frac{E_y h^3}{12(1 - \nu_x \nu_y)}, \quad B = D_x D_y + \frac{G_o h^3}{6} \quad (2.2)$$

E_x and E_y are the Young's moduli along x and y axes respectively, G_o is the rigidity modulus, ν_x and ν_y are Poisson's ratios for the material such that $E_x\nu_y = E_y\nu_x$, ρ is the mass density per unit volume of the plate, h is the plate thickness, t is the time, x and y are the spatial coordinates in x and y directions respectively, R_o is the rotatory inertia correction factor, K_o is the foundation constant, S_o shear modulus and g is the acceleration due to gravity, H(.) is the Heaviside function.

Rewriting equation (2.1), one obtains

$$
\mu\frac{\partial^2}{\partial t^2}W(x,y,t) + \mu\omega_n^2 W(x,y,t) = \rho h R_0\left[\frac{\partial^4}{\partial x^2\partial t^2}W(x,y,t) + \frac{\partial^4}{\partial y^2\partial t^2}W(x,y,t)\right] - 2B
$$

$$
\frac{\partial^4}{\partial x^2\partial y^2}W(x,y,t) - D_y\frac{\partial^4}{\partial y^4}W(x,y,t) - D_x\frac{\partial^4}{\partial x^4}W(x,y,t) + \mu\omega_n^2 W(x,y,t) - K_0(4x -
$$

$$
3x^2 + x^3)W(x,y,t) + G_o(-13 + 12x + 3x^2)\frac{\partial}{\partial x}W(x,y,t) - G_0(12 - 13x + 6x^2 + x^3)\Bigg[
$$

$$
\frac{\partial^2}{\partial x^2}W(x,y,t) + \frac{\partial^2}{\partial y^2}W(x,y,t)\Bigg] + \sum_{r=1}^{N}\Bigg[M_r g H(x - c_r t)H(y - s) - M_r\left(\frac{\partial^2}{\partial t^2}W(x,y,t)\right.
$$

$$
\left. + 2c_r\frac{\partial^2}{\partial x\partial t}W(x,y,t) + c_r^2\frac{\partial^2}{\partial x^2}W(x,y,t)\right)H(x - c_r t)H(y - s)\Bigg]
$$

(2.3)

Simplifying equation (2.3) further, one obtains

$$
\frac{\partial^2}{\partial t^2}W(x,y,t) + \omega_n^2 W(x,y,t) = \sum_{r=1}^{N}\Bigg[R_0\left(\frac{\partial^4}{\partial x^2\partial t^2}W(x,y,t) + \frac{\partial^4}{\partial y^2\partial t^2}W(x,y,t)\right) - \frac{2B}{\mu}
$$

$$
\frac{\partial^4}{\partial x^2\partial y^2}W(x,y,t) - \frac{D_y}{\mu}\frac{\partial^4}{\partial y^4}W(x,y,t) - \frac{D_x}{\mu}\frac{\partial^4}{\partial x^4}W(x,y,t) + \omega_n^2 W(x,y,t) - \frac{K_0}{\mu}(4x - 3x^2
$$

$$
+ x^3)W(x,y,t) + \frac{G_o}{\mu}(-13 + 12x + 3x^2)\frac{\partial}{\partial x}W(x,y,t) - \frac{G_0}{\mu}(12 - 13x + 6x^2 + x^3)\left(\frac{\partial^2}{\partial x^2}\right.
$$

$$
\left. W(x,y,t) + \frac{\partial^2}{\partial y^2}W(x,y,t)\right) + \sum_{r=1}^{N}\left(\frac{M_r}{\mu}g H(x - c_r t)H(y - s) - \frac{M_r}{\mu}\left(\frac{\partial^2}{\partial t^2}W(x,y,t) + 2c_r\right.\right.
$$

$$
\left.\left.\frac{\partial^2}{\partial x\partial t}W(x,y,t) + c_r^2\frac{\partial^2}{\partial x^2}W(x,y,t)\right)H(x - c_r t)H(y - s)\right)\Bigg]
$$

(2.4)

where ω_n^2 is the natural frequencies, $n = 1, 2, 3, ...$

The initial conditions, without any loss of generality, is taken as

$$W(x, y, t) = 0 = \frac{\partial}{\partial t} W(x, y, t) \qquad (2.5)$$

3 Analytical Approximate Solution

In order to solve equation (2.4), one applies technique of Shadnam et al which requires that the deflection of the plates be in series form as

$$W(x, y, t) = \sum_{n=1}^{N} \Psi_n(x, y) Q_n(t) \qquad (3.1)$$

where

$$\Psi_n(x, y) = \Psi_{jm}(x) \Psi_{hm}(y)$$

$$\Psi_{jm}x = \sin \zeta_{jm}x + A_{jm} \cos \zeta_{jm}x + B_{jm} \sinh \zeta_{jm}x + C_{jm} \cosh \zeta_{jm}x$$

$$\Psi_{hm}y = \sin \varphi_{hm}y + A_{hm} \cos \varphi_{hm}y + B_{hm} \sinh \varphi_{hm}y + C_{hm} \cosh \varphi_{hm}y$$

$$\zeta_{jm} = \frac{\phi_{jm}}{L_x}, \quad \varphi_{hm} = \frac{\phi_{hm}}{L_y}$$

The right hand side of equation (2.4), taken into account equation (3.1), written in the form of series takes the form

$$\sum_{n=1}^{\infty} \left[R_0 \left(\frac{\partial^2}{\partial x^2} \Psi_n(x, y) \ddot{Q}_n(t) + \frac{\partial^4}{\partial y^2} \Psi_n(x, y) \ddot{Q}_n(t) \right) - \frac{2B}{\mu} \frac{\partial^4}{\partial x^2 \partial y^2} \Psi_n(x, y) Q_n(t) - \frac{D_y}{\mu} \frac{\partial^4}{\partial y^4} \right.$$

$$\Psi_n(x, y) Q_n(t) - \frac{D_x}{\mu} \frac{\partial^4}{\partial x^4} \Psi_n(x, y) Q_n(t) + \omega_n^2 \Psi_n(x, y) Q_n(t) - \frac{K_0}{\mu} (4x - 3x^2 + x^3) \Psi_n(x, y)$$

$$Q_n(t) + \frac{G_o}{\mu} (-13 + 12x + 3x^2) \frac{\partial}{\partial x} \Psi_n(x, y) Q_n(t) - \frac{G_0}{\mu} (12 - 13x + 6x^2 + x^3) \left(\frac{\partial^2}{\partial x^2} \Psi_n(x, y) \right.$$

$$\left. Q_n(t) + \frac{\partial^2}{\partial y^2} \Psi_n(x, y) Q_n(t) \right) + \sum_{r=1}^{N} \left(\frac{M_r}{\mu} gH(x - c_r t) H(y - s) - \frac{M_r}{\mu} \left(\Psi_n(x, y) \ddot{Q}_n(t) + \right. \right.$$

$$\left. \left. 2c \frac{\partial}{\partial x} \Psi_n(x, y) \dot{Q}_n(t) + c_r^2 \frac{\partial^2}{\partial x^2} \Psi_n(x, y) Q_n(t) \right) H(x - c_r t) H(y - s) \right) \right] = \sum_{n=1}^{N} \Psi_n(x, y) \Theta_n(t)$$

$$(3.2)$$

5

Multiplying both sides of equation (3.2) by $\Psi_m(x,y)$ and integrating on area A of the plate and considering the orthogonality of $\Psi_n(x,y)$, one obtains

$$\Theta_n(t) = \frac{1}{\theta^*} \sum_{n=1}^{\infty} \int_A \left[R_0 \left(\frac{\partial^2}{\partial x^2} \Psi_n(x,y)\ddot{Q}_n(t) + \frac{\partial^4}{\partial y^2} \Psi_n(x,y)\ddot{Q}_n(t) \right) - \frac{2B}{\mu} \frac{\partial^4}{\partial x^2 \partial y^2} \Psi_n(x,y) \right.$$

$$Q_n(t) - \frac{D_y}{\mu} \frac{\partial^4}{\partial y^4} \Psi_n(x,y) Q_n(t) - \frac{D_x}{\mu} \frac{\partial^4}{\partial x^4} \Psi_n(x,y) Q_n(t) + \omega_n^2 \Psi_n(x,y) Q_n(t) - \frac{K_0}{\mu}(4x-$$

$$3x^2 + x^3)\Psi_n(x,y) Q_n(t) + \frac{G_o}{\mu}(-13 + 12x + 3x^2)\frac{\partial}{\partial x}\Psi_n(x,y) Q_n(t) - \frac{G_0}{\mu}(12 - 13x$$

$$+ 6x^2 + x^3)\left(\frac{\partial^2}{\partial x^2}\Psi_n(x,y) Q_n(t) + \frac{\partial^2}{\partial y^2}\Psi_n(x,y) Q_n(t) \right) + \sum_{r=1}^{N} \left(\frac{M_r}{\mu}gH(x - c_rt)H(y - s) \right.$$

$$\left. - \frac{M_r}{\mu}\left(\Psi_n(x,y)\ddot{Q}_n(t) + 2c\frac{\partial}{\partial x}\Psi_n(x,y)\dot{Q}_n(t) + c_r^2 \frac{\partial^2}{\partial x^2}\Psi_n(x,y) Q_n(t) \right)H(x - c_rt)H(y - s) \right.$$

$$\left. \left. \right) \right]\Psi_m(x,y)dA$$

$$\tag{3.3}$$

and zero when $n \neq m$

where

$$\theta^* = \int_A \Psi_n^2(x,y)dA \tag{3.4}$$

Making use of equation (3.3) and taking into account equation (3.2), equation (2.4) can be written as

$$\Psi_n(x,y)\left[\omega_n^2 Q_n(t) + \ddot{Q}_n(t) \right] = \frac{\Psi_n(x,y)}{\theta^*} \sum_{q=1}^{\infty} \int_A \left[R_0 \left(\frac{\partial^2 \Psi_q(x,y)}{\partial x^2}\Psi_m(x,y)\ddot{Q}_q(t) + \frac{\partial^2 \Psi_q(x,y)}{\partial y^2} \right. \right.$$

$$\Psi_m(x,y)\ddot{Q}_q(t) \left. \right) - \frac{2B}{\mu}\frac{\partial^2 \Psi_q(x,y)}{\partial x^2 \partial y^2}\Psi_m(x,y) Q_q(t) - \frac{D_y}{\mu}\frac{\partial^4 \Psi_q(x,y)}{\partial y^4}\Psi_m(x,y) Q_q(t) + \frac{D_x}{\mu}\frac{\partial^4 \Psi_q(x,y)}{\partial x^4}$$

$$\Psi_m(x,y) Q_q(t) - \frac{K_0}{\mu}(4x - 3x^2 + x^3)\Psi_q(x,y)\Psi_m(x,y) Q_q(t) + \frac{G_o}{\mu}(-13 + 12x + 3x^2)\frac{\partial \Psi_q(x,y)}{\partial x}$$

$$\Psi_m(x,y) Q_q(t) - \frac{G_o}{\mu}(12 - 13x + 6x^2 + x^3)\left(\frac{\partial^2 \Psi_q(x,y)}{\partial x^2}\Psi_m(x,y) Q_q(t) + \frac{\partial^2 \Psi_q(x,y)}{\partial y^2}\Psi_m(x,y) \right.$$

$$\left. Q_q(t) \right) + \sum_{r=1}^{N} \left(\frac{M_r}{\mu}g\Psi_m(x,y)H(x - c_rt)H(y - s) - \frac{M_r}{\mu}\left(\Psi_q(x,y)\Psi_m(x,y)\ddot{Q}_q(t) + 2c_r \right. \right.$$

$$\left. \left. \frac{\partial \Phi_q(x,y)}{\partial x}\Phi_m(x,y)\dot{Q}_q(t) + c_r^2\frac{\partial^2 \Phi_q(x,y)}{\partial x^2}\Phi_m(x,y) Q_q(t) \right)H(x - c_rt)H(y - s) \right) \right]dA$$

$$\tag{3.5}$$

On further simplification of equation (3.5), one obtains

$$\ddot{Q}_n(t) + \omega_n^2 Q_n(t) = \frac{1}{\theta^*} \sum_{q=1}^{\infty} \int_A \left[R_0 \left(\frac{\partial^2 \Psi_q(x,y)}{\partial x^2} \Psi_m(x,y) \ddot{Q}_q(t) + \frac{\partial^2 \Psi_q(x,y)}{\partial y^2} \Psi_m(x,y) \ddot{Q}_q(t) \right) \right.$$

$$- \frac{2B}{\mu} \frac{\partial^2 \Psi_q(x,y)}{\partial x^2 \partial y^2} \Psi_m(x,y) Q_q(t) - \frac{D_y}{\mu} \frac{\partial^4 \Psi_q(x,y)}{\partial y^4} \Psi_m(x,y) Q_q(t) - \frac{D_x}{\mu} \frac{\partial^4 \Psi_q(x,y)}{\partial x^4} \Psi_m(x,y)$$

$$Q_q(t) + \omega_q^2 \Psi_q(x,y) \Psi_m(x,y) Q_n(t) - \frac{K_0}{\mu}(4x - 3x^2 + x^3) \Psi_q(x,y) \Psi_m(x,y) Q_q(t) + \frac{G_o}{\mu}(-13$$

$$+ 12x + 3x^2)\frac{\partial \Psi_q(x,y)}{\partial x} \Psi_m(x,y) Q_q(t) - \frac{G_o}{\mu}(12 - 13x + 6x^2 + x^3)\left(\frac{\partial^2 \Psi_q(x,y)}{\partial x^2} \Psi_m(x,y) Q_q(t) \right.$$

$$\left. + \frac{\partial^2 \Psi_q(x,y)}{\partial y^2} \Psi_m(x,y) Q_q(t) \right) + \sum_{r=1}^{N} \left(\frac{M_r}{\mu} g \Psi_m(x,y) H(x - c_r t) H(y - s) - \frac{M_r}{\mu} \left(\Psi_q(x,y) \Psi_m(x,y) \right. \right.$$

$$\left. \ddot{Q}_q(t) + 2c_r \frac{\partial \Phi_q(x,y)}{\partial x} \Phi_m(x,y) \dot{Q}_q(t) + c_r^2 \frac{\partial^2 \Phi_q(x,y)}{\partial x^2} \Phi_m(x,y) Q_q(t) \right) H(x - c_r t) H(y - s) \right) \Bigg] dA$$

$$(3.6)$$

The system of equations in equation (3.6) is a set of coupled ordinary differential equations

where $H(x - c_r t)$ and $H(y - s)$ are the Heaviside functions which are defined as

$$H(x - c_r t) = \begin{cases} 1, for\ x \geq c_r t \\ 0, for\ x < c_r t \end{cases}, \qquad H(y - s) = \begin{cases} 1, for\ y \geq s \\ 0, for\ y < s \end{cases} \qquad (3.7)$$

With the properties

$$(i) \frac{d}{dx}[H(x - c_r t)] = \delta(x - c_r t), \qquad \frac{d}{dy}[H(y - s)] = \delta(y - s) \qquad (3.8)$$

$$(ii) f(x)H(x - c_r t) = \begin{cases} f(x), for\ x \geq c_r t \\ 0, for\ x < c_r t \end{cases}, \qquad f(y)H(y - s) = \begin{cases} f(y), for\ y \geq s \\ 0, for\ y < s \end{cases} \qquad (3.9)$$

Using the Fourier series representation, the Heaviside functions take the form

$$H(x - c_r t) = \frac{1}{4} + \frac{1}{\pi} \sum_{r=1}^{N} \frac{\sin(2n + 1)\pi(x - c_r t)}{2n + 1}, 0 < x < 1 \qquad (3.10)$$

$$H(y - s) = \frac{1}{4} + \frac{1}{\pi} \sum_{r=1}^{N} \frac{\sin(2n + 1)\pi(y - s)}{2n + 1}, 0 < y < 1 \qquad (3.11)$$

On putting equations (3.7) to (3.11) into equation (3.6) and simplifying, one obtains

$$\ddot{Q}_n(t) + \omega_n^2 Q_n(t) - \frac{1}{\theta^*}\sum_{q=1}^{\infty}\left[R_0 T_1 \ddot{Q}_q(t) - \frac{2B}{\mu}T_2 Q_q(t) - \frac{D_y}{\mu}T_3 Q_q(t) - \frac{D_x}{\mu}T_4 Q_q(t) + (\omega_q^2 F_4^* - \right.$$

$$\frac{K_0}{\mu}F_5^*)Q_q(t) + \frac{G_0}{\mu}(T_6 + T_7)Q_q(t) - \sum_{r=1}^{N}\frac{M_r}{\mu}\left(\left(T_8 + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty}E_1^*\frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty}E_2^*\right.\right.\right.$$

$$\frac{\sin(2j+1)\pi c_r t}{2j+1}\right)\left(\sum_{k=1}^{\infty}E_3^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_4^*\frac{\sin(2k+1)\pi s}{2k+1}\right) + \frac{1}{4\pi}\left(\sum_{j=1}^{\infty}E_5^*\frac{\cos(2j+1)\pi c_r t}{2j+1}\right.$$

$$\left.\left.- \sum_{j=1}^{\infty}E_6^*\frac{\sin(2j+1)\pi c_r t}{2j+1}\right) + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_7^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_8^*\frac{\sin(2k+1)\pi s}{2k+1}\right)\right)\ddot{Q}_q(t)+$$

$$2c_r\left(T_9 + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty}E_9^*\frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty}E_{10}^*\frac{\sin(2j+1)\pi c_r t}{2j+1}\right)\left(\sum_{k=1}^{\infty}E_{11}^*\frac{\cos(2k+1)\pi s}{2k+1}\right.\right.$$

$$- \sum_{k=1}^{\infty}E_{12}^*\frac{\sin(2k+1)\pi s}{2k+1}\right) + \frac{1}{4\pi}\left(\sum_{j=1}^{\infty}E_{13}^*\frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty}E_{14}^*\frac{\sin(2j+1)\pi c_r t}{2j+1}\right)$$

$$+ \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_{15}^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_{16}^*\frac{\sin(2k+1)\pi s}{2k+1}\right)\right)\dot{Q}_q(t) + c_r^2\left(T_{10} + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty}E_{17}^*\right.\right.$$

$$\frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty}E_{18}^*\frac{\sin(2j+1)\pi c_r t}{2j+1}\right)\left(\sum_{k=1}^{\infty}E_{19}^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_{20}^*\frac{\sin(2k+1)\pi s}{2k+1}\right)$$

$$\left.\right) + \frac{1}{4\pi}\left(\sum_{j=1}^{\infty}E_{21}^*\frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty}E_{22}^*\frac{\sin(2j+1)\pi c_r t}{2j+1}\right) + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_{23}^*\frac{\cos(2k+1)\pi s}{2k+1}\right.$$

$$\left.\left.\left.- \sum_{k=1}^{\infty}E_{24}^*\frac{\sin(2k+1)\pi s}{2k+1}\right)\right)Q_q(t)\right)\right] = \sum_{q=1}^{\infty}\sum_{r=1}^{N}\frac{M_r g}{\mu\theta^*}\Psi_m(ct)\Psi_m(s)$$

(3.12)

which is the transformed equation governing the problem of an orthotropic rectangular plate resting on bi-parametric elastic foundation.

where

$$T_1 = \int_A \left[\frac{\partial^2}{\partial x^2}\Psi_q(x,y)\Psi_m(x,y) + \frac{\partial^2}{\partial y^2}\Psi_q(x,y)\Psi_m(x,y)\right]dA \qquad (3.13)$$

$$T_2 = \int_A \frac{\partial^2}{\partial x^2}\left[\frac{\partial^2}{\partial x^2}\Psi_q(x,y)\right]\Psi_m(x,y)dA \qquad (3.14)$$

$$T_3 = \int_A \frac{\partial^4}{\partial y^4}\left[\Psi_q(x,y)\right]\Psi_m(x,y)dA \qquad (3.15)$$

$$T_4 = \int_A \frac{\partial^4}{\partial x^4}\left[\Psi_q(x,y)\right]\Psi_m(x,y)dA \qquad (3.16)$$

$$F_4^* = \int_A \Psi_q(x,y)\Psi_m(x,y)dA \tag{3.17}$$

$$T_5 = 4U_1 - 3U_2 + U_3, \qquad T_6 = -13A_1 + 12A_2 + 3A_3 \tag{3.18}$$

$$T_7 = 12f_1 - 13f_2 + 6f_3 + f_4 + 12f_5 - 13f_6 + 6f_7 + f_8 \tag{3.19}$$

$$T_8 = \frac{1}{16}\int_A \Psi_q(x,y)\Psi_m(x,y)dA \tag{3.20}$$

$$E_1^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\sin(2j+1)\pi x dA \tag{3.21}$$

$$E_2^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\cos(2j+1)\pi x dA \tag{3.22}$$

$$E_3^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\sin(2k+1)\pi y dA \tag{3.23}$$

$$E_4^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\cos(2k+1)\pi y dA \tag{3.24}$$

$$E_5^* = E_1^*, \quad E_6^* = E_2^*, \quad E_7^* = E_3^*, \quad E_8^* = E_4^* \tag{3.25}$$

$$T_9 = \frac{1}{16}\int_A \frac{\partial}{\partial x}\Psi_q(x,y)\Psi_m(x,y)dA \tag{3.26}$$

$$E_9^* = \int_A \frac{\partial}{\partial x}\left(\Psi_q(x,y)\right)\Psi_m(x,y)\sin(2j+1)\pi x dA \tag{3.27}$$

$$E_{10}^* = \int_A \frac{\partial}{\partial x}\left(\Psi_q(x,y)\right)\Psi_m(x,y)\cos(2j+1)\pi x dA \tag{3.28}$$

$$E_{11}^* = \int_A \frac{\partial}{\partial x}\left(\Psi_q(x,y)\right)\Psi_m(x,y)\sin(2k+1)\pi y dA \tag{3.29}$$

$$E_{12}^* = \int_A \frac{\partial}{\partial x}\Psi_q(x,y)\Psi_m(x,y)\cos(2k+1)\pi y dA \tag{3.30}$$

$$E_{13}^* = E_9^*, \quad E_{14}^* = E_{10}^*, \quad E_{15}^* = E_{11}^*, \quad E_{16}^* = E_{12}^* \tag{3.31}$$

$$T_{10} = \frac{1}{16}\int_A \frac{\partial^2}{\partial x^2}\left(\Psi_q(x,y)\right)\Psi_m(x,y)dA \tag{3.32}$$

$$E_{17}^* = \int_A \frac{\partial^2}{\partial x^2}\left(\Psi_q(x,y)\right)\Psi_m(x,y)\sin(2j+1)\pi x dA \tag{3.33}$$

$$E_{18}^* = \int_A \frac{\partial^2}{\partial x^2}\left(\Psi_q(x,y)\right)\Psi_m(x,y)\cos(2j+1)\pi x dA \tag{3.34}$$

$$E_{19}^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\sin(2k+1)\pi y dA \tag{3.35}$$

$$E_{20}^* = \int_A \frac{\partial^2}{\partial x^2}\left(\Psi_q(x,y)\right)\Psi_m(x,y)\cos(2k+1)\pi y dA \qquad (3.36)$$

$$E_{21}^* = E_{17}^*, \quad E_{22}^* = E_{18}^*, \quad E_{23}^* = E_{19}^*, \quad E_{24}^* = E_{20}^* \qquad (3.37)$$

$\Psi_m(x,y)$ is assumed to be the products of functions $\Psi_{pm}(x)\Psi_{bm}(y)$ which are the beam functions in the directions of x and y axes respectively. That is

$$\Psi_m(x,y) = \Psi_{pm}(x)\Psi_{bm}(y) \qquad (3.38)$$

where

$$\Phi_m(x) = \sin\frac{\Gamma_m x}{L_x} + A_m\cos\frac{\Gamma_m x}{L_x} + B_m\sinh\frac{\Gamma_m x}{L_x} + C_m\cosh\frac{\Gamma_m x}{L_x} \qquad (3.39)$$

$$\Phi_m(y) = \sin\frac{\Gamma_m y}{L_y} + A_m\cos\frac{\Gamma_m y}{L_y} + B_m\sinh\frac{\Gamma_m y}{L_y} + C_m\cosh\frac{\Gamma_m y}{L_y} \qquad (3.40)$$

where A_{pm}, B_{pm}, C_{pm}, A_{bm}, B_{bm} and C_{bm} are constants determined by the boundary conditions. And Ψ_{pm} and Ψ_{bm} are called the mode frequencies

where

$$\lambda_{pm} = \frac{\xi_{pm}}{L_x}, \qquad \lambda_{bm} = \frac{\xi_{bm}}{L_y} \qquad (3.41)$$

Considering a unit mass, equation (3.12) can be re-written as

$$\ddot{Q}_n(t) + \omega_n^2 Q_n(t) - \frac{1}{\theta^*}\sum_{q=1}^{\infty}\left[R_0 T_1\ddot{Q}_q(t) - \frac{2B}{\mu}T_2 Q_q(t) - \frac{D_y}{\mu}T_3 Q_q(t) - \frac{D_x}{\mu}T_4 Q_q(t)+\right.$$

$$(\omega_q^2 F_4^* - \frac{K_0}{\mu}T_5)Q_q(t) + \frac{G_0}{\mu}(T_6+T_7)Q_q(t) - \alpha\varrho\left(\left(T_8 + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty}E_1^*\frac{\cos(2j+1)\pi ct}{2j+1}\right.\right.\right.$$

$$-\sum_{j=1}^{\infty}E_2^*\frac{\sin(2j+1)\pi ct}{2j+1}\right)\left(\sum_{k=1}^{\infty}E_3^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_4^*\frac{\sin(2k+1)\pi s}{2k+1}\right) + \frac{1}{4\pi}\left(\right.$$

$$\sum_{j=1}^{\infty}E_5^*\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_6^*\frac{\sin(2j+1)\pi ct}{2j+1}\right) + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_7^*\frac{\cos(2k+1)\pi s}{2k+1} - \right.$$

$$\left.\left.\sum_{k=1}^{\infty}E_8^*\frac{\sin(2k+1)\pi s}{2k+1}\right)\right)\ddot{Q}_q(t) + 2c\left(T_9 + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty}E_9^*\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_{10}^*\right.\right.$$

$$\frac{\sin(2j+1)\pi ct}{2j+1}\right)\left(\sum_{k=1}^{\infty}E_{11}^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_{12}^*\frac{\sin(2k+1)\pi s}{2k+1}\right) + \frac{1}{4\pi}\left(\sum_{j=1}^{\infty}E_{13}^*\right.$$

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$$\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{14}^* \frac{\sin(2j+1)\pi ct}{2j+1} \Bigg) + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty} E_{15}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_{16}^* \right.$$

$$\left. \frac{\sin(2k+1)\pi s}{2k+1} \right)\Bigg) \dot{Q}_q(t) + c^2 \left(T_{10} + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty} E_{17}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{18}^* \frac{\sin(2j+1)\pi ct}{2j+1} \right. \right.$$

$$\left. \Bigg) \left(\sum_{k=1}^{\infty} E_{19}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} B_{20}^* \frac{\sin(2k+1)\pi s}{2k+1} \right) + \frac{1}{4\pi}\left(\sum_{j=1}^{\infty} E_{21}^* \frac{\cos(2j+1)\pi ct}{2j+1} \right. \right.$$

$$\left. - \sum_{j=1}^{\infty} E_{22}^* \frac{\sin(2j+1)\pi ct}{2j+1} \right) + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi s}{2k+1} \right)$$

$$\left. \Bigg) Q_q(t) \right) \Bigg] = \sum_{q=1}^{\infty}\sum_{r=1}^{N} \frac{Mg}{\mu\theta^*}\Psi_m(ct)\Psi_m(s) \tag{3.42}$$

equation (3.42) is the fundamental equation of the problem. where

$$\alpha = \frac{M}{\mu\varrho}, \quad \varrho = L_x L_y \tag{3.43}$$

$$\Psi_m(ct) = \sin\chi_m t + A_m\cos\chi_m t + B_m\sinh\chi_m t + C_m\cosh\chi_m t \tag{3.44}$$

$$\Psi_m(s) = \sin\nu_m + A_m\cos\nu_m + B_m\sinh\nu_m + C_m\cosh\nu_m \tag{3.45}$$

$$\chi_m = \frac{\phi_m c}{L_x}, \quad \nu_m = \frac{\phi_m s}{L_y} \tag{3.46}$$

3.1 Orthotropic Rectangular Plate Traversed by a Moving Force

In moving force, we account for only the load being transferred to the structure. In this case, the inertia effect is negligible. Setting $\varpi = 0$ in the fundamental equation (3.42), one obtains

$$\ddot{Q}_n(t) + (1 - \frac{F_4^*}{\theta^*})\omega_n^2 Q_n(t) - \frac{1}{\mu\theta^*}\left(\mu R_0 T_1\ddot{Q}_n(t) - 2BT_2 Q_n(t) - D_y T_3 Q_n(t) - D_x T_4 Q_n(t) \right.$$

$$\left. - K_o T_5 Q_n(t) + G_0(T_6 + T_7)Q_n(t) \right) - \frac{1}{\mu\theta^*}\sum_{q=1}^{\infty}\left[\mu R_0 T_1\ddot{Q}_q(t) - 2BT_2 Q_q(t) - D_y T_3 Q_q(t) \right.$$

$$\left. - D_x F_4^* Q_q(t) + (\mu\omega_q^2 F_4^* - K_o T_5)Q_q(t) + G_0(T_6 + T_7)Q_q(t) \right] = \sum_{q=1}^{\infty}\sum_{r=1}^{N} \frac{Mg}{\mu\Theta^*}\Psi_m(ct)\Psi_m(s)$$

$$\tag{3.47}$$

which can further be simplified as

$$\ddot{Q}_n(t) + \chi_n^2 Q_n(t) - \tau^* \left(\mu R_0 T_1 \ddot{Q}_n(t) - 2BT_2 Q_n(t) - D_y T_3 Q_n(t) - D_x T_4 Q_n(t) - K_o T_5 \right.$$

$$\left. Q_n(t) + G_0(T_6 + T_7)Q_n(t) \right) - \tau^* \sum_{q=1}^{\infty} \left[\mu R_0 T_1 \ddot{Q}_q(t) - 2BT_2 Q_q(t) - D_y T_3 Q_q(t) - D_x T_4 \right.$$

$$\left. Q_q(t) + (\mu \omega_q^2 F_4^* - K_o T_5)Q_q(t) + G_0(T_6 + T_7)Q_q(t) \right] = \sum_{q=1}^{\infty} \sum_{r=1}^{N} Mg\tau^* \Psi_m(ct)\Psi_m(s)$$

$$(3.48)$$

On expanding, re-arranging and simplifying equation (4.48), one obtains

$$\ddot{Q}_n(t) + \frac{(\chi_n^2 - \tau^* J_6^*)}{[1 - \tau^* \mu R_0 T_1]} Q_n(t) + \frac{\tau}{[1 - \tau^* \mu R_0 T_1]} \sum_{q=1, q \neq n}^{\infty} \left(\mu R_0 T_1 \ddot{Q}_q(t) - 2BT_2 Q_q(t) - D_y T_3 Q_q(t) \right.$$

$$\left. - D_x T_4 Q_q(t) + (\mu \omega_q^2 F_4^* - K_o T_5)Q_q(t) + G_0(T_6 + T_7)Q_q(t) \right) = \frac{\tau^* Mg}{[1 - \tau^* \mu R_0 F_1^*]} \Psi_m(ct)\Psi_m(s)$$

$$(3.49)$$

where

$$\tau^* = \frac{1}{\mu \theta^*}, \quad \chi_n^2 = (1 - \frac{F_4^*}{\theta^*})\omega_n^2, \quad J_6^* = -2BT_2 - D_y T_3 - D_x T_4 - K_0 T_5 + G_0(T_6 + T_7) \quad (3.50)$$

For any arbitrary ratio Υ, defined as $\tau^* = \frac{\Upsilon}{1+\Upsilon}$, one obtains

$$\Upsilon = \frac{\tau^*}{1 - \tau^*} = \tau^* + o(\tau^{*2}) + ... \tag{3.51}$$

For only $o(\tau^*)$, one obtains

$$\tau^* = \Upsilon \tag{3.52}$$

Applying binomial expansion,

$$\frac{1}{1 - \Upsilon \mu R_0 F_1^*} = 1 + \Upsilon \mu R_0 F_1^* + o(\Upsilon^2) + ... \tag{3.53}$$

On putting equation (4.53) into equation (4.49), one obtains

$$\ddot{Q}_n(t) + (\chi_n^2 - \Upsilon J_6^*)(1 + \Upsilon \mu R_0 T_1 + o(\Upsilon^2) + ...)Q_n(t) + \Upsilon(1 + \tau^* \mu R_0 T_1 + o(\Upsilon^2) + ...)$$

$$\sum_{q=1, q \neq n}^{\infty} \left(\mu R_0 F_1^* \ddot{Z}_q(t) - 2BF_2^* Q_q(t) - D_y F_3^* Q_q(t) - D_x F_4^* Q_q(t) + (\mu \omega_q^2 - K_0)F_5^* Q_q(t) + \right.$$

$$\left. G_0(F_6^* + F_7^*)Q_q(t) \right) = (1 + \Upsilon \mu R_0 T_1 + o(\Upsilon^2) + ...)Mg\Psi_m(ct)\Psi_m(s)$$

$$(3.54)$$

Retaining only $o(\Upsilon)$, equation (4.54) becomes

$$\ddot{Q}_n(t) + (\chi_n^2(1 + \Upsilon \mu R_0 T_1) - \Upsilon J_6^*)Q_n(t) + \Upsilon \sum_{q=1, q \neq n}^{\infty} \left(\mu R_0 F_1^* \ddot{Q}_q(t) - 2BF_2^* Q_q(t) - D_y F_3^* \right.$$

$$\left. Q_q(t) - D_x F_4^* Q_q(t) + (\mu \omega_q^2 - K_0)F_5^* Q_q(t) + G_0(F_6^* + F_7^*)Q_q(t) \right) = \Upsilon Mg\Psi_m(ct)\Psi_m(s)$$

$$(3.55)$$

which is simplified further as

$$\ddot{Q}_n(t) + J_7^* Q_n(t) + \Upsilon \sum_{q=1, q \neq n}^{\infty} \left(\mu R_0 F_1^* \ddot{Q}_q(t) - 2BF_2^* Q_q(t) - D_y F_3^* Q_q(t) - D_x F_4^* Q_q(t) + \right.$$

$$\left. (\mu \omega_q^2 - K_0)F_5^* Q_q(t) + G_0(F_6^* + F_7^*)Q_q(t) \right) = \Upsilon Mg\Psi_m(ct)\Psi_m(s)$$

$$(3.56)$$

where

$$J_7^* = \chi_n^2(1 + \Upsilon \mu R_0 T_1) - \Upsilon J_6^* \tag{3.57}$$

Using Struble's technique, the solution to the homogeneous part of part of equation (3.57) is assumed to take the form

$$Q_n(t) = \varphi(n, t)\cos(\chi_n t - \rho(n, t)) + ... \tag{3.58}$$

where

$$\varphi(n, t) = \epsilon_n \tag{3.59}$$

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and

$$\phi(n, t) = \left(\frac{\chi_n^2 - J_7^*}{2\chi_n}\right)t + \iota_n \tag{3.60}$$

On putting equations (3.59) and (3.60) into equation (3.58), one obtains

$$Q_n(t) = \epsilon_n \cos\left(\chi_n t - \left(\frac{\chi_n^2 - J_7^*\varphi(n, t)}{2\chi_n}\right)t - \iota_n\right) \tag{3.61}$$

On further simplification, one obtains

$$Q_n(t) = \epsilon_n \cos(\upsilon_n t - \iota_n) \tag{3.62}$$

where

$$\upsilon_n = \chi_n - \left(\frac{\chi_n^2 - J_7^*\varphi(n, t)}{2\chi_n}\right) \tag{3.63}$$

is the modified frequency for moving force problem for orthotropic rectangular plate resting on variable elastic bi-parametric foundation.

Using equation (3.63), the homogeneous part of equation (3.56)

$$\ddot{Q}_n(t) + \upsilon_n^2 Q_n(t) = 0 \tag{3.64}$$

Hence, the entire equation (3.56) gives

$$\ddot{Q}_n(t) + \upsilon_n^2 Q_n(t) = \Upsilon M g \Psi_m(ct)\Psi_m(s) \tag{3.65}$$

Re-writing equation (3.65), one obtains

$$\ddot{Q}_n(t) + \upsilon_n^2 Q_n(t) = \Upsilon M g \Psi_m(s)[\sin\chi_m(t) + A_m \cos\chi_m t + B_m \sinh\chi_m t$$

$$+ C_m \cosh\chi_m t] \tag{3.66}$$

To obtain the solution to equation (3.66), one makes use of Laplace transformation techniques to obtain

$$Q_n(t) = \frac{Mg\Upsilon\Phi_m(s)}{\upsilon_n(\chi_m^4 - \upsilon_n^4)}\Bigg[(\chi_m^2 + \upsilon_n^2)(\chi_m \sin\upsilon_n t - \upsilon_n \sin\chi_m t) - A_m \upsilon_n(\chi_m^2 + \upsilon_n^2)$$

$$(\cos\chi_m t - \cos\upsilon_n t) - B_m(\chi_m^2 - \upsilon_n^2)(\alpha_m \sin\upsilon_n t - \upsilon_n \sinh\chi_m t) + C_m \upsilon_n(\chi_m^2 - \upsilon_n^2) \tag{3.67}$$

$$(\cosh\chi_m t - \cos\upsilon_n t)\Bigg]$$

which on inversion yields

$$W(x,y,t) = \sum_{jm=1}^{\infty} \sum_{hm=1}^{\infty} \frac{Mg\Upsilon\Phi_m(s)}{\upsilon_n(\chi_m^4 - \upsilon_n^4)} \left[(\chi_m^2 + \upsilon_n^2)(\chi_m \sin \upsilon_n t - \upsilon_n \sin \chi_m t) - A_m \upsilon_n(\chi_m^2 \right.$$

$$+ \upsilon_n^2)(\cos \chi_m t - \cos \upsilon_n t) - B_m(\chi_m^2 - \upsilon_n^2)(\chi_m \sin \upsilon_n t - \upsilon_n \sinh \chi_m t) + C_m \upsilon_n(\chi_m^2$$

$$\left. - \upsilon_n^2)(\cosh \chi_m t - \cos \upsilon_n t) \right] \left(\sin \frac{\phi_{jm}}{L_x}x + A_{jm} \cos \frac{\phi_{jm}}{L_x}x + B_{jm} \sinh \frac{\phi_{jm}}{L_x}x + C_{jm} \cosh \frac{\phi_{jm}}{L_x}x \right)$$

$$\left(\sin \frac{\phi_{hm}}{L_y}y + A_{hm} \cos \frac{\phi_{hm}}{L_y}y + B_{hm} \sinh \frac{\phi_{hm}}{L_y}y + C_{hm} \cosh \frac{\phi_{hm}}{L_y}y \right)$$

$$(3.68)$$

which is the transverse displacement response to a moving force of orthotropic rectangular plate resting on variable elastic bi-parametric foundation.

3.2 Orthotropic Rectangular Plate Traversed by a Moving Mass

In moving mass problem, the moving load is assumed rigid, and the weight and as well as inertia forces are transferred to the moving load. That is the inertia effect is not negligible. Thus $\varpi \neq 0$ and so it is required to solve the entire equation (3.42).To solve the equation,one employs analytical approximate method. This method is known as an approximate analytical method of Struble. The homogeneous part of equation (3.42) shall be replaced by a free system operator defined by the modified frequency υ_n. Thus, the entire equation becomes

$$\ddot{Q}_n(t) + \upsilon_n^2 Q_n(t) + \alpha \varrho^* \sum_{q=1}^{\infty} \left[\left(F_8^* + \frac{1}{\pi^2} \left(\sum_{j=1}^{\infty} E_1^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_2^* \right. \right. \right.$$

$$\frac{\sin(2j+1)\pi ct}{2j+1} \right) \left(\sum_{k=1}^{\infty} E_3^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_4^* \frac{\sin(2k+1)\pi s}{2k+1} \right) + \frac{1}{4\pi} \left(\sum_{j=1}^{\infty} E_5^* \right.$$

$$\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_6^* \frac{\sin(2j+1)\pi ct}{2j+1} \right) + \frac{1}{4\pi} \left(\sum_{k=1}^{\infty} E_7^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_8^* \right.$$

$$\left. \left. \frac{\sin(2k+1)\pi s}{2k+1} \right) \right) \ddot{Q}_q(t) + 2c \left(F_9^* + \frac{1}{\pi^2} \left(\sum_{j=1}^{\infty} E_9^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{10}^* \frac{\sin(2j+1)\pi ct}{2j+1} \right. \right.$$

$$\left. \right) \left(\sum_{k=1}^{\infty} E_{11}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{j=1}^{\infty} E_{12}^* \frac{\sin(2k+1)\pi s}{2k+1} \right) + \frac{1}{4\pi} \left(\sum_{j=1}^{\infty} E_{13}^* \frac{\cos(2j+1)\pi ct}{2j+1} \right.$$

$$
- \sum_{j=1}^{\infty} E_{14}^* \frac{\sin(2j+1)\pi ct}{2j+1} \Bigg) + \frac{1}{4\pi} \Bigg(\sum_{k=1}^{\infty} E_{15}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_{16}^* \frac{\sin(2k+1)\pi s}{2k+1}
$$

$$
\Bigg) \Bigg) \dot{Q}_q(t) + c^2 \Bigg(F_{10}^* + \frac{1}{\pi^2} \Bigg(\sum_{j=1}^{\infty} E_{17}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{18}^* \frac{\sin(2j+1)\pi ct}{2j+1} \Bigg)
$$

$$
\Bigg(\sum_{k=1}^{\infty} E_{19}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_{20}^* \frac{\sin(2k+1)\pi s}{2k+1} \Bigg) + \frac{1}{4\pi} \Bigg(\sum_{j=1}^{\infty} E_{21}^* \frac{\cos(2j+1)\pi ct}{2j+1} \tag{3.69}
$$

$$
- \sum_{j=1}^{\infty} E_{22}^* \frac{\sin(2j+1)\pi ct}{2j+1} \Bigg) + \frac{1}{4\pi} \Bigg(\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi s}{2k+1}
$$

$$
\Bigg) \Bigg) Q_q(t) \Bigg] = \sum_{q=1}^{\infty} \frac{g\alpha}{\theta^*} \Phi_m(ct)\Phi_m(s)
$$

where $\qquad \varrho^* = \frac{\varrho}{\theta^*}$

On expanding,simplifying and rearranging equation (4.88), one obtains

$$
\ddot{Q}_n(t) + 2c\alpha\varrho^* \Bigg(F_9^* + \frac{1}{\pi^2} \Bigg(\sum_{j=1}^{\infty} E_9^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{10}^* \frac{\sin(2j+1)\pi ct}{2j+1} \Bigg) \Bigg(\sum_{k=1}^{\infty} E_{11}^*
$$

$$
\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{12}^* \frac{\sin(2k+1)\pi ct}{2k+1} \Bigg) + \frac{1}{4\pi} \Bigg(\sum_{j=1}^{\infty} E_{13}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{14}^*
$$

$$
\frac{\sin(2j+1)\pi ct}{2j+1} \Bigg) + \Bigg(\sum_{k=1}^{\infty} E_{15}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{16}^* \frac{\sin(2k+1)\pi ct}{2k+1} \Bigg) \Bigg) \dot{Q}_n(t) +
$$

$$
\Bigg(v_n^2 \Bigg(1 - \alpha\varrho^* \Bigg(F_8^* + \frac{1}{\pi^2} \Bigg(\sum_{j=1}^{\infty} E_1^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_2^* \frac{\sin(2j+1)\pi ct}{2j+1} \Bigg)
$$

$$
\Bigg(\sum_{k=1}^{\infty} E_3^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_4^* \frac{\sin(2k+1)\pi ct}{2k+1} \Bigg) + \frac{1}{4\pi} \Bigg(\sum_{j=1}^{\infty} E_5^* \frac{\cos(2j+1)\pi ct}{2j+1} -
$$

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$$\sum_{j=1}^{\infty} E_6^* \frac{\sin(2j+1)\pi ct}{2j+1}\right) + \left(\sum_{k=1}^{\infty} E_7^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_8^* \frac{\sin(2k+1)\pi ct}{2k+1}\right)\right)\right)\right) +$$

$$c^2 \alpha \varrho^* \left(F_{10}^* + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty} E_{17}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{18}^* \frac{\sin(2j+1)\pi ct}{2j+1}\right)\left(\sum_{k=1}^{\infty} E_{19}^*\right)\right.$$

$$\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{20}^* \frac{\sin(2k+1)\pi ct}{2k+1}\right) + \frac{1}{4\pi}\left(\sum_{j=1}^{\infty} E_{21}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{22}^*$$

$$\left.\frac{\sin(2j+1)\pi ct}{2j+1}\right) + \left(\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi ct}{2k+1}\right)\right) Q_n(t)$$

$$+ \alpha \varrho^* \sum_{q=1, q \neq n}^{\infty} \left[\left(F_8^* + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty} E_1^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_2^* \frac{\sin(2j+1)\pi ct}{2j+1}\right)\left(\sum_{k=1}^{\infty} E_3^*\right.\right.$$

$$\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_4^* \frac{\sin(2k+1)\pi ct}{2k+1}\right) + \frac{1}{4\pi}\left(\sum_{j=1}^{\infty} E_5^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_6^*$$

$$\left.\frac{\sin(2j+1)\pi ct}{2j+1}\right) + \left(\sum_{k=1}^{\infty} E_7^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_8^* \frac{\sin(2k+1)\pi ct}{2k+1}\right)\right) \ddot{Q}_q(t) +$$

$$2c\left(F_9^* + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty} E_9^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{10}^* \frac{\sin(2j+1)\pi ct}{2j+1}\right)\left(\sum_{k=1}^{\infty} E_{11}^* \frac{\cos(2k+1)\pi ct}{2k+1}\right.\right.$$

$$\left.- \sum_{k=1}^{\infty} E_{12}^* \frac{\sin(2k+1)\pi ct}{2k+1}\right) + \frac{1}{4\pi}\left(\sum_{j=1}^{\infty} E_{13}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{14}^* \frac{\sin(2j+1)\pi ct}{2j+1}\right)$$

$$\left.+ \left(\sum_{k=1}^{\infty} E_{15}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{16}^* \frac{\sin(2k+1)\pi ct}{2k+1}\right)\right)\dot{Q}_q(t) + c^2\left(F_{10}^* + \frac{1}{\pi^2}\left(\sum_{j=1}^{\infty} E_{17}^*\right.\right.$$

$$\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{18}^* \frac{\sin(2j+1)\pi ct}{2j+1}\right)\left(\sum_{k=1}^{\infty} E_{19}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{20}^*\right.$$

$$\left.\frac{\sin(2k+1)\pi ct}{2k+1}\right) + \frac{1}{4\pi}\left(\sum_{j=1}^{\infty} E_{21}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{22}^* \frac{\sin(2j+1)\pi ct}{2j+1}\right) + \frac{1}{4\pi}$$

$$\left.\left(\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi ct}{2k+1}\right)\right) Q_q(t)\right] = \frac{g\alpha}{\theta^*}\Phi_m(ct)\Phi_m(s) \tag{3.70}$$

Applying modified asymptotic method of Struble, the solution to equation (3.70) takes the form

$$Q_n(t) = \psi(n,t)\cos(v_n t - G(n,t)) + v_n Q_1(t) + \dots \tag{3.71}$$

where

$$\psi(n,t) = \beta e^{-\alpha \varrho^* J_8 t} \tag{3.72}$$

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and

$$F(n,t) = \frac{1}{2v_n}\left[v_n^2\varpi\varphi^*\left(F_9^* + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_7^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_8^*\frac{\sin(2k+1)\pi s}{2k+1}\right)\right)\right.$$
$$\left. - c^2\varpi\varphi^*\left(F_{10}^* + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_{23}^*\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty}E_{24}^*\frac{\sin(2k+1)\pi ct}{2k+1}\right)\right)\right]t + \tau_n \qquad (3.73)$$

On putting equations (3.72) and (3.73) into equation (3.71), one obtains

$$Q_n(t) = Ze^{-\alpha\varrho^* J_8 t}\cos\left[v_n t - \frac{1}{2v_n}\left(v_n^2\alpha\varrho^*\left(F_8^* + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_7^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_8^*\right.\right.\right.\right.$$
$$\left.\frac{\sin(2k+1)\pi s}{2k+1}\right)\right) - c^2\alpha\varrho^*\left(F_{10}^* + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_{23}^*\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty}E_{24}^*\frac{\sin(2k+1)\pi ct}{2k+1}\right)$$
$$\left.\left.\right)\right)t - \tau_n\right]$$

$$(3.74)$$

On further simplifications, one obtains

$$Q_n(t) = Ze^{-\alpha\varrho^* J_8 t}\cos[\beta_n t - \varepsilon_n] \qquad (3.75)$$

where

$$\beta_n = v_n - \frac{1}{2v_n}\left(v_n^2\alpha\varrho^*\left(F_8^* + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_7^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_8^*\frac{\sin(2k+1)\pi s}{2k+1}\right)\right)\right.$$
$$\left. - c^2\alpha\varrho^*\left(F_{10}^* + \frac{1}{4\pi}\left(\sum_{k=1}^{\infty}E_{23}^*\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty}E_{24}^*\frac{\sin(2k+1)\pi ct}{2k+1}\right)\right)\right) \qquad (3.76)$$

is the modified frequency representing the frequency of the free system.

Using the same argument used to solve equation (3.56), the homogeneous part of equation (3.70) becomes

$$\ddot{Q}_n(t) + \beta_n^2 Q_n(t) = 0 \qquad (3.77)$$

Hence, the entire equation becomes

$$\ddot{Q}_n(t) + \beta_n^2 Q_n(t) = \frac{g\alpha}{\theta^*}\Phi_m(ct)\Phi_m(s) \qquad (3.78)$$

Rewriting equation (3.78), one obtains

$$\ddot{Q}_n(t) + \beta_n^2 Q_n(t) = \frac{g\alpha}{\theta^*}\Phi_m(s)[\sin\chi_m t + A_m\cos\chi_m t + B_m\sinh\chi_m t + C_m\cosh\chi_m t] \qquad (3.79)$$

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Following the procedures applied to solve equation (3.66), one obtains

$$Q_n(t) = \frac{g\alpha\Phi_m(s)}{\theta^*\beta_n(\chi_m^4 - \beta_n^4)}\left[(\chi_m^2 + \beta_n^2)(\chi_m \sin \beta_n t - \beta_n \sin \chi_m t) - A_m\beta_n(\chi_m^2 + \beta_n^2)\right.$$

$$(\cos \chi_m t - \cos \beta_n t) - B_m(\chi_m^2 - \beta_n^2)(\chi_m \sin \beta_n t - \beta_n \sinh \chi_m t) + C_m\beta_n(\chi_m^2 - \beta_n^2) \quad (3.80)$$

$$\left.(\cosh \chi_m t - \cos \beta_n t)\right]$$

which on inversion yields

$$W(x,y,t) = \sum_{jm=1}^{\infty}\sum_{hm=1}^{\infty}\frac{g\alpha\Phi_m(s)}{\theta^*\beta_n(\chi_m^4 - \beta_n^4)}\left[(\chi_m^2 + \beta_n^2)(\chi_m \sin \beta_n t - \beta_n \sin \chi_m t) - A_m\beta_n(\chi_m^2 + \beta_n^2)\right.$$

$$(\cos \chi_m t - \cos \beta_n t) - B_m(\chi_m^2 - \beta_n^2)(\chi_m \sin \beta_n t - \beta_n \sinh \chi_m t) + C_m\beta_n(\chi_m^2 - \beta_n^2)$$

$$\left.(\cosh \chi_m t - \cos \beta_n t)\right]\left(\sin \frac{\phi_{jm}}{L_x}x + A_{jm}\cos \frac{\phi_{jm}}{L_x}x + B_{jm}\sinh \frac{\phi_{jm}}{L_x}x + C_{jm}\cosh \frac{\phi_{jm}}{L_x}x\right)$$

$$\left(\sin \frac{\phi_{hm}}{L_y}y + A_{hm}\cos \frac{\phi_{hm}}{L_y}y + B_{hm}\sinh \frac{\phi_{hm}}{L_y}y + C_{hm}\cosh \frac{\phi_{hm}}{L_y}y\right)$$

$$(3.81)$$

which is the transverse displacement response to a moving mass of an orthotropic rectangular plate resting on variable elastic bi-parametric foundation.

3.3   ILLUSTRATIVE EXAMPLES

3.3.1   Orthotropic Rectangular Plate Clamped at All Edges

For an orthotropic plate clamped at all its edges, the boundary conditions are given by

$$W(0,y,t) = 0, \quad W(L_x,y,t) = 0 \quad (3.82)$$

$$W(x,0,t) = 0, \quad W(x,L_y,t) = 0 \quad (3.83)$$

$$\frac{\partial W(0,y,t)}{\partial x} = 0, \quad \frac{\partial W(L_x,y,t)}{\partial x} = 0 \quad (3.84)$$

$$\frac{\partial W(x,0,t)}{\partial y} = 0, \quad \frac{\partial W(x,L_y,t)}{\partial y} = 0 \quad (3.85)$$

Thus,for the normal modes

$$\xi_{pm}(0) = 0, \quad \xi_{pm}(L_x) = 0 \tag{3.86}$$

$$\xi_{qm}(0) = 0, \quad \xi_{qm}(L_y) = 0 \tag{3.87}$$

$$\frac{\partial \xi_{pm}(0)}{\partial x} = 0, \quad \frac{\partial \xi_{pm}(L_x)}{\partial x} = 0 \tag{3.88}$$

$$\frac{\partial \xi_{qm}(0)}{\partial y} = 0, \quad \frac{\partial \xi_{qm}(L_y)}{\partial y} = 0 \tag{3.89}$$

For simplicity, our initial conditions are of the form

$$W(x, y, 0) = 0 = \frac{\partial W(x, y, o)}{\partial t} \tag{3.90}$$

Using the boundary conditions in equations (3.86) to (3.89) and the initial conditions given by

equation (3.90), it can be shown that

$$A_{pm} = \frac{\sinh \xi_{pm} - \sin \xi_{pm}}{\cos \xi_{pm} - \cosh \xi_{pm}} = \frac{\cos \xi_{pm} - \cosh \xi_{pm}}{\sin \xi_{pm} + \sinh \xi_{pm}} \tag{3.91}$$

$$A_{qm} = \frac{\sinh \xi_{qm} - \sin \xi_{qm}}{\cos \xi_{qm} - \cosh \xi_{qm}} = \frac{\cos \xi_{qm} - \cosh \xi_{qm}}{\sin \xi_{qm} + \sinh \xi_{qm}} \tag{3.92}$$

In the same vein, we have

$$A_m = \frac{\sinh \xi_m - \sin \xi_m}{\cos \xi_m - \cosh \xi_m} = \frac{\cos \xi_m - \cosh \xi_m}{\sin \xi_m + \sinh \xi_m} \tag{3.93}$$

$$B_{pm} = -1, \quad B_{qm} = -1, \quad \Rightarrow B_m = -1 \tag{3.94}$$

$$C_{pm} = -A_{pm}, \quad C_{qm} = -A_{qm}, \quad \Rightarrow C_m = -A_m \tag{3.95}$$

and from equation (3.93) , one obtains

$$\cos \xi_m \cosh \xi_m = 1 \tag{3.96}$$

which is termed the frequency equation for the dynamical problem, such that

$$\xi_1 = 4.73004, \quad \xi_2 = 7.85320, \quad \xi_3 = 10.9951 \tag{3.97}$$

On using equations (3.91), (3.92), (3.93),(3.94),(3.95) and (3.97) in equations (3.68) and (3.81), one obtains the displacement response to a moving force and a moving mass of clamped orthotropic rectangular plate resting on bi-parametric condition respectively.

3.3.2 Graphs of the Clamped-clamped End Conditions

Figures 1 and 2 display the effect of foundation modulus K_o on the deflection profile of clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses respectively. The graphs show that the response amplitude decreases as the value of foundation modulus K_o increases.

Figure 3.1: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying K_o and Traversed by Moving Force

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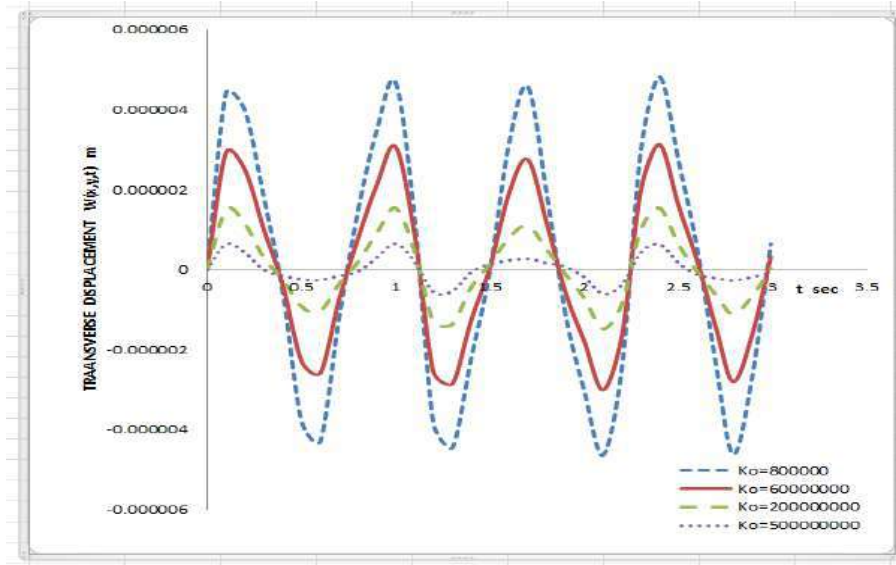
Figure 3.2: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying K_o and Traversed by Moving Mass

Figures 3 and 4 display the effect of shear modulus G_o on the deflection profile of clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses respectively. The graphs show that the response amplitude decreases as the value of shear modulus G_o increases.
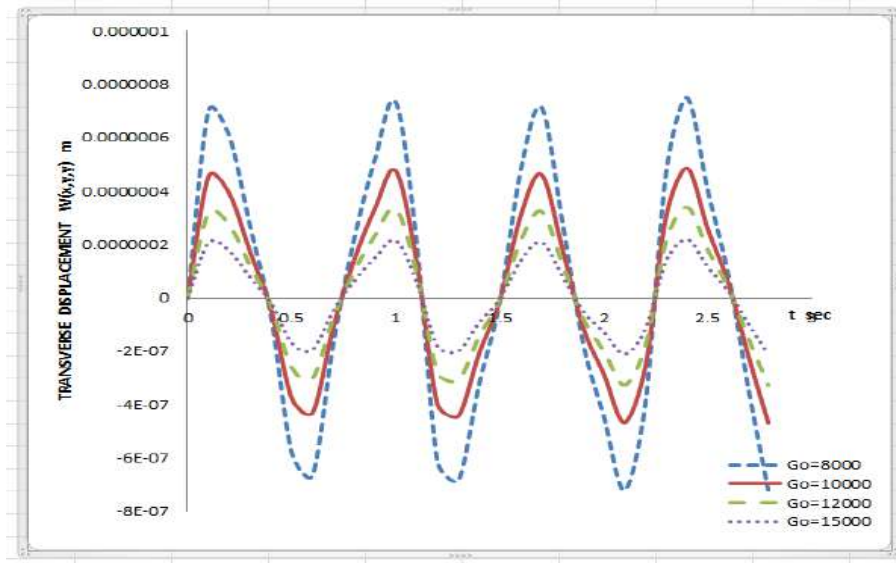
Figure 3.3: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying G_o and Traversed by Moving Force
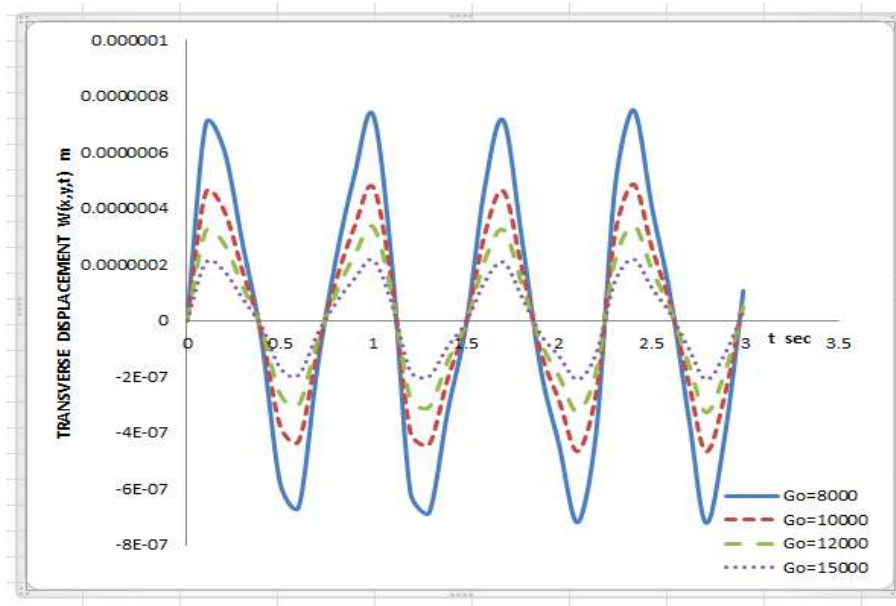
Figure 3.4: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying G_o and Traversed by Moving Mass

Figures 5 and 6 display the effect of flexural rigidity of the plate along x-axis D_x on the deflection profile of Clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses

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respectively. The graphs show that the response amplitude decreases as the value of flexural rigidity D_x increases.
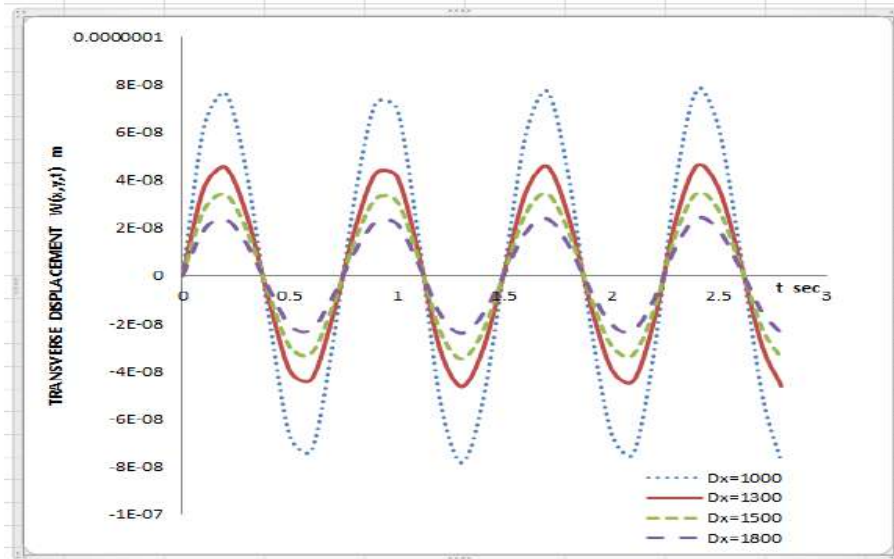
Figure 3.5: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying D_x and Traversed by Moving Force
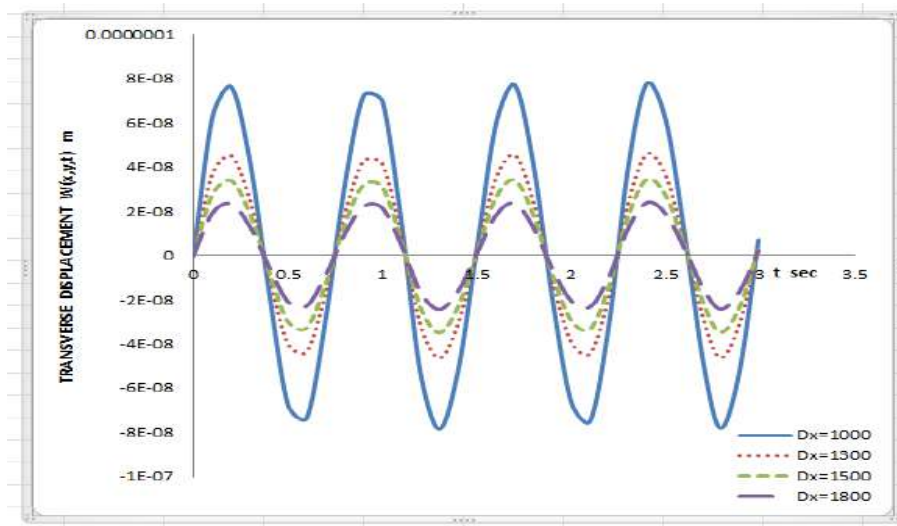
Figure 3.6: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying D_x and Traversed by Moving Mass

Figures 7 and 8 display the effect of flexural rigidity of the plate along y-axis D_y on the deflection

profile of Clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses respectively. The graphs show that the response amplitude decreases as the value of flexural rigidity D_y increases.
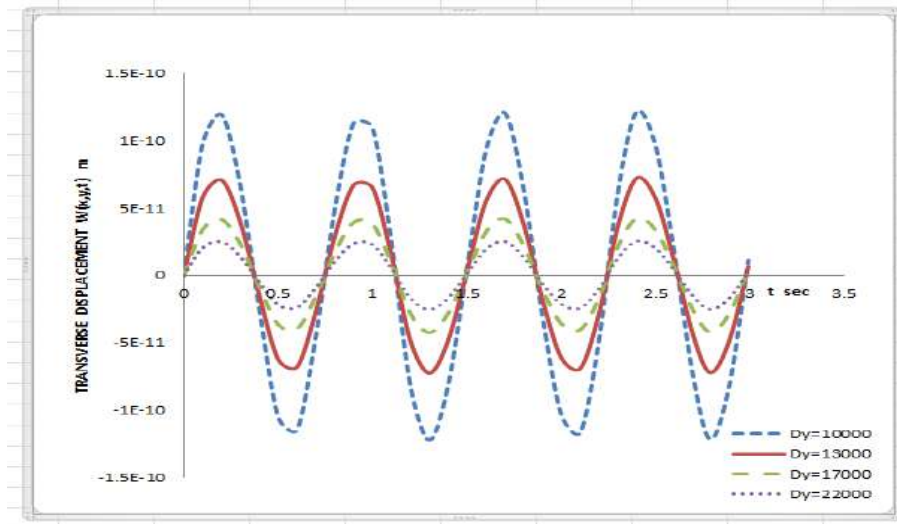
Figure 3.7: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying D_y and Traversed by Moving Force
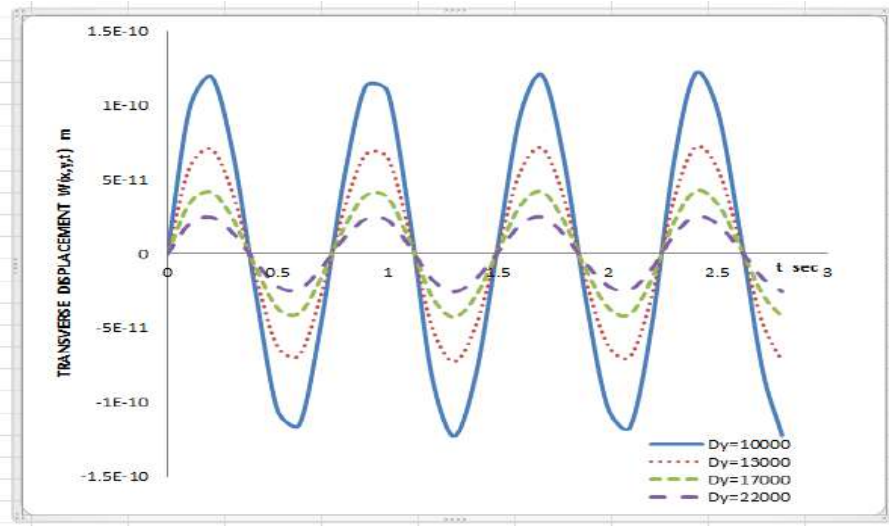
Figure 3.8: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying D_y and Traversed by Moving Mass

Figures 9 and 10 display the effect of rotatory inertia R_o on the deflection profile of Clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses respectively. The graphs show that the response amplitude decreases as the value of rotatory inertia R_o increases.
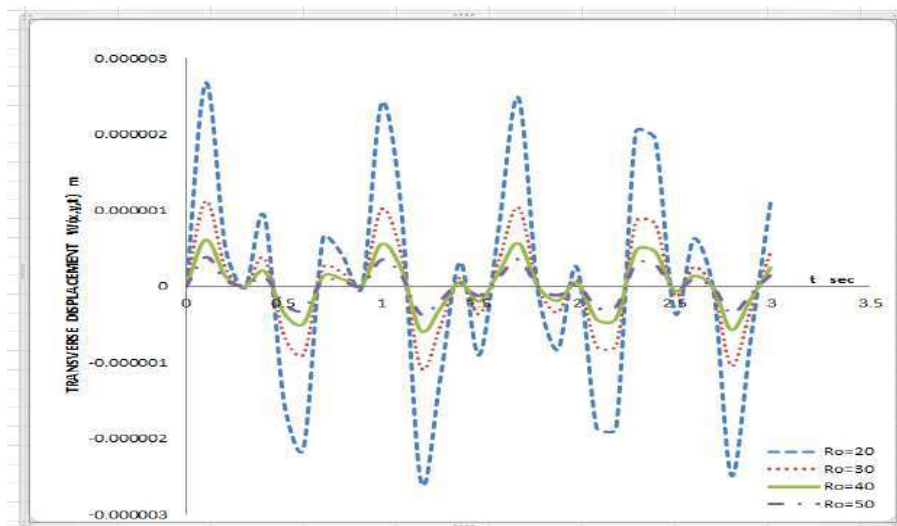
Figure 3.9: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying R_o and Traversed by Moving Force

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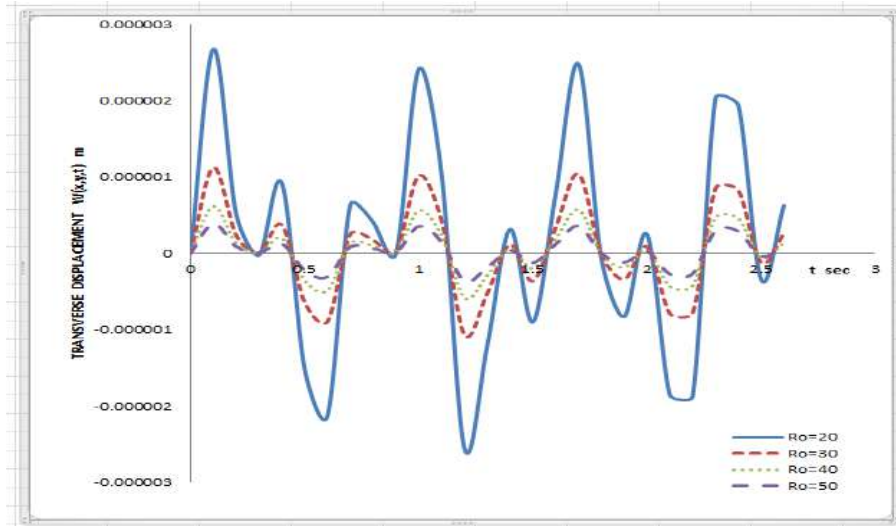
Figure 3.10: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying R_o and Traversed by Moving Mass

Figure 11 displays the comparison between moving force and moving mass for fixed values of $R_o, \quad G_o, \quad K_o, \quad D_x$ and D_y.
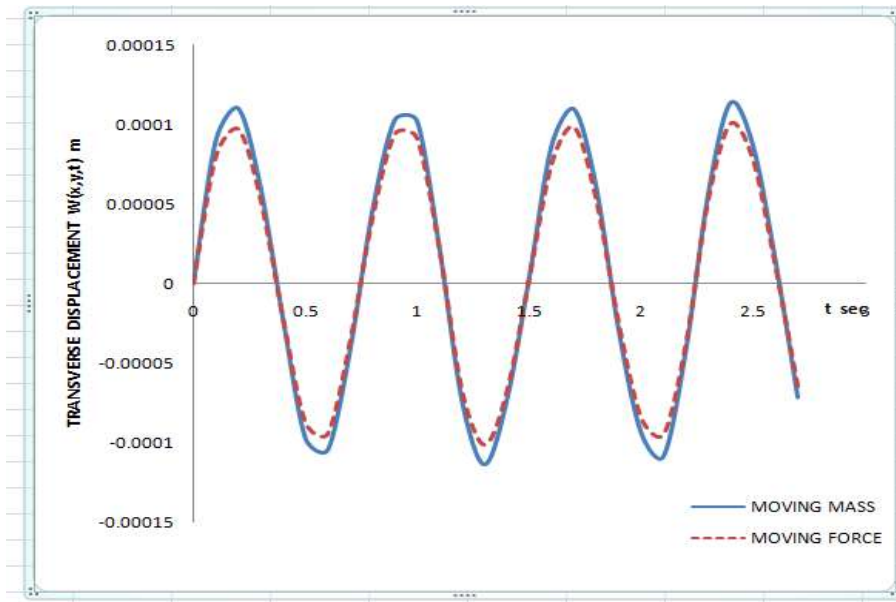
Figure 3.11: Displacement Profile of Comparison between Moving Force and Moving Mass

4   Conclusion

In this research work, the problem of vibration of orthotropic rectangular plate under the action of moving masses and resting on a variable elastic Pasternak foundation with clamped end conditions has been studied. The closed form solutions of the fourth order partial differential equations with variable and singular coefficients governing the orthotropic rectangular plates is obtained for both cases of moving force and moving mass using a solution technique that is based on the separation of variables which was used to remove the singularity in the governing fourth order partial differential equation and thereby reducing it to a sequence of coupled second order differential equations. The modified asymptotic method of Struble and Laplace transformation techniques are then employed to obtain the analytical solution to the two-dimensional dynamical problem.

The solutions are then analyzed. The analyses show that, for the same natural frequency and the critical speed, the moving mass problem is smaller than that of the moving force problem. Resonance is reached earlier in the moving mass system than in the moving force problem. That is to say the moving force solution is not an upper bound for the accurate solution of the moving mass problem.

The results in plotted curves show that as foundation modulus K_o and the shear modulus G_o increase, the amplitudes of plates decrease for both cases of moving force and moving mass problems. As the rotatory inertia correction factor R_o increases, the amplitudes of plates decrease for both cases of moving force and moving mass problems. As the flexural rigidities along both the x-axis D_x and y-axis D_y increase, the amplitudes of plates decrease for both cases of moving force and moving mass problems.

It can be shown further from the results that for fixed values of foundation modulus and shear modulus, rotatory inertia correction factor, flexural rigidities along both x-axis and y-axis,the

amplitude for the moving mass problem is greater than that of the moving force problem which implies that resonance is reached earlier in moving mass problem than in moving force problem of simply supported orthotropic rectangular plates resting on bi-parametric foundation.

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Vibration of Orthotropic Rectangular Plates Under the Action of Moving Distributed Masses and Resting on a Variable Elastic Pasternak Foundation with Clamped End Conditions

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Abstract— This work investigates the vibration of orthotropic rectangular plate resting on a variable elastic Pasternak foundation under the action of moving distributed masses. The governing equation is a fourth order partial differential equation with variable and singular co-efficients. The solutions to the problem are obtained by transforming the fourth order partial differential equation for the problem to a set of coupled second order ordinary differential equations using the technique of Shadnam et al[11] which are then simplified using modified asymptotic method of Struble. The closed form solution is analyzed, resonance conditions are obtained and the results are presented in plotted curves for both cases of moving distributed mass and moving distributed force.

I. INTRODUCTION

The problems related to thin structural bodies (rods, beams, plates,and shells) with other bodies have widespread application in various fields of science and technology. The physical phenomena involved in the impact event include structural responses, contact effects and wave propagation. The problems associated with these are always topical issues in the field of applied mechanics. Since these problems belong to the problems related to dynamic contact interaction, their solution is connected with cumbersome mathematical tasks. To this end , several researchers had worked and some are still working on the dynamic behavior of orthotropic rectangular plates. Ambartsumian [1] examined the five fundamental differential equations describing the equilibrium of an orthotropic plate with a cylindrical anisotropy for the case when all radial planes

crossing the axis of anisotropy are the planes of elastic symmetry. Sveklo [2] suggested the contact theory for two anisotropic bodies under compression according to which the contact pressure is distributed over an elliptical contact region. The same structural effects are also true of the concrete slab in a composite girder bridge, but the steel orthotropic deck is considerably lighter, and therefore allows longer span bridges to be more efficiently designed. Awodola [3] studied the effect of plate parameters on the vibrations under moving masses of elastically supported plate resting on bi-parametric foundation with stiffness variation.Szekrenyes [4] investigated the interface fracture in orthotropic composite plates using second order shear deformation theory. Yan [5] proposed elastic orthotropic models and used these in the nonlinear analysis of concrete structures subjected to monotonic or pseudo dynamic

loading. Since these models can appropriately describe the strain softening behavior of concrete beyond the peak stress and show good agreement with the strength envelope obtained from experimental results Hu and Yao [6] studied the vibration solutions of rectangular orthotropic plates by symplectic geometry method. In the same vien, Alshaya, Hunt and Rowlands [7] examined stresses and strains in thick perforated orthotropic plates. Gbadeyan and Dada [8] found the natural frequency of rectangular plates traversed by moving concentrated masses. Awodola and Adeoye [9] investigated the behavior of simply supported orthotropic rectangular plate by applying the technique of variable separable. Adeoye and Awodola [10] studied the dynamic behavior of orthotropic rectangular plate with clamped-clamped boundary conditions by making use of the technique of Shadnam Due to inability of researchers to

solve orthotropic plates problems by analytical methods, this work aims at solving the governing equation by analytical solution and also considers the effect of the flexural rigidities in both x and y directions.

II.   GOVERNING EQUATION

The dynamic transverse displacement $W(x, y, t)$ of orthotropic rectangular plates when it is resting on a bi-parametric elastic foundation and traversed by distributed mass M_r moving with constant velocity c_r along a straight line parallel to the x-axis issuing from point y = s on the y-axis with flexural rigidities D_x and D_y is governed by the fourth order partial differential equation given as

$$D_x \frac{\partial^4}{\partial x^4} W(x,y,t) + 2B \frac{\partial^4}{\partial x^2 \partial y^2} W(x,y,t) + D_y \frac{\partial^4}{\partial y^4} W(x,y,t) + \mu \frac{\partial^2}{\partial t^2} W(x,y,t) - \rho h R_0$$
$$[\frac{\partial^4}{\partial x^2 \partial t^2} W(x,y,t) + \frac{\partial^4}{\partial y^2 \partial t^2} W(x,y,t)] + K_0(4x - 3x^2 + x^3)W(x,y,t) + S_0(-13 +$$
$$12x + 3x^2)\frac{\partial}{\partial x} W(x,y,t) - S_0(12 - 13x + 6x^2 + x^3)[\frac{\partial^2}{\partial x^2} W(x,y,t) + \frac{\partial^2}{\partial y^2} W(x,y,t)] \qquad (2.1)$$
$$-\sum_{r=1}^{N} [M_r g H(x-ct)H(y-s) - M_r(\frac{\partial^2}{\partial t^2} W(x,y,t) + 2c_r \frac{\partial^2}{\partial x \partial t} W(x,y,t) + c_r^2$$
$$\frac{\partial^2}{\partial x^2} W(x,y,t))H(x-c_r t)H(y-s)] = 0$$

where D_x and D_y are the flexural rigidities of the plate along x and y axes respectively.

$$D_x = \frac{E_x h^3}{12(1-\nu_x \nu_y)}, \quad D_y = \frac{E_y h^3}{12(1-\nu_x \nu_y)}, \quad B = D_x D_y + \frac{G_o h^3}{6} \qquad (2.2)$$

E_x and E_y are the Young's moduli along x and y axes respectively, G_o is the rigidity modulus, ν_x and ν_y are Poisson's ratios for the material such that $E_x \nu_y = E_y \nu_x$, ρ is the mass density per unit volume of the plate, h is the plate thickness, t is the time, x and y are the spatial coordinates in x and y directions respectively, R_o is the rotatory inertia correction factor, K_o is the foundation constant, S_o shear modulus and g is the acceleration due to gravity, H(.) is the Heaviside function.

Rewriting equation (2.1), one obtains

$$\mu \frac{\partial^2}{\partial t^2} W(x,y,t) + \mu \omega_n^2 W(x,y,t) = \rho h R_0 [\frac{\partial^4}{\partial x^2 \partial t^2} W(x,y,t) + \frac{\partial^4}{\partial y^2 \partial t^2} W(x,y,t)] - 2B$$
$$\frac{\partial^4}{\partial x^2 \partial y^2} W(x,y,t) - D_y \frac{\partial^4}{\partial y^4} W(x,y,t) - D_x \frac{\partial^4}{\partial x^4} W(x,y,t) + \mu \omega_n^2 W(x,y,t) - K_0(4x -$$
$$3x^2 + x^3)W(x,y,t) + G_o(-13 + 12x + 3x^2)\frac{\partial}{\partial x} W(x,y,t) - G_0(12 - 13x + 6x^2 + x^3)[\qquad (2.3)$$
$$\frac{\partial^2}{\partial x^2} W(x,y,t) + \frac{\partial^2}{\partial y^2} W(x,y,t)] + \sum_{r=1}^{N} [M_r g H(x-c_r t)H(y-s) - M_r(\frac{\partial^2}{\partial t^2} W(x,y,t)$$
$$+2c_r \frac{\partial^2}{\partial x \partial t} W(x,y,t) + c_r^2 \frac{\partial^2}{\partial x^2} W(x,y,t))H(x-c_r t)H(y-s)]$$

Simplifying equation (2.3) further, one obtains

$$\frac{\partial^2}{\partial t^2} W(x,y,t) + \omega_n^2 W(x,y,t) = \sum_{r=1}^{N} [R_0(\frac{\partial^4}{\partial x^2 \partial t^2} W(x,y,t) + \frac{\partial^4}{\partial y^2 \partial t^2} W(x,y,t)) - \frac{2B}{\mu}$$
$$\frac{\partial^4}{\partial x^2 \partial y^2} W(x,y,t) - \frac{D_y}{\mu} \frac{\partial^4}{\partial y^4} W(x,y,t) - \frac{D_x}{\mu} \frac{\partial^4}{\partial x^4} W(x,y,t) + \omega_n^2 W(x,y,t) - \frac{K_0}{\mu}(4x - 3x^2$$
$$+x^3)W(x,y,t) + \frac{G_o}{\mu}(-13 + 12x + 3x^2)\frac{\partial}{\partial x} W(x,y,t) - \frac{G_0}{\mu}(12 - 13x + 6x^2 + x^3)(\frac{\partial^2}{\partial x^2} \qquad (2.4)$$
$$W(x,y,t) + \frac{\partial^2}{\partial y^2} W(x,y,t)) + \sum_{r=1}^{N} (\frac{M_r}{\mu} g H(x-c_r t)H(y-s) - \frac{M_r}{\mu}(\frac{\partial^2}{\partial t^2} W(x,y,t) + 2c_r$$
$$\frac{\partial^2}{\partial x \partial t} W(x,y,t) + c_r^2 \frac{\partial^2}{\partial x^2} W(x,y,t))H(x-c_r t)H(y-s))]$$

where ω_n^2 is the natural frequencies, $n = 1,2,3,\ldots$

The initial conditions, without any loss of generality, is taken as

$$W(x,y,t) = 0 = \frac{\partial}{\partial t}W(x,y,t) \tag{2.5}$$

III.   ANALYTICAL APPROXIMATE SOLUTION

In order to solve equation (2.4), one applies technique of Shadnam et al which requires that the deflection of the plates be in series form as

$$W(x,y,t) = \sum_{n=1}^{N} \Psi_n(x,y)Q_n(t) \tag{3.1}$$

where

$$\Psi_n(x,y) = \Psi_{jm}(x)\Psi_{hm}(y)$$

$$\Psi_{jm}x = \sin\zeta_{jm}x + A_{jm}\cos\zeta_{jm}x + B_{jm}\sinh\zeta_{jm}x + C_{jm}\cosh\zeta_{jm}x$$

$$\Psi_{hm}y = \sin\varphi_{hm}y + A_{hm}\cos\varphi_{hm}y + B_{hm}\sinh\varphi_{hm}y + C_{hm}\cosh\varphi_{hm}y$$

$$\zeta_{jm} = \frac{\phi_{jm}}{L_x}, \quad \varphi_{hm} = \frac{\phi_{hm}}{L_y}$$

The right hand side of equation (2.4), taken into account equation (3.1), written in the form of series takes the form

$$\sum_{n=1}^{\infty} [R_0(\frac{\partial^2}{\partial x^2}\Psi_n(x,y)\ddot{Q}_n(t) + \frac{\partial^4}{\partial y^2}\Psi_n(x,y)\ddot{Q}_n(t)) - \frac{2B}{\mu}\frac{\partial^4}{\partial x^2\partial y^2}\Psi_n(x,y)Q_n(t) - \frac{D_y}{\mu}\frac{\partial^4}{\partial y^4}$$
$$\Psi_n(x,y)Q_n(t) - \frac{D_x}{\mu}\frac{\partial^4}{\partial x^4}\Psi_n(x,y)Q_n(t) + \omega_n^2\Psi_n(x,y)Q_n(t) - \frac{K_0}{\mu}(4x - 3x^2 + x^3)\Psi_n(x,y)$$
$$Q_n(t) + \frac{G_o}{\mu}(-13 + 12x + 3x^2)\frac{\partial}{\partial x}\Psi_n(x,y)Q_n(t) - \frac{G_0}{\mu}(12 - 13x + 6x^2 + x^3)(\frac{\partial^2}{\partial x^2}\Psi_n(x,y) \tag{3.2}$$
$$Q_n(t) + \frac{\partial^2}{\partial y^2}\Psi_n(x,y)Q_n(t)) + \sum_{r=1}^{N}(\frac{M_r}{\mu}gH(x - c_rt)H(y - s) - \frac{M_r}{\mu}(\Psi_n(x,y)\ddot{Q}_n(t) +$$
$$2c\frac{\partial}{\partial x}\Psi_n(x,y)\dot{Q}_n(t) + c_r^2\frac{\partial^2}{\partial x^2}\Psi_n(x,y)Q_n(t))H(x - c_rt)H(y - s))] = \sum_{n=1}^{N}\Psi_n(x,y)\Theta_n(t)$$

Multiplying both sides of equation (3.2) by $\Psi_m(x,y)$ and integrating on area A of the plate and considering the orthogonality of $\Psi_n(x,y)$, one obtains

$$\Theta_n(t) = \frac{1}{\theta^*}\sum_{n=1}^{\infty}\int_A [R_0(\frac{\partial^2}{\partial x^2}\Psi_n(x,y)\ddot{Q}_n(t) + \frac{\partial^4}{\partial y^2}\Psi_n(x,y)\ddot{Q}_n(t)) - \frac{2B}{\mu}\frac{\partial^4}{\partial x^2\partial y^2}\Psi_n(x,y)$$
$$Q_n(t) - \frac{D_y}{\mu}\frac{\partial^4}{\partial y^4}\Psi_n(x,y)Q_n(t) - \frac{D_x}{\mu}\frac{\partial^4}{\partial x^4}\Psi_n(x,y)Q_n(t) + \omega_n^2\Psi_n(x,y)Q_n(t) - \frac{K_0}{\mu}(4x -$$
$$3x^2 + x^3)\Psi_n(x,y)Q_n(t) + \frac{G_o}{\mu}(-13 + 12x + 3x^2)\frac{\partial}{\partial x}\Psi_n(x,y)Q_n(t) - \frac{G_o}{\mu}(12 - 13x$$
$$+6x^2 + x^3)(\frac{\partial^2}{\partial x^2}\Psi_n(x,y)Q_n(t) + \frac{\partial^2}{\partial y^2}\Psi_n(x,y)Q_n(t)) + \sum_{r=1}^{N}(\frac{M_r}{\mu}gH(x - c_rt)H(y - s) \tag{3.3}$$
$$-\frac{M_r}{\mu}(\Psi_n(x,y)\ddot{Q}_n(t) + 2c\frac{\partial}{\partial x}\Psi_n(x,y)\dot{Q}_n(t) + c_r^2\frac{\partial^2}{\partial x^2}\Psi_n(x,y)Q_n(t))H(x - c_rt)H(y - s)$$
$$)]\Psi_m(x,y)dA$$

and zero when $n \neq m$

where

$$\theta^* = \int_A \Psi_n^2(x,y)dA \tag{3.4}$$

Making use of equation (3.3) and taking into account equation (3.2), equation (2.4) can be written as

$$\Psi_n(x,y)[\omega_n^2 Q_n(t) + \ddot{Q}_n(t)] = \frac{\Psi_n(x,y)}{\theta^*}\sum_{q=1}^{\infty}\int_A [R_0(\frac{\partial^2\Psi_q(x,y)}{\partial x^2}\Psi_m(x,y)\ddot{Q}_q(t) + \frac{\partial^2\Psi_q(x,y)}{\partial y^2}$$

$$\Psi_m(x,y)\ddot{Q}_q(t)) - \frac{2B}{\mu}\frac{\partial^2\Psi_q(x,y)}{\partial x^2 \partial y^2}\Psi_m(x,y)Q_q(t) - \frac{D_y}{\mu}\frac{\partial^4\Psi_q(x,y)}{\partial y^4}\Psi_m(x,y)Q_q(t) + \frac{D_x}{\mu}\frac{\partial^4\Psi_q(x,y)}{\partial x^4}$$

$$\Psi_m(x,y)Q_q(t) - \frac{K_0}{\mu}(4x - 3x^2 + x^3)\Psi_q(x,y)\Psi_m(x,y)Q_q(t) + \frac{G_o}{\mu}(-13 + 12x + 3x^2)\frac{\partial\Psi_q(x,y)}{\partial x}$$

$$\Psi_m(x,y)Q_q(t) - \frac{G_o}{\mu}(12 - 13x + 6x^2 + x^3)(\frac{\partial^2\Psi_q(x,y)}{\partial x^2}\Psi_m(x,y)Q_q(t) + \frac{\partial^2\Psi_q(x,y)}{\partial y^2}\Psi_m(x,y)$$

$$Q_q(t)) + \sum_{r=1}^{N}(\frac{M_r}{\mu}g\Psi_m(x,y)H(x - c_r t)H(y - s) - \frac{M_r}{\mu}(\Psi_q(x,y)\Psi_m(x,y)\ddot{Q}_q(t) + 2c_r$$

$$\frac{\partial\Phi_q(x,y)}{\partial x}\Phi_m(x,y)\dot{Q}_q(t) + c_r^2\frac{\partial^2\Phi_q(x,y)}{\partial x^2}\Phi_m(x,y)Q_q(t))H(x - c_r t)H(y - s))]dA \qquad (3.5)$$

On further simplification of equation (3.5), one obtains

$$\ddot{Q}_n(t) + \omega_n^2 Q_n(t) = \frac{1}{\theta^*}\sum_{q=1}^{\infty}\int_A [R_0(\frac{\partial^2\Psi_q(x,y)}{\partial x^2}\Psi_m(x,y)\ddot{Q}_q(t) + \frac{\partial^2\Psi_q(x,y)}{\partial y^2}\Psi_m(x,y)\ddot{Q}_q(t))$$

$$- \frac{2B}{\mu}\frac{\partial^2\Psi_q(x,y)}{\partial x^2 \partial y^2}\Psi_m(x,y)Q_q(t) - \frac{D_y}{\mu}\frac{\partial^4\Psi_q(x,y)}{\partial y^4}\Psi_m(x,y)Q_q(t) - \frac{D_x}{\mu}\frac{\partial^4\Psi_q(x,y)}{\partial x^4}\Psi_m(x,y)$$

$$Q_q(t) + \omega_q^2\Psi_q(x,y)\Psi_m(x,y)Q_n(t) - \frac{K_0}{\mu}(4x - 3x^2 + x^3)\Psi_q(x,y)\Psi_m(x,y)Q_q(t) + \frac{G_o}{\mu}(-13$$

$$+ 12x + 3x^2)\frac{\partial\Psi_q(x,y)}{\partial x}\Psi_m(x,y)Q_q(t) - \frac{G_o}{\mu}(12 - 13x + 6x^2 + x^3)(\frac{\partial^2\Psi_q(x,y)}{\partial x^2}\Psi_m(x,y)Q_q(t) \qquad (3.6)$$

$$+ \frac{\partial^2\Psi_q(x,y)}{\partial y^2}\Psi_m(x,y)Q_q(t)) + \sum_{r=1}^{N}(\frac{M_r}{\mu}g\Psi_m(x,y)H(x - c_r t)H(y - s) - \frac{M_r}{\mu}(\Psi_q(x,y)\Psi_m(x,y)$$

$$\ddot{Q}_q(t) + 2c_r\frac{\partial\Phi_q(x,y)}{\partial x}\Phi_m(x,y)\dot{Q}_q(t) + c_r^2\frac{\partial^2\Phi_q(x,y)}{\partial x^2}\Phi_m(x,y)Q_q(t))H(x - c_r t)H(y - s))]dA$$

The system of equations in equation (3.6) is a set of coupled ordinary differential equations

where $H(x - c_r t)$ and $H(y - s)$ are the Heaviside functions which are defined as

$$H(x - c_r t) = \begin{cases}1, for\ x\geq c_r t \\ 0, for\ x < c_r t\end{cases}, \qquad H(y - s) = \begin{cases}1, for\ y\geq s \\ 0, for\ y < s\end{cases} \qquad (3.7)$$

With the properties

$$(i)\frac{d}{dx}[H(x - c_r t)] = \delta(x - c_r t), \qquad \frac{d}{dy}[H(y - s)] = \delta(y - s) \qquad (3.8)$$

$$(ii)f(x)H(x - c_r t) = \begin{cases}f(x), for\ x\geq c_r t \\ 0, for\ x < c_r t\end{cases}, \qquad f(y)H(y - s) = \begin{cases}f(y), for\ y\geq s \\ 0, for\ y < s\end{cases} \qquad (3.9)$$

Using the Fourier series representation, the Heaviside functions take the form

$$H(x - c_r t) = \frac{1}{4} + \frac{1}{\pi}\sum_{r=1}^{N}\frac{\sin(2n+1)\pi(x - c_r t)}{2n+1}, 0 < x < 1 \qquad (3.10)$$

$$H(y - s) = \frac{1}{4} + \frac{1}{\pi}\sum_{r=1}^{N}\frac{\sin(2n+1)\pi(y - s)}{2n+1}, 0 < y < 1 \qquad (3.11)$$

On putting equations (3.7) to (3.11) into equation (3.6) and simplifying, one obtains

$$\ddot{Q}_n(t) + \omega_n^2 Q_n(t) - \frac{1}{\theta^*}\sum_{q=1}^{\infty}[R_0 T_1\ddot{Q}_q(t) - \frac{2B}{\mu}T_2 Q_q(t) - \frac{D_y}{\mu}T_3 Q_q(t) - \frac{D_x}{\mu}T_4 Q_q(t) + (\omega_q^2 F_4^* -$$

$$\frac{K_0}{\mu}F_5^*)Q_q(t) + \frac{G_o}{\mu}(T_6 + T_7)Q_q(t) - \sum_{r=1}^{N}\frac{M_r}{\mu}((T_8 + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_1^*\frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty}E_2^*$$

$$\frac{\sin(2j+1)\pi c_r t}{2j+1})(\sum_{k=1}^{\infty}E_3^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_4^*\frac{\sin(2k+1)\pi s}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty}E_5^*\frac{\cos(2j+1)\pi c_r t}{2j+1}$$

$$- \sum_{j=1}^{\infty}E_6^*\frac{\sin(2j+1)\pi c_r t}{2j+1}) + \frac{1}{4\pi}(\sum_{k=1}^{\infty}E_7^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_8^*\frac{\sin(2k+1)\pi s}{2k+1}))\ddot{Q}_q(t) +$$

$$2c_r(T_9 + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_9^*\frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty}E_{10}^*\frac{\sin(2j+1)\pi c_r t}{2j+1})(\sum_{k=1}^{\infty}E_{11}^*\frac{\cos(2k+1)\pi s}{2k+1}$$

$$-\sum_{k=1}^{\infty} E_{12}^* \frac{\sin(2k+1)\pi s}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty} E_{13}^* \frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty} E_{14}^* \frac{\sin(2j+1)\pi c_r t}{2j+1})$$
$$+ \frac{1}{4\pi}(\sum_{k=1}^{\infty} E_{15}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_{16}^* \frac{\sin(2k+1)\pi s}{2k+1}))\dot{Q}_q(t) + c_r^2(T_{10} + \frac{1}{\pi^2}(\sum_{j=1}^{\infty} E_{17}^*$$
$$\frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty} E_{18}^* \frac{\sin(2j+1)\pi c_r t}{2j+1})(\sum_{k=1}^{\infty} E_{19}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_{20}^* \frac{\sin(2k+1)\pi s}{2k+1}$$
$$) + \frac{1}{4\pi}(\sum_{j=1}^{\infty} E_{21}^* \frac{\cos(2j+1)\pi c_r t}{2j+1} - \sum_{j=1}^{\infty} E_{22}^* \frac{\sin(2j+1)\pi c_r t}{2j+1}) + \frac{1}{4\pi}(\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi s}{2k+1}$$
$$-\sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi s}{2k+1}))Q_q(t))] = \sum_{q=1}^{\infty} \sum_{r=1}^{N} \frac{M_r g}{\mu\theta^*} \Psi_m(ct)\Psi_m(s) \tag{3.12}$$

which is the transformed equation governing the problem of an orthotropic rectangular plate resting on bi-parametric elastic foundation.

where

$$T_1 = \int_A [\frac{\partial^2}{\partial x^2}\Psi_q(x,y)\Psi_m(x,y) + \frac{\partial^2}{\partial y^2}\Psi_q(x,y)\Psi_m(x,y)]dA \tag{3.13}$$

$$T_2 = \int_A \frac{\partial^2}{\partial x^2}[\frac{\partial^2}{\partial x^2}\Psi_q(x,y)]\Psi_m(x,y)dA \tag{3.14}$$

$$T_3 = \int_A \frac{\partial^4}{\partial y^4}[\Psi_q(x,y)]\Psi_m(x,y)dA \tag{3.15}$$

$$T_4 = \int_A \frac{\partial^4}{\partial x^4}[\Psi_q(x,y)]\Psi_m(x,y)dA \tag{3.16}$$

$$F_4^* = \int_A \Psi_q(x,y)\Psi_m(x,y)dA \tag{3.17}$$

$$T_5 = 4U_1 - 3U_2 + U_3, \qquad T_6 = -13A_1 + 12A_2 + 3A_3 \tag{3.18}$$

$$T_7 = 12f_1 - 13f_2 + 6f_3 + f_4 + 12f_5 - 13f_6 + 6f_7 + f_8 \tag{3.19}$$

$$T_8 = \frac{1}{16}\int_A \Psi_q(x,y)\Psi_m(x,y)dA \tag{3.20}$$

$$E_1^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\sin(2j+1)\pi x dA \tag{3.21}$$

$$E_2^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\cos(2j+1)\pi x dA \tag{3.22}$$

$$E_3^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\sin(2k+1)\pi y dA \tag{3.23}$$

$$E_4^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\cos(2k+1)\pi y dA \tag{3.24}$$

$$E_5^* = E_1^*, \quad E_6^* = E_2^*, \quad E_7^* = E_3^*, \quad E_8^* = E_4^* \tag{3.25}$$

$$T_9 = \frac{1}{16}\int_A \frac{\partial}{\partial x}\Psi_q(x,y)\Psi_m(x,y)dA \tag{3.26}$$

$$E_9^* = \int_A \frac{\partial}{\partial x}(\Psi_q(x,y))\Psi_m(x,y)\sin(2j+1)\pi x dA \tag{3.27}$$

$$E_{10}^* = \int_A \frac{\partial}{\partial x}(\Psi_q(x,y))\Psi_m(x,y)\cos(2j+1)\pi x dA \tag{3.28}$$

$$E_{11}^* = \int_A \frac{\partial}{\partial x}(\Psi_q(x,y))\Psi_m(x,y)\sin(2k+1)\pi y dA \tag{3.29}$$

$$E_{12}^* = \int_A \frac{\partial}{\partial x}\Psi_q(x,y)\Psi_m(x,y)\cos(2k+1)\pi y dA \tag{3.30}$$

$$E_{13}^* = E_9^*, \quad E_{14}^* = E_{10}^*, \quad E_{15}^* = E_{11}^*, \quad E_{16}^* = E_{12}^* \tag{3.31}$$

$$T_{10} = \frac{1}{16}\int_A \frac{\partial^2}{\partial x^2}(\Psi_q(x,y))\Psi_m(x,y)dA \tag{3.32}$$

$$E_{17}^* = \int_A \frac{\partial^2}{\partial x^2}(\Psi_q(x,y))\Psi_m(x,y)\sin(2j+1)\pi x dA \tag{3.33}$$

$$E_{18}^* = \int_A \frac{\partial^2}{\partial x^2}(\Psi_q(x,y))\Psi_m(x,y)\cos(2j+1)\pi x dA \tag{3.34}$$

$$E_{19}^* = \int_A \Psi_q(x,y)\Psi_m(x,y)\sin(2k+1)\pi y dA \tag{3.35}$$

$$E_{20}^* = \int_A \frac{\partial^2}{\partial x^2}(\Psi_q(x,y))\Psi_m(x,y)\cos(2k+1)\pi y dA \tag{3.36}$$

$$E_{21}^* = E_{17}^*, \quad E_{22}^* = E_{18}^*, \quad E_{23}^* = E_{19}^*, \quad E_{24}^* = E_{20}^* \tag{3.37}$$

$\Psi_m(x,y)$ is assumed to be the products of functions $\Psi_{pm}(x)\Psi_{bm}(y)$ which are the beam functions in the directions of x and y axes respectively. That is

$$\Psi_m(x,y) = \Psi_{pm}(x)\Psi_{bm}(y) \tag{3.38}$$

where

$$\Phi_m(x) = \sin\frac{\Gamma_m x}{L_x} + A_m\cos\frac{\Gamma_m x}{L_x} + B_m\sinh\frac{\Gamma_m x}{L_x} + C_m\cosh\frac{\Gamma_m x}{L_x} \tag{3.39}$$

$$\Phi_m(y) = \sin\frac{\Gamma_m y}{L_y} + A_m\cos\frac{\Gamma_m y}{L_y} + B_m\sinh\frac{\Gamma_m y}{L_y} + C_m\cosh\frac{\Gamma_m y}{L_y} \tag{3.40}$$

where A_{pm}, B_{pm}, C_{pm}, A_{bm}, B_{bm} and C_{bm} are constants determined by the boundary conditions. And Ψ_{pm} and Ψ_{bm} are called the mode frequencies

where

$$\lambda_{pm} = \frac{\xi_{pm}}{L_x}, \qquad \lambda_{bm} = \frac{\xi_{bm}}{L_y} \tag{3.41}$$

Considering a unit mass, equation (3.12) can be re-written as

$$\ddot{Q}_n(t) + \omega_n^2 Q_n(t) - \frac{1}{\theta^*}\sum_{q=1}^{\infty}\left[R_0 T_1 \ddot{Q}_q(t) - \frac{2B}{\mu}T_2 Q_q(t) - \frac{D_y}{\mu}T_3 Q_q(t) - \frac{D_x}{\mu}T_4 Q_q(t) + \right.$$

$$(\omega_q^2 F_4^* - \frac{K_0}{\mu}T_5)Q_q(t) + \frac{G_0}{\mu}(T_6 + T_7)Q_q(t) - \alpha\rho((T_8 + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_1^* \frac{\cos(2j+1)\pi ct}{2j+1}$$

$$-\sum_{j=1}^{\infty}E_2^* \frac{\sin(2j+1)\pi ct}{2j+1})(\sum_{k=1}^{\infty}E_3^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_4^* \frac{\sin(2k+1)\pi s}{2k+1}) + \frac{1}{4\pi}($$

$$\sum_{j=1}^{\infty}E_5^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_6^* \frac{\sin(2j+1)\pi ct}{2j+1}) + \frac{1}{4\pi}(\sum_{k=1}^{\infty}E_7^* \frac{\cos(2k+1)\pi s}{2k+1} -$$

$$\sum_{k=1}^{\infty}E_8^* \frac{\sin(2k+1)\pi s}{2k+1}))\ddot{Q}_q(t) + 2c(T_9 + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_9^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_{10}^*$$

$$\frac{\sin(2j+1)\pi ct}{2j+1})(\sum_{k=1}^{\infty}E_{11}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_{12}^* \frac{\sin(2k+1)\pi s}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty}E_{13}^*$$

$$\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_{14}^* \frac{\sin(2j+1)\pi ct}{2j+1}) + \frac{1}{4\pi}(\sum_{k=1}^{\infty}E_{15}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_{16}^*$$

$$\frac{\sin(2k+1)\pi s}{2k+1}))\dot{Q}_q(t) + c^2(T_{10} + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_{17}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_{18}^* \frac{\sin(2j+1)\pi ct}{2j+1}$$

$$)(\sum_{k=1}^{\infty}E_{19}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}B_{20}^* \frac{\sin(2k+1)\pi s}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty}E_{21}^* \frac{\cos(2j+1)\pi ct}{2j+1}$$

$$-\sum_{j=1}^{\infty}E_{22}^* \frac{\sin(2j+1)\pi ct}{2j+1}) + \frac{1}{4\pi}(\sum_{k=1}^{\infty}E_{23}^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_{24}^* \frac{\sin(2k+1)\pi s}{2k+1})$$

$$\left.)Q_q(t))\right] = \sum_{q=1}^{\infty}\sum_{r=1}^{N}\frac{Mg}{\mu\theta^*}\Psi_m(ct)\Psi_m(s) \tag{3.42}$$

equation (3.42) is the fundamental equation of the problem. where

$$\alpha = \frac{M}{\mu\rho}, \quad \rho = L_x L_y \tag{3.43}$$

$$\Psi_m(ct) = \sin\chi_m t + A_m\cos\chi_m t + B_m\sinh\chi_m t + C_m\cosh\chi_m t \tag{3.44}$$

$$\Psi_m(s) = \sin\nu_m + A_m\cos\nu_m + B_m\sinh\nu_m + C_m\cosh\nu_m \tag{3.45}$$

$$\chi_m = \frac{\phi_m c}{L_x}, \quad \nu_m = \frac{\phi_m s}{L_y} \tag{3.46}$$

3.1 Orthotropic Rectangular Plate Traversed by a Moving Force

In moving force, we account for only the load being transferred to the structure. In this case, the inertia effect is negligible. Setting $\varpi = 0$ in the fundamental equation (3.42), one obtains

$$\ddot{Q}_n(t) + (1 - \frac{F_4^*}{\theta^*})\omega_n^2 Q_n(t) - \frac{1}{\mu\theta^*}(\mu R_0 T_1 \ddot{Q}_n(t) - 2BT_2 Q_n(t) - D_y T_3 Q_n(t) - D_x T_4 Q_n(t)$$

$$-K_0 T_5 Q_n(t) + G_0(T_6 + T_7)Q_n(t)) - \frac{1}{\mu\theta^*}\sum_{q=1}^{\infty}[\mu R_0 T_1 \ddot{Q}_q(t) - 2BT_2 Q_q(t) - D_y T_3 Q_q(t) \tag{3.47}$$

$$-D_x F_4^* Q_q(t) + (\mu\omega_q^2 F_4^* - K_0 T_5)Q_q(t) + G_0(T_6 + T_7)Q_q(t)] = \sum_{q=1}^{\infty}\sum_{r=1}^{N}\frac{Mg}{\mu\Theta^*}\Psi_m(ct)\Psi_m(s)$$

which can further be simplified as

$$\ddot{Q}_n(t) + \chi_n^2 Q_n(t) - \tau^*(\mu R_0 T_1 \ddot{Q}_n(t) - 2BT_2 Q_n(t) - D_y T_3 Q_n(t) - D_x T_4 Q_n(t) - K_0 T_5$$

$$Q_n(t) + G_0(T_6 + T_7)Q_n(t)) - \tau^*\sum_{q=1}^{\infty}[\mu R_0 T_1 \ddot{Q}_q(t) - 2BT_2 Q_q(t) - D_y T_3 Q_q(t) - D_x T_4 \tag{3.48}$$

$$Q_q(t) + (\mu\omega_q^2 F_4^* - K_0 T_5)Q_q(t) + G_0(T_6 + T_7)Q_q(t)] = \sum_{q=1}^{\infty}\sum_{r=1}^{N}Mg\tau^*\Psi_m(ct)\Psi_m(s)$$

On expanding, re-arranging and simplifying equation (4.48), one obtains

$$\ddot{Q}_n(t) + \frac{(\chi_n^2 - \tau^* J_6^*)}{[1 - \tau^*\mu R_0 T_1]}Q_n(t) + \frac{\tau}{[1 - \tau^*\mu R_0 T_1]}\sum_{q=1,q\neq n}^{\infty}(\mu R_0 T_1 \ddot{Q}_q(t) - 2BT_2 Q_q(t) - D_y T_3 Q_q(t)$$

$$-D_x T_4 Q_q(t) + (\mu\omega_q^2 F_4^* - K_0 T_5)Q_q(t) + G_0(T_6 + T_7)Q_q(t)) = \frac{\tau^* Mg}{[1 - \tau^*\mu R_0 F_1^*]}\Psi_m(ct)\Psi_m(s) \tag{3.49}$$

where

$$\tau^* = \frac{1}{\mu\theta^*}, \quad \chi_n^2 = (1 - \frac{F_4^*}{\theta^*})\omega_n^2, \quad J_6^* = -2BT_2 - D_y T_3 - D_x T_4 - K_0 T_5 + G_0(T_6 + T_7) \tag{3.50}$$

For any arbitrary ratio Υ, defined as $\tau^* = \frac{\Upsilon}{1+\Upsilon}$, one obtains

$$\Upsilon = \frac{\tau^*}{1-\tau^*} = \tau^* + o(\tau^{*2}) + \dots \tag{3.51}$$

For only $o(\tau^*)$, one obtains

$$\tau^* = \Upsilon \tag{3.52}$$

Applying binomial expansion,

$$\frac{1}{1 - \Upsilon\mu R_0 F_1^*} = 1 + \Upsilon\mu R_0 F_1^* + o(\Upsilon^2) + \dots \tag{3.53}$$

On putting equation (4.53) into equation (4.49), one obtains

$$\ddot{Q}_n(t) + (\chi_n^2 - \Upsilon J_6^*)(1 + \Upsilon\mu R_0 T_1 + o(\Upsilon^2) + \dots)Q_n(t) + \Upsilon(1 + \tau^*\mu R_0 T_1 + o(\Upsilon^2) + \dots)$$
$$\sum_{q=1, q \neq n}^{\infty} (\mu R_0 F_1^* \ddot{Z}_q(t) - 2BF_2^* Q_q(t) - D_y F_3^* Q_q(t) - D_x F_4^* Q_q(t) + (\mu\omega_q^2 - K_0)F_5^* Q_q(t) + \tag{3.54}$$
$$G_0(F_6^* + F_7^*)Q_q(t)) = (1 + \Upsilon\mu R_0 T_1 + o(\Upsilon^2) + \dots)Mg\Psi_m(ct)\Psi_m(s)$$

Retaining only $o(\Upsilon)$, equation (4.54) becomes

$$\ddot{Q}_n(t) + (\chi_n^2(1 + \Upsilon\mu R_0 T_1) - \Upsilon J_6^*)Q_n(t) + \Upsilon\sum_{q=1, q\neq n}^{\infty}(\mu R_0 F_1^* \ddot{Q}_q(t) - 2BF_2^* Q_q(t) - D_y F_3^*$$
$$Q_q(t) - D_x F_4^* Q_q(t) + (\mu\omega_q^2 - K_0)F_5^* Q_q(t) + G_0(F_6^* + F_7^*)Q_q(t)) = \Upsilon Mg\Psi_m(ct)\Psi_m(s) \tag{3.55}$$

which is simplified further as

$$\ddot{Q}_n(t) + J_7^* Q_n(t) + \Upsilon\sum_{q=1, q\neq n}^{\infty}(\mu R_0 F_1^* \ddot{Q}_q(t) - 2BF_2^* Q_q(t) - D_y F_3^* Q_q(t) - D_x F_4^* Q_q(t) +$$
$$(\mu\omega_q^2 - K_0)F_5^* Q_q(t) + G_0(F_6^* + F_7^*)Q_q(t)) = \Upsilon Mg\Psi_m(ct)\Psi_m(s) \tag{3.56}$$

where

$$J_7^* = \chi_n^2(1 + \Upsilon\mu R_0 T_1) - \Upsilon J_6^* \tag{3.57}$$

Using Struble's technique, the solution to the homogeneous part of part of equation (3.57) is assumed to take the form

$$Q_n(t) = \varphi(n,t)\cos(\chi_n t - \rho(n,t)) + \dots \tag{3.58}$$

where

$$\varphi(n,t) = \varepsilon_n \tag{3.59}$$

and

$$\phi(n,t) = (\frac{\chi_n^2 - J_7^*}{2\chi_n})t + \iota_n \tag{3.60}$$

On putting equations (3.59) and (3.60) into equation (3.58), one obtains

$$Q_n(t) = \varepsilon_n\cos(\chi_n t - (\frac{\chi_n^2 - J_7^*\varphi(n,t)}{2\chi_n})t - \iota_n) \tag{3.61}$$

On further simplification, one obtains

$$Q_n(t) = \varepsilon_n\cos(\upsilon_n t - \iota_n) \tag{3.62}$$

where

$$\upsilon_n = \chi_n - (\frac{\chi_n^2 - J_7^*\varphi(n,t)}{2\chi_n}) \tag{3.63}$$

is the modified frequency for moving force problem for orthotropic rectangular plate resting on variable elastic bi-parametric foundation.

Using equation (3.63), the homogeneous part of equation (3.56)

$$\ddot{Q}_n(t) + \upsilon_n^2 Q_n(t) = 0 \tag{3.64}$$

Hence, the entire equation (3.56) gives

$$\ddot{Q}_n(t) + \upsilon_n^2 Q_n(t) = \Upsilon Mg\Psi_m(ct)\Psi_m(s) \tag{3.65}$$

Re-writing equation (3.65), one obtains

$$\ddot{Q}_n(t) + v_n^2 Q_n(t) = \Upsilon Mg\Psi_m(s)[\sin\chi_m(t) + A_m\cos\chi_m t + B_m\sinh\chi_m t$$
$$+ C_m\cosh\chi_m t] \tag{3.66}$$

To obtain the solution to equation (3.66), one makes use of Laplace transformation techniques to obtain

$$Q_n(t) = \frac{Mg\Upsilon\Phi_m(s)}{v_n(\chi_m^4 - v_n^4)}[(\chi_m^2 + v_n^2)(\chi_m\sin v_n t - v_n\sin\chi_m t) - A_m v_n(\chi_m^2 + v_n^2)$$
$$(\cos\chi_m t - \cos v_n t) - B_m(\chi_m^2 - v_n^2)(\alpha_m\sin v_n t - v_n\sinh\chi_m t) + C_m v_n(\chi_m^2 - v_n^2)$$
$$(\cosh\chi_m t - \cos v_n t)] \tag{3.67}$$

which on inversion yields

$$W(x,y,t) = \sum_{jm=1}^{\infty}\sum_{hm=1}^{\infty}\frac{Mg\Upsilon\Phi_m(s)}{v_n(\chi_m^4 - v_n^4)}[(\chi_m^2 + v_n^2)(\chi_m\sin v_n t - v_n\sin\chi_m t) - A_m v_n(\chi_m^2$$
$$+ v_n^2)(\cos\chi_m t - \cos v_n t) - B_m(\chi_m^2 - v_n^2)(\chi_m\sin v_n t - v_n\sinh\chi_m t) + C_m v_n(\chi_m^2$$
$$- v_n^2)(\cosh\chi_m t - \cos v_n t)](\sin\frac{\phi_{jm}}{L_x}x + A_{jm}\cos\frac{\phi_{jm}}{L_x}x + B_{jm}\sinh\frac{\phi_{jm}}{L_x}x + C_{jm}\cosh\frac{\phi_{jm}}{L_x}x)$$
$$(\sin\frac{\phi_{hm}}{L_y}y + A_{hm}\cos\frac{\phi_{hm}}{L_y}y + B_{hm}\sinh\frac{\phi_{hm}}{L_y}y + C_{hm}\cosh\frac{\phi_{hm}}{L_y}y) \tag{3.68}$$

which is the transverse displacement response to a moving force of orthotropic rectangular plate resting on variable elastic bi-parametric foundation.

3.2 Orthotropic Rectangular Plate Traversed by a Moving Mass

In moving mass problem, the moving load is assumed rigid, and the weight and as well as inertia forces are transferred to the moving load. That is the inertia effect is not negligible. Thus $\varpi \neq 0$ and so it is required to solve the entire equation (3.42).To solve the equation,one employs analytical approximate method. This method is known as an approximate analytical method of Struble. The homogeneous part of equation (3.42) shall be replaced by a free system operator defined by the modified frequency v_n. Thus, the entire equation becomes

$$\ddot{Q}_n(t) + v_n^2 Q_n(t) + \alpha\rho^*\sum_{q=1}^{\infty}[(F_8^* + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_1^*\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_2^*$$
$$\frac{\sin(2j+1)\pi ct}{2j+1})(\sum_{k=1}^{\infty}E_3^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_4^*\frac{\sin(2k+1)\pi s}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty}E_5^*$$
$$\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_6^*\frac{\sin(2j+1)\pi ct}{2j+1}) + \frac{1}{4\pi}(\sum_{k=1}^{\infty}E_7^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_8^*$$
$$\frac{\sin(2k+1)\pi s}{2k+1}))\ddot{Q}_q(t) + 2c(F_9^* + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_9^*\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_{10}^*\frac{\sin(2j+1)\pi ct}{2j+1}$$
$$)(\sum_{k=1}^{\infty}E_{11}^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{j=1}^{\infty}E_{12}^*\frac{\sin(2k+1)\pi s}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty}E_{13}^*\frac{\cos(2j+1)\pi ct}{2j+1}$$

$$- \sum_{j=1}^{\infty}E_{14}^*\frac{\sin(2j+1)\pi ct}{2j+1}) + \frac{1}{4\pi}(\sum_{k=1}^{\infty}E_{15}^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_{16}^*\frac{\sin(2k+1)\pi s}{2k+1}$$
$$))\dot{Q}_q(t) + c^2(F_{10}^* + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_{17}^*\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_{18}^*\frac{\sin(2j+1)\pi ct}{2j+1})$$
$$(\sum_{k=1}^{\infty}E_{19}^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_{20}^*\frac{\sin(2k+1)\pi s}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty}E_{21}^*\frac{\cos(2j+1)\pi ct}{2j+1}$$
$$- \sum_{j=1}^{\infty}E_{22}^*\frac{\sin(2j+1)\pi ct}{2j+1}) + \frac{1}{4\pi}(\sum_{k=1}^{\infty}E_{23}^*\frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty}E_{24}^*\frac{\sin(2k+1)\pi s}{2k+1}$$
$$))Q_q(t)] = \sum_{q=1}^{\infty}\frac{g\alpha}{\theta^*}\Phi_m(ct)\Phi_m(s) \tag{3.69}$$

where $\rho^* = \frac{\rho}{\theta^*}$

On expanding,simplifying and rearranging equation (4.88), one obtains

$$\ddot{Q}_n(t) + 2c\alpha\rho^*(F_9^* + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_9^*\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_{10}^*\frac{\sin(2j+1)\pi ct}{2j+1})(\sum_{k=1}^{\infty}E_{11}^*$$
$$\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty}E_{12}^*\frac{\sin(2k+1)\pi ct}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty}E_{13}^*\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_{14}^*$$
$$\frac{\sin(2j+1)\pi ct}{2j+1}) + (\sum_{k=1}^{\infty}E_{15}^*\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty}E_{16}^*\frac{\sin(2k+1)\pi ct}{2k+1}))\dot{Q}_n(t) +$$
$$(v_n^2(1 - \alpha\rho^*(F_8^* + \frac{1}{\pi^2}(\sum_{j=1}^{\infty}E_1^*\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty}E_2^*\frac{\sin(2j+1)\pi ct}{2j+1})$$
$$(\sum_{k=1}^{\infty}E_3^*\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty}E_4^*\frac{\sin(2k+1)\pi ct}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty}E_5^*\frac{\cos(2j+1)\pi ct}{2j+1} -$$

$$\sum_{j=1}^{\infty} E_6^* \frac{\sin(2j+1)\pi ct}{2j+1}) + (\sum_{k=1}^{\infty} E_7^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_8^* \frac{\sin(2k+1)\pi ct}{2k+1}))))+$$

$$c^2 \alpha \rho^* (F_{10}^* + \frac{1}{\pi^2}(\sum_{j=1}^{\infty} E_{17}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{18}^* \frac{\sin(2j+1)\pi ct}{2j+1})(\sum_{k=1}^{\infty} E_{19}^*$$

$$\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{20}^* \frac{\sin(2k+1)\pi ct}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty} E_{21}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{22}^*$$

$$\frac{\sin(2j+1)\pi ct}{2j+1}) + (\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi ct}{2k+1}))Q_n(t)$$

$$+\alpha \rho^* \sum_{q=1,q\neq n}^{\infty} [(F_8^* + \frac{1}{\pi^2}(\sum_{j=1}^{\infty} E_1^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_2^* \frac{\sin(2j+1)\pi ct}{2j+1})(\sum_{k=1}^{\infty} E_3^*$$

$$\frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_4^* \frac{\sin(2k+1)\pi ct}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty} E_5^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_6^*$$

$$\frac{\sin(2j+1)\pi ct}{2j+1}) + (\sum_{k=1}^{\infty} E_7^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_8^* \frac{\sin(2k+1)\pi ct}{2k+1}))\ddot{Q}_q(t) +$$

$$2c(F_9^* + \frac{1}{\pi^2}(\sum_{j=1}^{\infty} E_9^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{10}^* \frac{\sin(2j+1)\pi ct}{2j+1})(\sum_{k=1}^{\infty} E_{11}^* \frac{\cos(2k+1)\pi ct}{2k+1}$$

$$-\sum_{k=1}^{\infty} E_{12}^* \frac{\sin(2k+1)\pi ct}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty} E_{13}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{14}^* \frac{\sin(2j+1)\pi ct}{2j+1})$$

$$+(\sum_{k=1}^{\infty} E_{15}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{16}^* \frac{\sin(2k+1)\pi ct}{2k+1}))\dot{Q}_q(t) + c^2(F_{10}^* + \frac{1}{\pi^2}(\sum_{j=1}^{\infty} E_{17}^*$$

$$\frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{18}^* \frac{\sin(2j+1)\pi ct}{2j+1})(\sum_{k=1}^{\infty} E_{19}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{20}^*$$

$$\frac{\sin(2k+1)\pi ct}{2k+1}) + \frac{1}{4\pi}(\sum_{j=1}^{\infty} E_{21}^* \frac{\cos(2j+1)\pi ct}{2j+1} - \sum_{j=1}^{\infty} E_{22}^* \frac{\sin(2j+1)\pi ct}{2j+1}) + \frac{1}{4\pi}$$

$$(\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi ct}{2k+1}))Q_q(t)] = \frac{g\alpha}{\theta^*}\Phi_m(ct)\Phi_m(s) \tag{3.70}$$

Applying modified asymptotic method of Struble, the solution to equation (3.70) takes the form

$$Q_n(t) = \psi(n,t)\cos(\upsilon_n t - G(n,t)) + \upsilon_n Q_1(t) + \ldots \tag{3.71}$$

where

$$\psi(n,t) = \beta e^{-\alpha\rho^* J_8 t} \tag{3.72}$$

and

$$F(n,t) = \frac{1}{2\upsilon_n}[\upsilon_n^2 \varpi\varphi^*(F_9^* + \frac{1}{4\pi}(\sum_{k=1}^{\infty} E_7^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_8^* \frac{\sin(2k+1)\pi s}{2k+1}))$$
$$-c^2 \varpi\varphi^*(F_{10}^* + \frac{1}{4\pi}(\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi ct}{2k+1}))]t + \tau_n \tag{3.73}$$

On putting equations (3.72) and (3.73) into equation (3.71), one obtains

$$Q_n(t) = Ze^{-\alpha\rho^* J_8 t}\cos[\upsilon_n t - \frac{1}{2\upsilon_n}(\upsilon_n^2 \alpha\rho^*(F_8^* + \frac{1}{4\pi}(\sum_{k=1}^{\infty} E_7^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_8^*$$

$$\frac{\sin(2k+1)\pi s}{2k+1})) - c^2 \alpha\rho^*(F_{10}^* + \frac{1}{4\pi}(\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi ct}{2k+1})$$

$$))t - \tau_n] \tag{3.74}$$

On further simplifications, one obtains

$$Q_n(t) = Ze^{-\alpha\rho^* J_8 t}\cos[\beta_n t - \varepsilon_n] \tag{3.75}$$

where

$$\beta_n = \upsilon_n - \frac{1}{2\upsilon_n}(\upsilon_n^2 \alpha\rho^*(F_8^* + \frac{1}{4\pi}(\sum_{k=1}^{\infty} E_7^* \frac{\cos(2k+1)\pi s}{2k+1} - \sum_{k=1}^{\infty} E_8^* \frac{\sin(2k+1)\pi s}{2k+1}))$$

$$-c^2 \alpha\rho^*(F_{10}^* + \frac{1}{4\pi}(\sum_{k=1}^{\infty} E_{23}^* \frac{\cos(2k+1)\pi ct}{2k+1} - \sum_{k=1}^{\infty} E_{24}^* \frac{\sin(2k+1)\pi ct}{2k+1}))) \tag{3.76}$$

is the modified frequency representing the frequency of the free system.

Using the same argument used to solve equation (3.56), the homogeneous part of equation (3.70) becomes

$$\ddot{Q}_n(t) + \beta_n^2 Q_n(t) = 0 \tag{3.77}$$

Hence, the entire equation becomes

$$\ddot{Q}_n(t) + \beta_n^2 Q_n(t) = \frac{g\alpha}{\theta^*}\Phi_m(ct)\Phi_m(s) \tag{3.78}$$

Rewriting equation (3.78), one obtains

$$\ddot{Q}_n(t) + \beta_n^2 Q_n(t) = \frac{g\alpha}{\theta^*}\Phi_m(s)[\sin\chi_m t + A_m\cos\chi_m t + B_m\sinh\chi_m t + C_m\cosh\chi_m t] \tag{3.79}$$

Following the procedures applied to solve equation (3.66), one obtains

$$
\begin{aligned}
Q_n(t) = \frac{g\alpha\Phi_m(s)}{\theta^*\beta_n(\chi_m^4 - \beta_n^4)}&[(\chi_m^2 + \beta_n^2)(\chi_m\sin\beta_n t - \beta_n\sin\chi_m t) - A_m\beta_n(\chi_m^2 + \beta_n^2)\\
&(\cos\chi_m t - \cos\beta_n t) - B_m(\chi_m^2 - \beta_n^2)(\chi_m\sin\beta_n t - \beta_n\sinh\chi_m t) + C_m\beta_n(\chi_m^2 - \beta_n^2)\\
&(\cosh\chi_m t - \cos\beta_n t)]
\end{aligned}
\tag{3.80}
$$

which on inversion yields

$$
\begin{aligned}
W(x,y,t) = \sum_{jm=1}^{\infty}\sum_{hm=1}^{\infty}\frac{g\alpha\Phi_m(s)}{\theta^*\beta_n(\chi_m^4 - \beta_n^4)}&[(\chi_m^2 + \beta_n^2)(\chi_m\sin\beta_n t - \beta_n\sin\chi_m t) - A_m\beta_n(\chi_m^2 + \beta_n^2)\\
&(\cos\chi_m t - \cos\beta_n t) - B_m(\chi_m^2 - \beta_n^2)(\chi_m\sin\beta_n t - \beta_n\sinh\chi_m t) + C_m\beta_n(\chi_m^2 - \beta_n^2)\\
&(\cosh\chi_m t - \cos\beta_n t)](\sin\frac{\phi_{jm}}{L_x}x + A_{jm}\cos\frac{\phi_{jm}}{L_x}x + B_{jm}\sinh\frac{\phi_{jm}}{L_x}x + C_{jm}\cosh\frac{\phi_{jm}}{L_x}x)\\
&(\sin\frac{\phi_{hm}}{L_y}y + A_{hm}\cos\frac{\phi_{hm}}{L_y}y + B_{hm}\sinh\frac{\phi_{hm}}{L_y}y + C_{hm}\cosh\frac{\phi_{hm}}{L_y}y)
\end{aligned}
\tag{3.81}
$$

which is the transverse displacement response to a moving mass of an orthotropic rectangular plate resting on variable elastic bi-parametric foundation.

3.3 ILLUSTRATIVE EXAMPLES

3.3.1 Orthotropic Rectangular Plate Clamped at All Edges

For an orthotropic plate clamped at all its edges, the boundary conditions are given by

$$W(0,y,t) = 0, \quad W(L_x,y,t) = 0 \tag{3.82}$$

$$W(x,0,t) = 0, \quad W(x,L_y,t) = 0 \tag{3.83}$$

$$\frac{\partial W(0,y,t)}{\partial x} = 0, \quad \frac{\partial W(L_x,y,t)}{\partial x} = 0 \tag{3.84}$$

$$\frac{\partial W(x,0,t)}{\partial y} = 0, \quad \frac{\partial W(x,L_y,t)}{\partial y} = 0 \tag{3.85}$$

Thus,for the normal modes

$$\xi_{pm}(0) = 0, \quad \xi_{pm}(L_x) = 0 \tag{3.86}$$

$$\xi_{qm}(0) = 0, \quad \xi_{qm}(L_y) = 0 \tag{3.87}$$

$$\frac{\partial\xi_{pm}(0)}{\partial x} = 0, \quad \frac{\partial\xi_{pm}(L_x)}{\partial x} = 0 \tag{3.88}$$

$$\frac{\partial\xi_{qm}(0)}{\partial y} = 0, \quad \frac{\partial\xi_{qm}(L_y)}{\partial y} = 0 \tag{3.89}$$

For simplicity, our initial conditions are of the form

$$W(x,y,0) = 0 = \frac{\partial W(x,y,o)}{\partial t} \tag{3.90}$$

Using the boundary conditions in equations (3.86) to (3.89) and the initial conditions given by equation (3.90), it can be shown that

$$A_{pm} = \frac{\sinh\xi_{pm} - \sin\xi_{pm}}{\cos\xi_{pm} - \cosh\xi_{pm}} = \frac{\cos\xi_{pm} - \cosh\xi_{pm}}{\sin\xi_{pm} + \sinh\xi_{pm}} \tag{3.91}$$

$$A_{qm} = \frac{\sinh\xi_{qm} - \sin\xi_{qm}}{\cos\xi_{qm} - \cosh\xi_{qm}} = \frac{\cos\xi_{qm} - \cosh\xi_{qm}}{\sin\xi_{qm} + \sinh\xi_{qm}} \qquad (3.92)$$

In the same vein, we have

$$A_m = \frac{\sinh\xi_m - \sin\xi_m}{\cos\xi_m - \cosh\xi_m} = \frac{\cos\xi_m - \cosh\xi_m}{\sin\xi_m + \sinh\xi_m} \qquad (3.93)$$

$$B_{pm} = -1, \quad B_{qm} = -1, \quad \Rightarrow B_m = -1 \qquad (3.94)$$

$$C_{pm} = -A_{pm}, \quad C_{qm} = -A_{qm}, \quad \Rightarrow C_m = -A_m \qquad (3.95)$$

and from equation (3.93) , one obtains

$$\cos\xi_m \cosh\xi_m = 1 \qquad (3.96)$$

which is termed the frequency equation for the dynamical problem, such that

$$\xi_1 = 4.73004, \quad \xi_2 = 7.85320, \quad \xi_3 = 10.9951 \qquad (3.97)$$

On using equations (3.91), (3.92), (3.93),(3.94),(3.95) and (3.97) in equations (3.68) and (3.81), one obtains the displacement response to a moving force and a moving mass of clamped orthotropic rectangular plate resting on bi-parametric condition respectively.

3.3.2   Graphs of the Clamped-clamped End Conditions

Figures 1 and 2 display the effect of foundation modulus K_o on the deflection profile of clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses respectively. The graphs show that the response amplitude decreases as the value of foundation modulus K_o increases.

Fig.1: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying K_o and Traversed by Moving Force
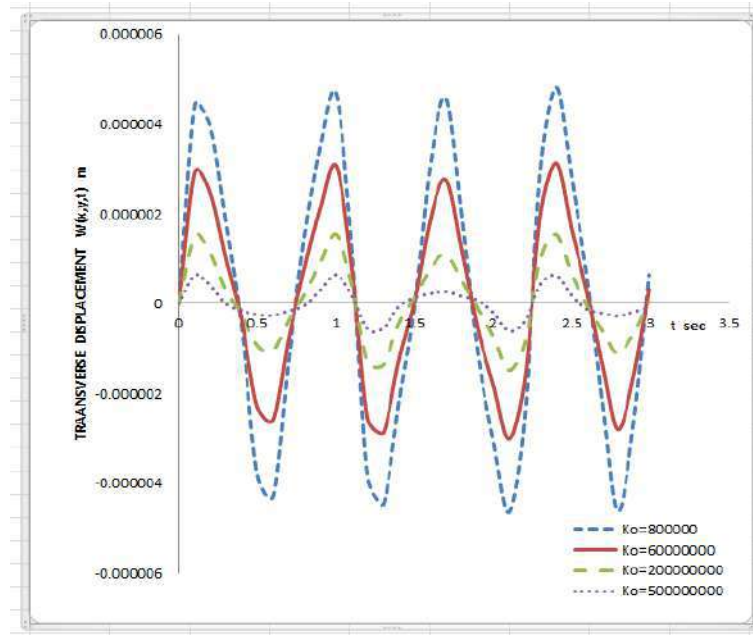
Fig.2: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying K_o and Traversed by Moving Mass

Figures 3 and 4 display the effect of shear modulus G_o on the deflection profile of clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses respectively. The graphs show that the response amplitude decreases as the value of shear modulus G_o increases.
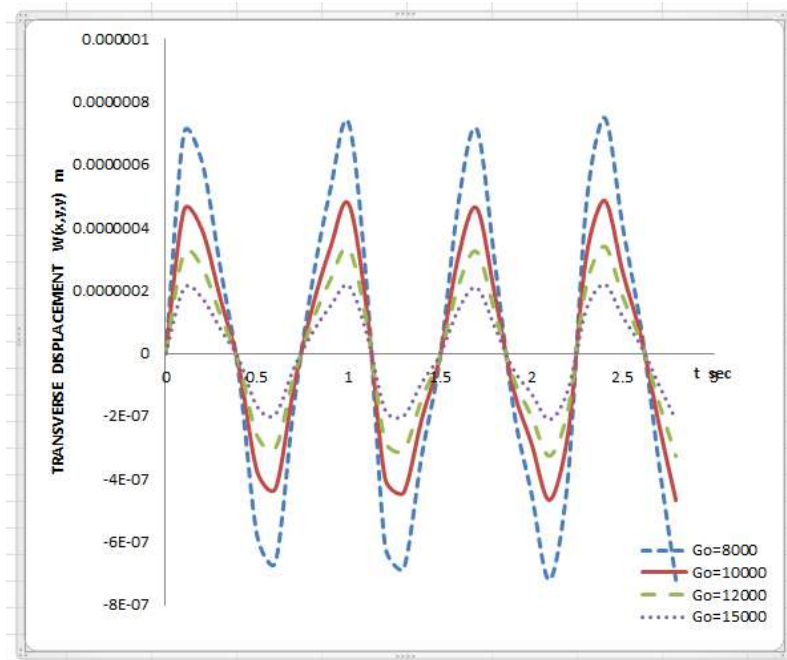
Fig.3: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying G_o and Traversed by Moving Force
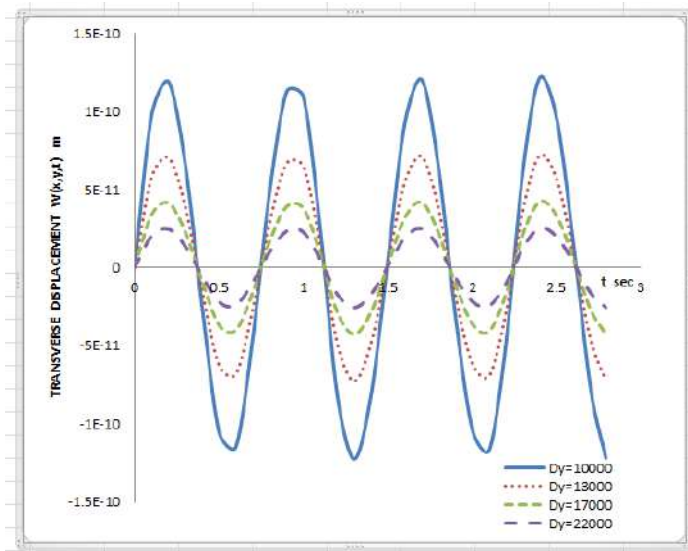
Fig.4: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying G_o and Traversed by Moving Mass

Figures 5 and 6 display the effect of flexural rigidity of the plate along x-axis D_x on the deflection profile of Clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses respectively. The graphs show that the response amplitude decreases as the value of flexural rigidity D_x increases.
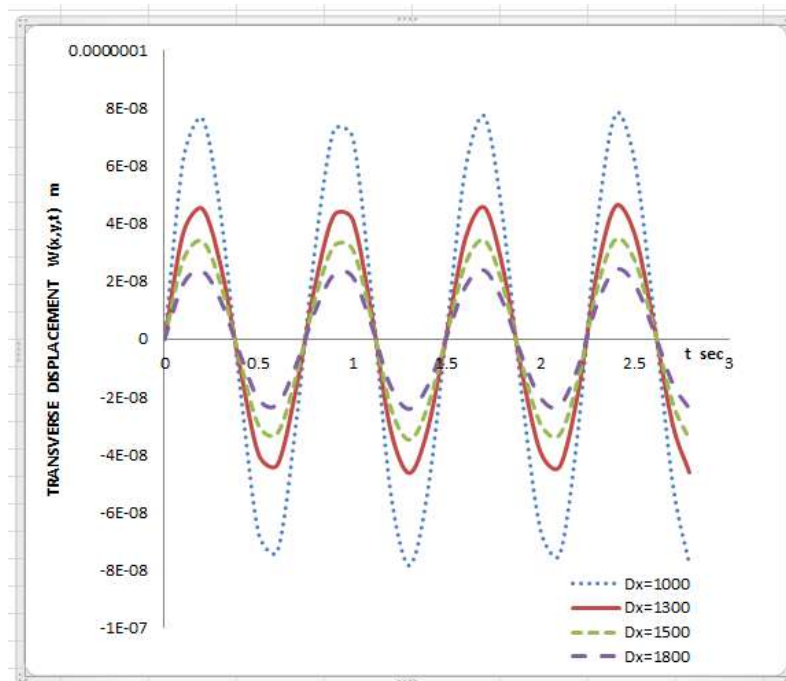
Fig.5: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying D_x and Traversed by Moving Force
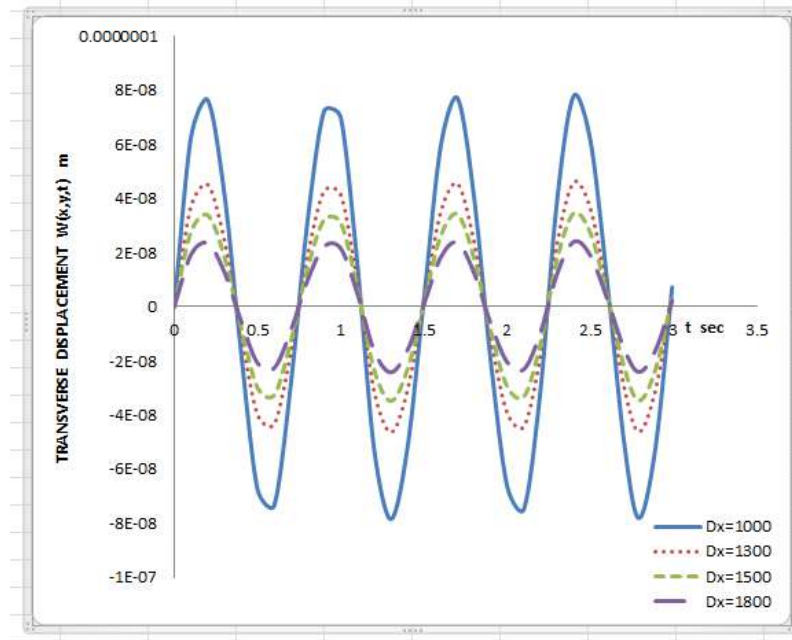
Fig.6: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying D_x and Traversed by Moving Mass

Figures 7 and 8 display the effect of flexural rigidity of the plate along y-axis D_y on the deflection profile of Clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses respectively. The graphs show that the response amplitude decreases as the value of flexural rigidity D_y increases.
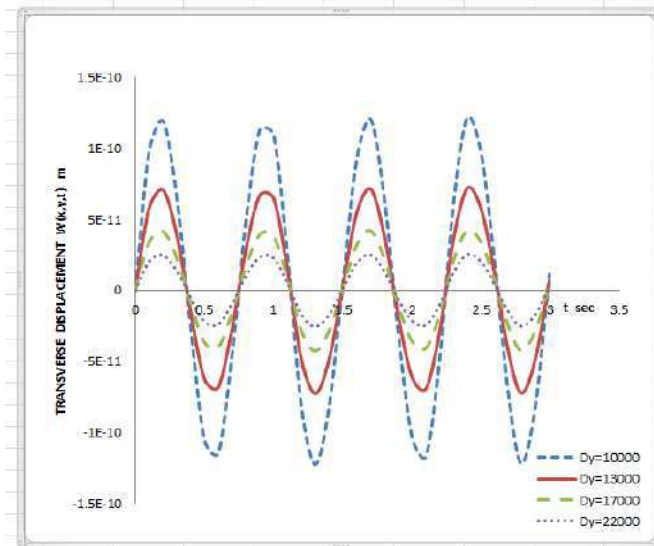
Fig.7: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying D_y and Traversed by Moving Force
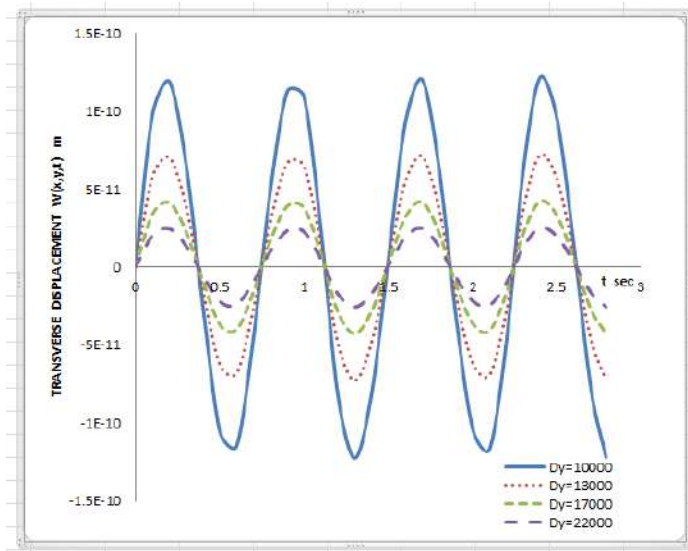
Fig.8: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying D_y and Traversed by Moving Mass

Figures 9 and 10 display the effect of rotatory inertia R_o on the deflection profile of Clamped-clamped orthotropic rectangular plate under the action of load moving at constant velocity in both cases of moving distributed forces and moving distributed masses respectively. The graphs show that the response amplitude decreases as the value of rotatory inertia R_o increases.
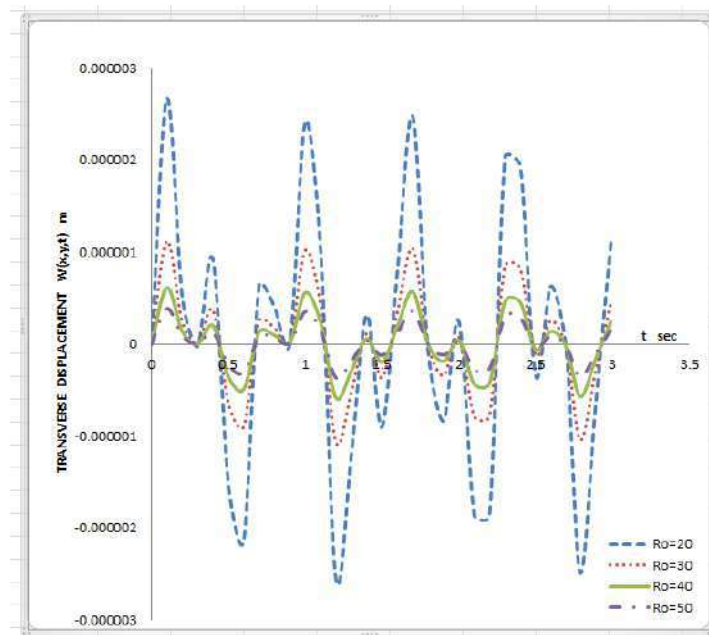
Fig.9: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying R_o and Traversed by Moving Force
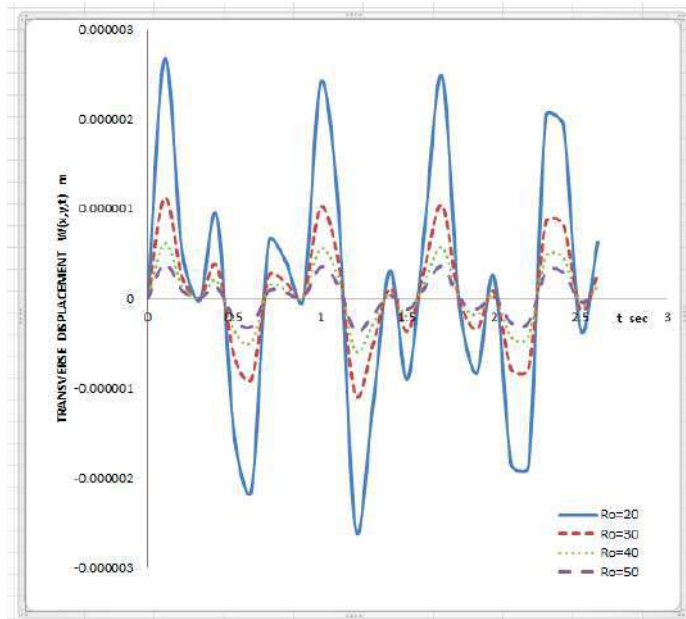
Fig.10: Displacement Profile of Clamped-clamped Orthotropic Rectangular Plate with Varying R_o and Traversed by Moving Mass

Figure 11 displays the comparison between moving force and moving mass for fixed values of R_o, G_o, K_o, D_x and D_y.
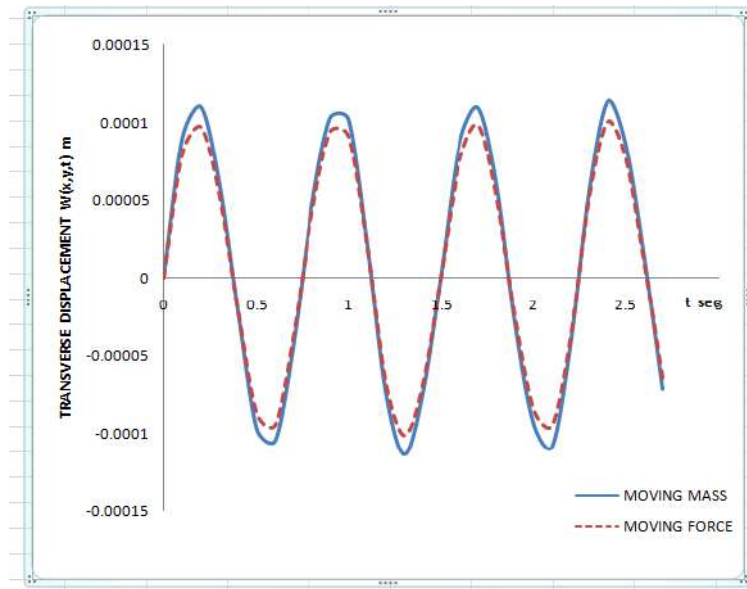
Fig.11: Displacement Profile of Comparison between Moving Force and Moving Mass

IV. CONCLUSION

In this research work, the problem of vibration of orthotropic rectangular plate under the action of moving masses and resting on a variable elastic Pasternak foundation with clamped end conditions has been studied. The closed form solutions of the fourth order partial differential equations with variable and singular coefficients governing the orthotropic rectangular plates is obtained for both cases of moving force and moving mass

using a solution technique that is based on the separation of variables which was used to remove the singularity in the governing fourth order partial differential equation and thereby reducing it to a sequence of coupled second order differential equations. The modified asymptotic method of Struble and Laplace transformation techniques are then employed to obtain the analytical solution to the two-dimensional dynamical problem.

The solutions are then analyzed. The analyses show that, for

the same natural frequency and the critical speed, the moving mass problem is smaller than that of the moving force problem. Resonance is reached earlier in the moving mass system than in the moving force problem. That is to say the moving force solution is not an upper bound for the accurate solution of the moving mass problem.

The results in plotted curves show that as foundation modulus K_o and the shear modulus G_o increase, the amplitudes of plates decrease for both cases of moving force and moving mass problems. As the rotatory inertia correction factor R_o increases, the amplitudes of plates decrease for both cases of moving force and moving mass problems. As the flexural rigidities along both the x-axis D_x and y-axis D_y increase, the amplitudes of plates decrease for both cases of moving force and moving mass problems.

It can be shown further from the results that for fixed values of foundation modulus and shear modulus, rotatory inertia correction factor, flexural rigidities along both x-axis and y-axis, the amplitude for the moving mass problem is greater than that of the moving force problem which implies that resonance is reached earlier in moving mass problem than in moving force problem of simply supported orthotropic rectangular plates resting on bi-parametric foundation.

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The Economic Feasibility of using Driwall in a Civil Construction work in the City of Manaus

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Abstract— *In recent years, a growing demand for construction methods has been noticed, aimed at optimizing construction processes and reducing costs, especially with regard to sealing. The Drywall technique (dry wall) is a constructive method that attends to these constructive first fruits and aimed at the perception of sustainability. The general objective is: to present a cost-benefit comparison of the use of "drywall sealing" in comparison with masonry in ceramic blocks, based on the feasibility study of a project in the city of Manaus. Identify the advantages and disadvantages of using the vertical sealing system using the masonry system with ceramic block (conventional) and Drywall. To achieve these objectives, quantitative research (in databases such as Scielo, Public Domain, CAPES and renowned institutions) of an exploratory nature was carried out, with inferences and qualitative data collection from personal experience as professionals working in the field of Civil Engineering and sedimented through bibliographic research limited to the period from 2010 to 2021. The results point to an initial cost reduction of around 20% to 30% of the total cost of the work. It is concluded that even despite the higher cost of acquiring Drywall, its use related to direct costs represented a reduction of 22.68%, not counting the cost reduction related to costs with foundations (which represents something around 9% to 12%, making it economically viable and at the same time regarding the quality and strength of internal seals.*

I. INTRODUCTION

The Brazilian economy in the last eight years has been experiencing moments of great fluctuations due to economic and political factors and, more recently, due to the COVID-19 pandemic. These factors have led to increased competition between companies, according to Pereira & de Azevedo (2020).

According to Ornstein et al., (2017) this way, the search for efficiency through methods of production process aims to bring not only speed and quality in the services offered, but it constitutes a factor of survival and competitiveness in the field of civil construction.

In an initial inference, it is known that conventional methods of internal sealing such as ceramic brick masonry,

in addition to generating a large volume of debris, demand considerable execution time, which increases the costs of the work (Guimarães et al., 2021).

It should be noted, however, that the sealing activity can use other constructive techniques, promoting the replacement of the conventional method by others such as Wood Frame, Light Stell Frame and Drywall, which "among its characteristics stand out speed in installation, lighter weight and debris generation, with a relatively low cost" (Molin & Malandrin, 2017, p. 71).

However, it is noteworthy that the Drywall constructive method still faces some resistance regarding its use by the population of medium and small cities, where it is believed that this opposition to the technique is due to few studies in the area and the population's own cultural issue who insists on not abandoning the traditional construction techniques that the people is used to (Oliveira, 2019).

According to Santos & Rachid (2016), the use of sealing in Drywall provides sustainable benefits, since it is a constructive technique considered clean, with less waste production, thus being a differential in current projects, allowing to add value to the property and the valuation at the time of its sale.

It is still necessary for the moment of choice to assess issues such as control and costs, where one cannot fail to control the cost-benefit ratio, highlighting that these necessarily involve "the price and quality binomial" (SANTOS; RACHID, 2016, p. 13).

Bauer (2012) states that in the construction industry, artisanal production methods can represent damage to several factors, such as waste or failures in execution; requiring continuous inspections to control the performance and quality of services.

With this in place and allied to the growing social pressure in the optimization of resources in the form of the use of technologies with less power of environmental degradation along with the need to reduce costs due to the sector's competitiveness.

Américo et al., (2019) states that by simplifying or reducing the number of steps or parts in the construction processes, these constitute one of the guiding principles of Drywall in the context of rationalized systems. Thus, when using Drywall for internal sealing (walls and/or ceiling) this is cited by several authors as highly productive and economical compared to the construction of ceramic masonry sealing walls.

These issues do not only involve technical-operational aspects, but are reflected from the perspective of the pillars of sustainability, where the environmental, social and economic aspects, when evaluated and applied together, give the enterprise a sustainable characteristic.

When using Drywall, it is clear that, in addition to aspects related to environmental comfort, according to Ching (2016), this is a material with great capacity for recycling and reuse, minimizing the environmental impacts of its use, as well as addressing issues related to the social dimension, since there are social and environmental cooperatives that collect solid waste from civil construction and reuse or recycle it, generating income for the people involved in this process.

Therefore, the present work seeks to bring the population and our peers closer to this constructive technique, contributing to its dissemination through information, demonstrating that Drywall provides, when done correctly, a reduction of the closing load on the structure that will support it, making it slimmer and cheaper, as well as ensuring the comfort and cleanliness of the work, reducing costs and the production of civil construction waste.

It should be noted that in addition to the faster installation and the reduction of manual processes, the construction system using Drywall brings one more positive point, it does not need curing time as with the use of sealing with ceramic blocks that it needs of mortar curing time, in addition to the fact that Drywall does not need preparation for final finishing (as occurs with the conventional system that needs roughcast and plaster).

This new technology brings with it numerous advantages compared to the cost-benefit ratio with conventional masonry, in this sense we highlight, in addition to the aforementioned points, its high versatility, especially if used in association with other materials, such as when you want to obtain a good acoustic performance usually Drywall walls make use of mineral wool and double sheet, thus providing an improvement in sound insulation (Oliveira, 2016).

These solutions, according to Keeler & Vaidya (2010) arising from the use of Drywall, extend to other constructive subsystems, such as electrical, telecommunications and hydraulic installations, resulting in time optimization, since the installation and finishing of these subsystems are quick and generate less waste.

In view of the above, this study aims to respond to a concern that permeates the authors of this article: is there really a competitive advantage of using Drywall as a sealing, compared to conventional masonry fence, using a ceramic block?

To answer this question, the present study has the general objective: to present a cost-benefit comparison of

the use of "Drywall sealing" in comparison with ceramic block masonry, based on the feasibility study of a project in the city of Manaus.

Specifically, it is intended (a) to identify the advantages and disadvantages of using the vertical sealing system using the masonry system with ceramic block (conventional) and Drywall; (b) Discuss the limitations and types of use of the vertical sealing system in drywall masonry; (c) Present comparative data on the feasibility and costs of using ceramic block and drywall sealing methods.

The importance of discussing the use of Drywall in civil construction is justified, given the challenge of choosing the most suitable construction processes, in order to meet the three prerequisites widely discussed in this sector: cost, quality and time.

Thus, when using the Drywall constructive method, it is sought to identify how this material tends to add value to the enterprise and thus maintain the competitiveness of organizations (Alves, 2012). With this, it is understood that the Drywall sealing system fills a gap of the three prerequisites, as it appears as a promising alternative to conventional sealing masonry, in addition to providing the reduction of waste arising from conventional sealing by ceramic blocks (Bauer, 2012; Bremer et al., 2013; dos Anjos & Teixeira, 2017), in addition to the decrease in the use of materials, time and labor (Guimarães et al., 2021).

II. LITERATURE REVIEW

2.1 Drywall: context, advantages and disadvantages

For Silva & Moreira (2017, p. 17) "more than 6000 years ago, huts were built with clay bricks also known as adobe, baked in the sun and with the addition of straw and grass to avoid deformations and cracks".

This method lasts until today and is widely used in various parts of the world, in particular it is the predominant method in Brazil, but it has gradually lost ground. This method is relatively simple.

Lima & Oliveira (2020) states that masonry consists of the union of ceramic blocks or bricks using mortar. This system has a dichotomy since, while it is extremely simple, which does not require manpower with great specializations, it presents important pathologies if it is not carried out by applying constructive techniques and improvised constructive solutions during the execution of the services (from Silva, 2015).

We agree with Lima & Oliveira (2020), who:

> Ceramic block masonry is the most common system in Brazil, and its main function is to separate and/or compartmentalize environments.

The ABNT NBR15270:2005 Ceramic Components defines ceramic block masonry as a "sealing masonry component that has prismatic holes perpendicular to the 2 phases that contain it (p. 4).

The conventional masonry fence constitutes the main load-bearing construction structures that support reinforced concrete, brick, trusses and metal beams that are covered with coatings, usually cement and paint.

In this way, it is clear that a labor force, with little qualification, can even perform the service relatively easily, but the same cannot be said regarding the desired quality and safety of the construction.

Arving (2015) states that the motivation for the invention of Drywall is related to two major fires that occurred in Chicago, in 1871, and the fire in New York, in 1890 which, due to the use of flammable materials and others that are easy to burn, such as wood. and paints, the main materials used in construction at the time, served as ignition and feeders for the claim.

When we carry out a reflective analysis of the construction systems used in the last twenty years in Brazil, it is clear that the development of construction technologies and innovative actions has brought answers to the growing demand for increasingly effective materials that can be used in construction , mainly in interior fences (Camillo, 2012; Faria, 2014; Tidd & Bessant, 2015).

Arving (2020) highlights that Drywall represents the answer to contractors and consumers who want built environments to be dry, warm, safe and aesthetic. Garcia (2018) points out that there is a demand for materials with good properties of

thermal and acoustic insulation, as well as resistance to fire and water, characteristics that are found in Drywall.

Arving (2020) highlights that when Drywall was invented in 1894 by August Sackett and consisted of a layer of plaster and felt. Neto & Fagundes (2020) also emphasizes that the first plasterboards appeared only in 1910 under the name Sackett Boards and consisted of four layers of special felt paper and three intermediate layers of plaster.

These authors further describe that they were placed on wooden slats. The first gypsum board appeared in 1917. In this way, sheets of paper were used on both sides to strengthen the gypsum core.

Drywall arrived in Europe about 20 years later and, after the end of World War II, was used on a large scale to reconstruct war damage. However, their low quality meant they were not widely used in construction. It was only from

1990 onwards that the new technology for producing these boards made them more useful (Labuto, 2014), Lockstein & Kichel, 2019).

Santos & Rachid (2016), Américo et al., (2019), and Neto & Fagundes (2020), agree that it was only around 1970 that Drywall began to be produced in Brazil, at the initiative of physician Roberto de Campos Guimarães, from the foundation in Petrolina (PE) of the first plasterboard factory for Drywall, a subsidiary of Gympsum.

However, it was only in the 1990s, encouraged by the implementation of new factories in the country and the evolution of construction processes, that this product began to gain greater acceptance in the Brazilian market (Labuto, 2014). In a more current context:

> The approval of the system by users caused several buildings, houses and housing developments (KNAUF, 2018). The history of Drywall arrived in Brazil producing practical and intelligent solutions in architecture, for example, in the use of ceilings, coatings and practical divisions for constructions in general (Américo et al., 2019, p. 75).

Despite the growing use of Drywall, in Brazil there is still resistance on the part of the population in the use of this material, combined with a lack of knowledge of this construction technology, which contributes to a certain distrust of the population in relation to Drywall.

In comparative terms, both the conventional method and the use of Drywall have advantages and disadvantages that involve the moment in which the economy and the market also involve the culture of the people. Therefore, in Chart 1, the advantages and disadvantages of each construction system are listed.

Chart 1 Comparison between conventional and Drywall systems

	Drywall	Alvenaria Convencional (Tijolos)
Vantagens	Facilidade na montagem.	Bom isolamento térmico e acústico.
	Ganho de área útil.	Boa resistência à pressão do vento, umidade e fogo.
	Adaptável a qualquer tipo de estrutura.	Resistente á infiltrações de água pluvial.
	Desmontabilidade fácil.	Durabilidade superior a cem anos, sem proteção e sem
	Local da obra limpo.	Facilidade de composição dos elementos de qualquer forma e
	Menor mão de obra.	Sem limitação de uso em relação às condições ambientais.
	Superfície plana.	Baixa inversão de capital na produção.
	Estrutura não contraventada.	Total disponibilidade de matéria prima.
	Mais leve.	Produção não poluente, sem geração de resíduos prejudiciais ao meio ambiente.
	Facilidade de instalação dos sistemas elétricos e hidráulicos.	-
	Bom isolamento térmico e acústico.	-
Desvantagens	Falta de mão de obra especializada.	Como não se utiliza projeto de alvenaria, as soluções construtivas são improvisadas durante a execução dos serviços.
	Baixa resitência mecânica.	Qualidade deficiente dos materiais utilizados e da execução.
	Baixa resitência à alta umidade.	Dificuldade na instalação de sistemas elétricos e hidráulicos.
	Os vazios internos podem ser ocupados por insetos se não pensado corretamente	Superfícies irregulares.
	Umidade relativa do ar elevada tende a desenvolver fungos.	Falta de mão de obra especializada.
	Objetos pendurados precisam ficar próximos aos reforços.	Área útil reduzida.
	-	Aparecimento de fissuras e trincas.
	-	Peso das vedações maiores.

Source: Adapted from Molin & Malandrin (2017), Oliveira (2019), Pereira & de Azevedo (2020).

It is noticed that each of the systems has advantages and disadvantages, but factors such as cost and time feasibility tend to influence the choice of method.

2.2 Drywall: some considerations about the constructive system

Drywall board, goes far beyond its properties and characteristics, offering much more possibilities than it seems at first sight. Among its benefits we highlight:

- Thermal insulation. If necessary, the Drywall layer effectively retains heat, it can be reinforced with a mini layer or other insulation (Rodrigues, 2017).
- Low weight. It does not overload the structure of the walls, thus it does not put much overlapping pressure, although some formations appear heavy and massive (Tres, 2017).
- Fire safety. Only a layer of cardboard can burn, which will not light and will cause a fire (Silva & de Almeida, 2016).
- Smooth surface, which allows an easy correction or perfectly masks imperfections in walls and planes (Soares, 2018).
- Flexibility: Interestingly, Drywall can be bent to give structures a smooth shape. Of course, to do this you need to know how to do it, some

skills will be needed, but they are quite simple (Villela, 2013).

- Resistance. Depending on the type of Drywall sheet, some of them are specially produced to become resistant to moisture and/or fire (Tavares & Gaspar, 2020).
- Environmental appeal and material safety, thus having a strong sustainable appeal (Peurifoy et al., 2015; Sandes, 2019).

These properties characterize the material to the maximum from the positive point of view of material use. However, Drywall has some restrictions, including:

- Fragility. The layer, when brushed, can break causing deformations. Although plaster can be used to correct the problem, but the area in question will be more fragile. Where it is recommended that this fact must be taken into account when designing.
- Insufficient sound insulation. Mass design - hollow, resonates, all sounds are very easy to penetrate, which sometimes creates some inconvenience. Acoustic or thermal acoustic insulators or similar materials are used to solve the problem.
- Weak capacity. If the customer needs to hang a custom cabinet or TV panel wall on a Drywall wall, they will need to be concerned with reinforcement in advance using a double layer of material on the opposite side or in the right place.

According to Lima & Oliveira (2020), since 2013, in Brazil, the Brazilian Association of Technical Standards, through the approval of NBR 15.575 - Housing Buildings - Performance, defined the quality levels to be met in construction systems, establishing levels of acoustic performance and durability of the building.

As previously highlighted, Drywall defects can be compensated, however, the main thing is to know them and take them into account during the project work, and they are chosen according to the characteristics of the place to be applied.

As the material's popularity led to mass use, a number of products and structures were created, among which there are many attractive designs. The excerpt brings many photos that feed the imagination in independent design.

In general terms, there is a standardization of colors that serves as parameters for choosing the different varieties and use of Drywall, as can be seen in Chart 2.

Chart 2 Characteristics of Drywall boards, commercialized in Brazil

Tipo	Caracteristicas e Utilização	Dimemsões
Placa de Drywall branca standard (ST)	A branca, ou cinza, é a placa de Drywall indicada para uso geral em áreas secas. Geralmente empregada em paredes e forros, é recomendada para salas, escritórios, e outros ambientes que precisem de divisão ou isolamento termoacústico do sistema Drywall. As paredes confeccionadas em Chapas Drywall Standart (ST) são as mais comuns e mais frequentemente utilizadas em projetos arquitetônicos em geral.	Branca ou cinza 6mm - 1200x2000; Branca 12,5mm - 1200x1800, 1200x2400, 1200x3000;
Placa de Drywall verde (RU)	Já para a aplicação em áreas úmidas, como cozinhas, banheiros, lavabos, lavanderias ou áreas de serviço, é indicado o uso da placa de drywall verde, resistente à umidade. Esse tipo de placa tem em sua composição química componentes hidrofugantes, que protegem a superfície contra respingos e umidade. No entanto, o material não é a prova de água, e não deve ser usado em tetos, saunas e piscinas, já que a umidade nestes espaços é constante. Isso, se dá devido a sua composição química, que inclui componentes hidrofugantes, as paredes de drywall do tipo RU são protegidas contra qualquer tipo de umidade, garantindo maior durabilidade em ambientes molhados. É importante destacar que a impermeabilização da base da parede de chapa verde é extremamente recomendada, devendo ser feita com a altura mínima de 20 centímetros do piso. As paredes em drywall do tipo RU **NÃO** são a prova da água,.	Verde 12,5mm - 1200x1800, 1200x2400, 1200x3000;
Placa de Drywall rosa (RF)	As placas Resistentes ao Fogo (RF) possuem fibra de vidro em sua composição, o que garante maior resistência ao fogo e ao calor. Dessa forma, paredes de drywall confeccionadas com o material devem ser utilizadas áreas com risco de incêndio (lareira, algumas áreas da cozinha), em escadas enclausuradas e saídas de emergência. Devido o auxílio da fibra de vidro no aumento da resistência ao fogo, a placa de drywall rosa é mais eficaz na proteção e segurança do que as placas standard, incluindo o cumprimento dos requisitos da Norma de Desempenho NBR 15.575.	Rosa 12,5mm - 1200x1800; Rosa 15mm - 1200x2400.

Source: Prepared by the authors.

By using this new technology, it provided, in addition to meeting new demands, it speeds up the completion of the work, in addition to the environmental issue due to the high degree of reuse of the components

According to data available on the website of the Brazilian Steel Construction Center (CBCA), when comparing the years 2014 and 2015, they indicate that the current demand for Drywall is still small compared to international consumption.

III. METODOLOGY

Conceptually, this study uses the deductive method, based on bibliographic research and with an exploratory objective, which, as described by Prodanov & de Freitas (2013), aims to provide greater familiarity with the studied phenomenon and with the issues raised, so that it can thus conduct the analysis in a more legitimate way to what has been produced on the subject under consideration.

It is justified to adopt this methodology, since it allows for a wide and diversified form of information collection, in addition to being able to use dispersed data in numerous publications, also helping in the construction or better definition of the conceptual framework that involves the proposed object of study.

This study began in March 2021 with the choice of the topic that took place through the observations of the authors of this study, where it was possible to identify the problem

to start the exploratory research of bibliographic material to carry out a theoretical approach on Drywall .

In order to prove the practice observed, bibliographical references were searched for in related studies for the development of the theoretical basis. Thus, this research is of a quali-quanti nature, since it is based on methodologies whose objective is to make a critical, contextualized and exploratory analysis about the use of Drywall as a constructive method, as well as to demonstrate the results obtained in our observations through data collected from the company responsible for the project.

Thus, articles, books and other materials that focus on studies on the theme Drywall as a constructive method were read and analyzed, in order to verify what already exists in the literature on the subject and what is being produced.

It should be noted that the data that supported the results and discussions is based on the definitions of NBR 6120/2019, which allowed us to calculate building structures, using the following formula:

- To calculate the weight per m² of wall:
  $P = \Upsilon ap \ x \ e \ x \ h \ x \ l$

  Which:
  $\Upsilon Tijolo$: Specific Weight

  e: Masonry Thickness

  h: Masonry Height

  l: Width

Finally, for comparative purposes, the Excel spreadsheet was used, built from data on average prices practiced in specialized trade in the city and Manaus, from budgets obtained in three construction material stores, a survey carried out between the second April fortnight and first week of May 2021.

With these data, charts, tables and graphs were elaborated as a way to expose perceptions, concepts, definitions, characteristics and values that are discussed and compared with the literature used.

It must be clarified that in order to identify the feasibility of using Drywall in the enterprise, the deduction method was used, in which it is assumed that the research goes from the general to the private. The author will share with readers his own experience in developing a feasibility study for a project as part of a group of companies that were developing an enterprise in the city of Manaus-AM.

In turn, the comparative analysis method consists of identifying the best results among the existing ones, identifying the factors that affect the achievement of the presented results.

IV.   RESULTS AND DISCUSSIONS

The constructive calculation method is used most often in developing perspectives for the development of individual branches of the organization of financial and economic activities. It allows the Civil Engineer to choose the most effective option to achieve the organization's ultimate goal and justify measures to master the ideal solution.

The economic and mathematical method is used in solving production optimization problems as a whole or in individual technological processes, as well as in choosing effective organizational, economic and technical and technological solutions.

It allows you to find the best option for using the organization's material and technical resources, promising practical areas of action for obtaining optimal results.

The balancing method allows you to coordinate and link all indicators that reflect the essence of processes or phenomena. It is widely used in the development of various plans, with its help a balance of all quantitative proportions is achieved.

With a systematic approach to the phenomenon under study, it is important to use the most appropriate methods for the dissemination of certain provisions. More often than not, several methods are used in combination - in this case, the identified economic patterns complement and enrich each other. It is necessary to know the potential of each method and know how to apply it in practice.

There are universal methods to calculate a feasibility study that save time in preparing a feasibility study that follows the originally developed feasibility study, these are done more efficiently using software, in this study, the spreadsheet owned by the company was used. company, which is all parameterized to perform calculations.

Due to the business strategy factor, the formulas and data sources will not be mentioned, being exposed a simulated construction of a 1.0 square meter wall.

Assis (2016) states that before directly considering the development and methodology for the formation of a feasibility study, it should be clarified that the feasibility study is mainly intended to confirm the feasibility of implementing a project and its financial return.

This process involves a multidisciplinary team that involves administrators, managers, financial, accounting and construction planning personnel, including the Civil Engineer.

The financial and economic service consolidates the information received from others and prepares this document both for internal users (a project to launch a new

type of business, investments to expand an existing business, modernization of production equipment, etc.) and for users external (obtaining a loan from a bank, recording the lease of fixed assets, attracting external investors in the development of the company, requesting a grant, etc.).

At its core, a feasibility study is obviously a kind of economic forecast for future periods and is on the same level as documents like:

- business plan;
- revenue and expense budget;
- forecast of the project's financial result;
- investment plan.

At the same time, the feasibility study has indisputable differences from these calculations: compared to the business plan, the feasibility study is less detailed and does not require detailed economic calculations; while the expense and income budget operates only with quantitative and total indicators of the results of the company's activities, then in the feasibility study, on the contrary, the financial plan of the results of the activities is only one of several sections; the forecast of the financial result is based only on sum indicators and contains only the final probabilistic result of the size of the enterprise's profit, in the feasibility study it is necessary to confirm the degree of probability of success in the implementation of the project; an investment plan requires not only certain calculations, but also a cash flow forecast to confirm the company's ability to return attracted investments (Souza & Carvalho, 2019).

In a feasibility study, the question of cash flows becomes important only when it is constituted in the context of loans or acquisition of fixed assets on a lease basis.

In general, the feasibility study is necessary so that, based on it, the recipients of the document can make an informed management decision on the feasibility of launching the proposed project, taking into account the technical, financial, organizational and technological resources allocated to the project. Therefore, the feasibility study, in our opinion, should still be recognized as a simplified version of the business plan.

In this study, we will highlight the importance of Drywwall as an innovative alternative in civil construction, so the idea of an exploratory research to develop this study proved to be inspiring and appropriate.

It is not intended to detail the steps and calculations of the feasibility study, but to bring one of the essential and necessary data for the elaboration of the feasibility. The study carried out by the Civil Engineer: the definition of the constructive method of sealing, depending on the cost.

With the evolution of materials technologies used in civil construction over the last thirty years, it led civil construction professionals at the time to seek to develop and use construction materials that were more resistant to fire and weather and that would allow construction quickly and efficiency (de Mattos; Guimarães, 2013).

In the conventional constructive method, used in sealing, where, in general, the base is prepared from the calculation of the weight that the project will support, to then lay the ceramic (brick) or cement blocks with the help of mortar to fixing them and joining them, in another phase, the walls are sectioned for the passage of installations and embedding of boxes, and then patches are made using mortar to fill in the voids (do Rosário, 2017).

The breaking of bricks in transport and execution, the use of mallets to open the tears in the walls and the frequency of removal of debris buckets from the work show the waste, many of the actions and occurrences are resolved through constructive solutions, sometimes at the base improvisation during the execution of services (Debs, 2017). Although:

> It must be clarified that masonry, when it has the function of sealing, means that it has no attribution to support loads beyond its own weight. This type of system allows for making cuts in the masonry, without harming the structure, as it does not have a structural function, however, it generates a large amount of waste (Lima & Oliveira, 2020, p.4).

That said, it is shown in table 1 and 2 the average values using the Drywall and conventional masonry method to build any room with the following dimensions 2m x 3m wide and 3m high with a total area of 30m², to obtain average price in the city of Manaus was researched in the table of SINAPI - 03 / 2021– AM in which it provided all the value of the input and the value of labor. SINAPI (National System for Research on Civil Construction Costs and Indexes) is a software created by the Federal Government, and widely used when the project is financed by Caixa Econômica, where through data inputs by the registered user, as a way to make it available by means of standardized calculations, information on costs and rates of civil housing construction.

With the evolution of SINAPI, other institutions started to use it and contribute to feed the database, today SINAPI is a reference in the composition of project costs in Brazil.

Among the parameters used are calculations such as the labor productivity indicator, whose formula is:

$$RUP = \frac{Hh}{Qs}$$

Which:

RUP: Unit Production Ledger

Hh: Wasted man-hours

Qs: Number of services performed

Thus, productivity depends on the effectiveness of the tasks to be performed due to the downtime, where it will only be productive if a greater amount of activities are performed in the shortest possible time, with the same number of people and with a minimum of stopped time.

It should be noted, however, that these correlations between SINAPI and the budget do not always reflect reality, since:

> A budget can result in two results: when poorly prepared and without defined criteria, it brings errors and omissions that generate losses and when well prepared, it guarantees the companies' profits and survival. As works with resources from the union are by decree obliged to use the SINAPI database, they seek compositions of ready services that resemble the projected services, in this way the quantifications are performed by the agency, and the unit cost applied is that found directly in the compositions spreadsheet. synthesis of SINAPI (Cavalcante; Silva & Carvalho, 2018, p.2).

average cost was obtained in the city of Manaus.

Table 1 Average cost of Drywall room of 30m²

Drywall							
Tipo	Descrição	Tipo	Unidade	Quantidade	Valor Unitário	Total	
Composição	PAREDE COM PLACAS DE GESSO ACARTONADO (DRYWALL), PARA USO INTERNO, COM DUAS FACES SIMPLES E ESTRUTURA METÁLICA COM GUIAS SIMPLES, COM VÃOS AF_06/2017_P	PARE - Paredes/Paineis	m²	1,0000000	80,97	R$	80,97
Composição Auxiliar	MONTADOR DE ESTRUTURA METÁLICA COM ENCARGOS COMPLEMENTARES	SEDI - Serviços Diversos	H	0,6280000	25,4	R$	15,95
Composição Auxiliar	SERVENTE COM ENCARGOS COMPLEMENTARES	SEDI - Serviços Diversos	H	0,1570000	17,01	R$	2,67
Insumo	FITA DE PAPEL REFORCADA COM LAMINA DE METAL PARA REFORCO DE CANTOS DE CHAPA DE GESSO PARA DRYWALL	Material	M	0,7925000	1,81	R$	1,43
Insumo	FITA DE PAPEL MICROPERFURADO, 50 X 150 MM, PARA TRATAMENTO DE JUNTAS DE CHAPA DE GESSO PARA DRYWALL	Material	M	2,5027000	0,14	R$	0,35
Insumo	MASSA DE REJUNTE EM PO PARA DRYWALL, A BASE DE GESSO, SECAGEM RAPIDA, PARA TRATAMENTO DE JUNTAS DE CHAPA DE GESSO (NECESSITA ADICAO DE AGUA)	Equipamento	KG	1,0327000	2,44	R$	2,51
Insumo	PINO DE ACO COM ARRUELA CONICA, DIAMETRO ARRUELA = "23" MM E COMP HASTE = "27" MM (ACAO INDIRETA)	Material	Cento	0,0290000	44,81	R$	1,29
Insumo	PERFIL GUIA, FORMATO U, EM ACO ZINCADO, PARA ESTRUTURA PAREDE DRYWALL, E = 0,5 MM, 70 X 3000 MM (L X C)	Material	M	0,9093000	7,06	R$	6,41
Insumo	PARAFUSO DRYWALL, EM ACO ZINCADO, CABECA LENTILHA E PONTA BROCA (LB), LARGURA 4,2 MM, COMPRIMENTO 13 MM	Material	UM	0,9149000	0,15	R$	0,13
Insumo	PARAFUSO DRYWALL, EM ACO FOSFATIZADO, CABECA TROMBETA E PONTA AGULHA (TA), COMPRIMENTO 25 MM	Material	UM	20,0077000	0,06	R$	1,20
Insumo	PLACA / CHAPA DE GESSO ACARTONADO, STANDARD (ST), COR BRANCA, E = 12,5 MM, 1200 X 2400 MM (L X C)	Material	m²	2,1060000	12,26	R$	25,81
Insumo	PERFIL MONTANTE, FORMATO C, EM ACO ZINCADO, PARA ESTRUTURA PAREDE DRYWALL, E = 0,5 MM, 70 X 3000 MM (L X C)	Material	M	2,8999000	8,01	R$	23,22

MO sem LS:	14,19	LS:	0,00	MO com LS:	R$ 14,19
Valor do BDI:	0,00	Quant.:	30,0000000	Valor com VDI:	R$ 80,97
				Preço Total:	R$2.439,10

Source: SINAPI – 03/2021 - Amazonas

In a first inference, it leads us to infer that by using specific products, Drywall makes the construction value of the square method a little more expensive, but it should be noted that the Company on screen is a construction company that buys in large quantities. quantities for their projects, which reduces costs.

With regard to the conventional construction, the values identified in table 2 were reached.

Table 2 Average cost of brick masonry in a room with an area of 30m²

Alvenaria

	Descrição	Tipo	Unidade	Quantidade	Valor Unitário	Total
Composição	ALVENARIA DE VEDAÇÃO DE BLOCOS CERÂMICOS FURADOS NA HORIZONTAL DE 9X19X19CM (ESPESSURA 9CM) DE PAREDES COM ÁREA LÍQUIDA MAIOR OU IGUAL A 6M² SEM VÃOS E ARGAMASSA DE ASSENTAMENTO COM PREPARO EM BETONEIRA. AF_06/2014	PARE - Paredes/Painéis	m²	1,0000000	70,43	R$ 70,43
Composição Auxiliar	ARGAMASSA TRAÇO 1:2:8 (EM VOLUME DE CIMENTO, CAL E AREIA MÉDIA ÚMIDA) PARA EMBOÇO/MASSA ÚNICA/ASSENTAMENTO DE ALVENARIA DE VEDAÇÃO, PREPARO MECÂNICO COM BETONEIRA 400 L. AF_08/2019	SEDI - Serviços Diversos	m³	0,0098000	702,88	R$ 6,88
Composição Auxiliar	PEDREIRO COM ENCARGOS COMPLEMENTARES	SEDI - Serviços Diversos	H	1,3700000	20,86	R$ 28,57
Composição Auxiliar	SERVENTE COM ENCARGOS COMPLEMENTARES	SEDI - Serviços Diversos	M	0,6850000	17,01	R$ 11,65
Insumo	BLOCO CERAMICO VAZADO PARA ALVENARIA DE VEDACAO, DE 9 X 19 X 19 CM (L X A X C)	Material	Mil	0,0279300	796,5	R$ 22,24
Insumo	PINO DE ACO COM FURO, HASTE = 27 MM (ACAO DIRETA)	Material	Cento	0,0050000	38,53	R$ 0,19
Insumo	TELA DE ACO SOLDADA GALVANIZADA/ZINCADA PARA ALVENARIA, FIO D = *1,20 A 1,70* MM, MALHA 15 X 15 MM, (C X L) *50 X 7,5* CM	Material	M	0,4200000	2,16	R$ 0,90

MO sem LS:	28,01	LS:	0,00	MO com LS:	R$ 28,01
Valor do BDI:	0,00	Quant.:	30,0000000	Valor com VDI:	R$ 70,43
				Preço Total:	R$2.112,90

Chapisco

	Descrição	Tipo	Unidade	Quantidade	Valor Unitário	Total
Composição	CHAPISCO APLICADO EM ALVENARIA (SEM PRESENÇA DE VÃOS) E ESTRUTURAS DE CONCRETO DE FACHADA, COM ROLO PARA TEXTURA ACRÍLICA. ARGAMASSA INDUSTRIALIZADA COM PREPARO MANUAL. AF_06/2014	REVE - REVESTIMENTO E TRATAMENTO DE SUPERFÍCIES	m²	1,0000000	11,36	R$ 11,36
Composição Auxiliar	ARGAMASSA INDUSTRIALIZADA PARA CHAPISCO ROLADO, PREPARO MANUAL. AF_08/2019	SEDI - Serviços Diversos	m³	0,0015000	6.153,66	R$ 9,23
Composição Auxiliar	PEDREIRO COM ENCARGOS COMPLEMENTARES	SEDI - Serviços Diversos	H	0,0730000	20,86	R$ 1,52
Composição Auxiliar	SERVENTE COM ENCARGOS COMPLEMENTARES	SEDI - Serviços Diversos	M	0,0360000	17,01	R$ 0,61

MO sem LS:	1,68	LS:	0,00	MO com LS:	R$ 1,68
Valor do BDI:	0,00	Quant.:	30,0000000	Valor com VDI:	R$ 11,36
				Preço Total:	R$ 340,80

Emboço

	Descrição	Tipo	Unidade	Quantidade	Valor Unitário	Total
Composição	EMBOÇO, PARA RECEBIMENTO DE CERÂMICA, EM ARGAMASSA TRAÇO 1:2:8, PREPARO MECÂNICO COM BETONEIRA 400L, APLICADO MANUALMENTE EM FACES INTERNAS DE PAREDES, PARA AMBIENTE COM ÁREA ENTRE 5M2 E 10M2, ESPESSURA DE 10MM, COM EXECUÇÃO DE TALISCAS. AF_06/2014	REVE - REVESTIMENTO E TRATAMENTO DE SUPERFÍCIES	m²	1,0000000	23,36	R$ 23,36
Composição Auxiliar	ARGAMASSA TRAÇO 1:2:8 (EM VOLUME DE CIMENTO, CAL E AREIA MÉDIA ÚMIDA) PARA EMBOÇO/MASSA ÚNICA/ASSENTAMENTO DE ALVENARIA DE VEDAÇÃO, PREPARO MECÂNICO COM BETONEIRA 400 L. AF_08/2019	SEDI - Serviços Diversos	m³	0,0213000	702,88	R$ 14,97
Composição Auxiliar	SERVENTE COM ENCARGOS COMPLEMENTARES	SEDI - Serviços Diversos	H	0,1140000	17,01	R$ 1,93
Composição Auxiliar	PEDREIRO COM ENCARGOS COMPLEMENTARES	SEDI - Serviços Diversos	M	0,3100000	20,86	R$ 6,46

MO sem LS:	7,41	LS:	0,00	MO com LS:	R$ 7,41
Valor do BDI:	0,00	Quant.:	30,0000000	Valor com VDI:	R$ 23,36
				Preço Total:	R$ 700,80
Total sem BDI:	3.154,50				

Source: SINAPI – 03/2021 - Amazonas

These data can serve as a budget comparison and when compared with other forms of budget calculation, such as the TCPO (Table of Compositions and Prices for Budgets) and CUB (Basic Unit Cost) they bring the Civil Engineer the necessary information to assess the overall cost of contracted works and services.

Given the above and correlated what was described in relation to Drywall, the characteristics, advantages and disadvantages of the main construction methods are described in a comparative way (Chart 3).

Chart 3: Main construction method

Tipo	Descrição	Vantagens	Desvantagens
Alvenaria de Vedação ou Convencional	Edificações de alvenaria de vedação ou convencional compõem-se por vigas, pilares e lajes de concreto armado. Estes elementos fazem parte da estrutura para a sustentação da edificação e a alvenaria tem função somente de vedar e separar ambientes. Para isso, normalmente são utilizados blocos cerâmicos.	Suporta grandes vãos. Grande disponibilidade de mão de obra e materiais. Pouca exigência de qualificação da mão de obra. Facilita futuras reformas e mudanças de projeto.	Maior custo. Maior tempo de execução. Gera muitos resíduos.
Alvenaria Estrutural	Na alvenaria estrutural, une-se a estrutura e vedação edificação, utilizando blocos cerâmicos ou de concreto, os dois específicos para este fim. O projeto de alvenaria estrutural deve ser muito bem detalhado e compatibilizado com os projetos elétrico e hidro-sanitário. Deve também, definir os vãos da edificação de acordo com a modulação do bloco que será utilizado.	Rapidez e facilidade de construção. Redução na mão de obra. Maior economia. Maior qualidade na execução. Menor desperdício de materiais.	As paredes não podem ser removidas sem realocar um elemento estrutural para suprir cargas. Limitações estéticas nos projetos arquitetônicos. Vãos livres limitados.
Steel Frame	O Steel Frame é um sistema construtivo industrializado e racionalizado. Sua estrutura é formada por perfis de aço galvanizado e seu fechamento é feito por meio de placas cimentícias, de madeira ou drywall. A principal diferença do steel frame para os outros sistemas é a limpeza do canteiro de obras, pois a geração de resíduos é mínima e não há necessidade do uso de água.	Agilidade na contrução. Redução do peso da estrutura. Maior precisão na execução. Melhor isolamento térmico e acústico. Menor custo.	Limite de pavimentos. Dificuldade em encontrar mão de obra especializada.
Wood Frame	O método de construção do wood frame é muito parecido com o steel frame. A diferença é que no lugar dos perfis de aço galvanizado são utilizados perfis de madeira, normalmente de reflorestamento, como o pinus. Este sistema construtivo é constituído por perfis de madeira maciça, contra ventados com chapas de OSB e estrutura de madeira autoclavada em função de proteger a edificação de cupins e umidade.	Canteiro de obras organizado e limpo. Uso de madeira de reflorestamento, única matéria-prima renovável da construção civil. Ótimo desempenho acústico e térmico. Agilidade na construção. Redução de geração de resíduos. Baixo custo.	Mão de obra especializada. Limites de pavimentos. Maiores cuidados com impermeabilização.
Paredes de Concreto	As paredes de concreto consistem em um sistema construtivo em paredes estruturais maciças de concreto armado. Estas paredes são concretadas com o auxílio de formas de madeira ou metálica que são montadas "in loco" de acordo com o projeto arquitetônico.	Alta produtividade. Alta resistência ao fogo. Pouco desperdício de materiais.	Baixa flexibilidade. Não tem um bom isolamento térmico e acústico. Devido ao uso de formas, tem alto custo para produção em pequena escala.

Source: Adapted from Camillo (2012), Fleury (2014), Kochem (2016).

It is thus perceived that based on the characteristics highlighted in 3, they allow the Civil Engineer to choose a wide range of different materials, since these methods allow their exclusive use or a mix of methods, depending on each project under analysis.

According to Tisaka (2011), conventional masonry is defined as a constructive system whose characteristics are the fact that the entire load of the structure is absorbed by the slabs, beams, pillars and foundation. In this system, according to the author, the vertical walls do not have any structural function, therefore they only serve as closing gaps and separating environments.

Thus, by choosing to use different dimensions of blocks, walls with different thickness of seals and thermal-acoustic efficiency will be obtained, which infers to make the work practical and suitable for each customer's needs.

According to Bauer (2012) and De Mattos; Guimarães (2013) these types of construction methods, consume a larger amount of mortar, mainly used in the settlement, have high costs in the construction or rental of wooden or metallic forms (those generally used in large projects) which increase costs, once, in general, these forms are removed at least twenty-one days after concreting. Ferreira (2014) adds that another point of material waste and cost increase in conventional construction occurs during the internal and external roughness for the execution of the plaster.

In the Drywall method, this can be installed in general from five basic steps and depending on the installation according to Ching (2016), it starts with the choice of material, followed by the demarcation of the place where the Drywall plates will be fixed , followed by fixing and installing the plates for subsequent electrical and hydraulic installation, followed by finishing. For a better understanding, a basic installation flow was elaborated (1), the step by step installation of Drywall slabs is described.
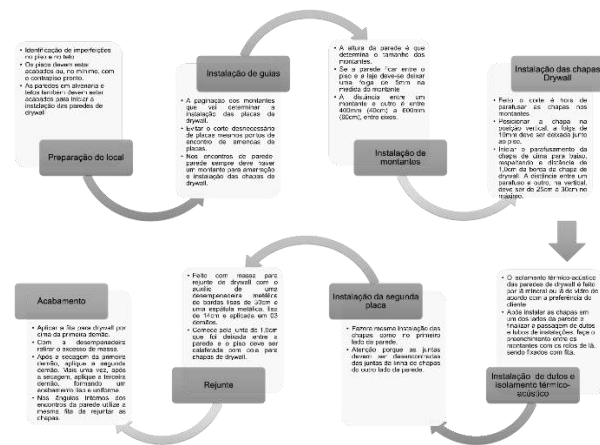
Fig. 1: Macro flow of Drywall installation process

Source: Adapted from DRYWALL (2011), Cardoso (2013), De Mattos; Guimarães (2013) and Leopoldo (2015).

It is inferred that despite being a relatively simple method to be installed and the finishing process uncomplicated, but as recommended (DRYWALL, 2011) that only specific materials should be used for use in Drywall type material, materials that are generally indicated or recommended by manufacturers, in general it is recommended to use acoustic insulation (Marinho & Cavalcante, 2017, Lima & Oliveira, 2020).

With this demonstrated, it is believed that the main forms of constructive methods and Drywall can be explored well, which will serve as a basis for future works.

The advantages of using conventional building systems (ceramic block or structural masonry) are public and notorious. For the defenders of this method, the examples of Egyptian pyramids or Greek temples stand out, which despite the bad weather and the action of time, still are standing demonstrating the technical legacy and architectural beauty of these constructions developed by ancient peoples (Martha, 2010).

However, proponents of using other systems such as Drywall point out that currently more than 80% of all single-family homes being built in the US state of Florida are using modern construction systems such as Drywall, Steel Frame Ligthing and ICF (Labuto, 2014; Kochem, 2016; Marinho & Cavalcante, 2017).

Another comparative pro Drywall refers to the analysis of waste compared to conventional systems, which have steel and waste from ceramic blocks as the materials that contributed a lot to the generation of waste (Fleury, 2014; Fonseca, 2018; Garcia, 2018).

This is due to the specific needs of cutting and preforming steel materials to meet the reinforcement specifications in a concrete structure, in the same way, the waste caused in the transport and laying of bricks and the need for after lifting the seal vertical, it is necessary to break parts of the walls to facilitate the installation of windows and doors or electrical installation.

In turn, the rigidity and strength of connections used in Drywall panels are crucial factors that influence the overall structural behavior, these connections use screws to be fixed, as they have the advantage of being cheaper and easier to make joints than glued joints by means of tapes (Fernandes, 2020). Where complementary preparation processes are required (Eastman et al., 2014).

These factors tend to affect the health of construction workers who install Drywall boards, as this exposes them to the risk of contracting various musculoskeletal injuries and disorders, especially for the lumbar, back and shoulder areas.

In the various Drywall manufacturers' manuals, there are recommendations that the plates be stored in flat places, they bring recommendations to their customers and installers about the risk of injuries caused by Drywall (dos Anjos & Teixeira, 2017; do Rosário (2017), mainly related to the fall of the plate on the installer and due to the repetitive movements resulting from these operations (da Silva, 2015).

Another argument for Drywall, refers to the characteristics of the materials used in its manufacture, which make this material a kind of barriers resistant to fire and even (Calçada, 2014). No studies were found related to the costs of maintaining these panels (Côrtes, 2018), likewise there is little or no experimental data and

information about Drywall assembly mechanisms that make them resistant to realistic fire conditions (Arving , 2020).

It should be noted that as there is no further information on physical properties, this can affect the calculation of the project's life cycle and cysts resulting from the time to be used to correct assembly failures (Crescêncio & de Barros, 2018).

Another appeal to the use of Drywall is that, due to the aforementioned characteristics, they make the buildings safer and, therefore, when passing this information on to the insurance company, the owner can claim a reduction in the value of the insurance.

In medium and large buildings and constructions, the building codes and municipal regulations (in medium and large cities) generally indicate the need to use flame-resistant materials and in larger projects there is a determination of compartments that inside a building must be insulated by fire barriers.

The studies listed here highlight that globally, Drywall systems are used as a replacement for bricks and construction with mortar (Medeiros & Pacheco, 2019). In the developed world, construction solutions are quite advanced from a standpoint as construction practices have evolved over a period of time mainly due to their performance and aesthetic appeal.

Other advantages of Drywall are highlighted by Kochem (2016) which highlight that construction practices are evolving and, therefore, the use of advanced construction systems is focused on effective performances related to situations such as fire, acoustics, recycling etc.

According to Eastman et al., (2014) in Brazil, the Metropolitan region of São Paulo gathers most of the consumption of plasterboard (Drywall) in the country, which represents between 38 and 40% of the Brazilian market.

According to Do Rosário (2017) Brazil has great possibilities of using the construction method in Drywall, due to the great demand for popular housing, which according to Assis (2016) recommends that one should take into account the minimum performance of the buildings that will use this method , in which they must have the minimum technical standards by type of

enterprise.

In the case of masonry walls made with perforated ceramic bricks, ABNT NBR 6120:1980 has as its main recommendation the use of a specific weight of 1300 kgf/m³, the same specification defined for reinforced concrete structures.

With this, it can be inferred that when using the Drywall system, the Civil Engineer must evaluate not only the costs themselves, but an entire production chain from a holistic perspective, which involves, in addition to the economic question, the socio-environmental question and of worker safety (Botelho, 2019).

Criticism of this constructive method, in addition to those already mentioned above, refers to failures arising from the lifting phase of the vertical fence that can have the consequences: waste of material, time and the constant evaluation of inspectors and the Civil Engineer himself. Some evidence of these failures was selected (Fig 2).
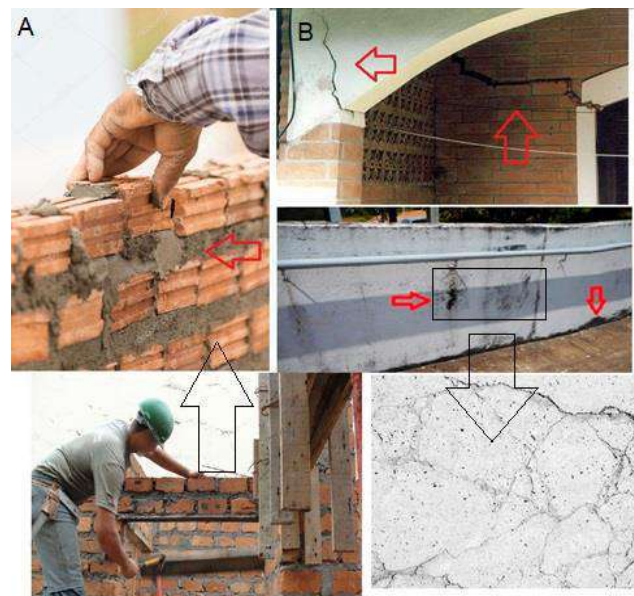
Fig 2: Examples of waste and failures in the conventional construction system

Source: Photomontage prepared by the author

In Fig 2A (we can see the excess of concrete used to lay the bricks), it is not uncommon to see cases of cracks (Fig 2B) resulting from a structural base consistent with the weight or from failures in the execution of the service.

Vechi, Gallardo & Teixeira, (2017) highlight that the civil construction segment, in addition to appropriating natural resources, is responsible for relevant transformations in the landscape which can, through the waste generated and when discarded incorrectly, cause significant impacts environmental issues.

With the increase in the number of works in progress and the availability of technologies, comparison becomes essential. According to Debs (2017) it has been adopted by medium and large corporations as a way to minimize costs and increase construction speed.

Likewise, the cost of recovering these failures is relatively high, compared to corrections arising from

construction in Drywall. In Fig. 3 a comparison of the construction methods is performed: conventional/structural masonry and Drywall.

Fig. 3: Comparison of Masonry x Drywall Construction System

Source: Chagas, 2017.

This comparison is more evident in the studies by Tisaka (2011) who, when analyzing the cost of construction using masonry and Drywall based on material and labor costs, show that when evaluating an area of 5,475.71 m² of walls , where 2,334.61 m² in a dry environment and 3,141.10 m² in a humid environment.

As indicated in the initial comparison, it is clear that in the acquisition cost analyses, the values alone already represent a reduction of 22.68%, which added to something around 16.11% of cost reduction with the material and foundation execution time, allows the entrepreneur to seek this cost reduction and productivity gain as a way to remain competitive.

It should be noted, however, that the studies demonstrate the feasibility of using Drywall only in internal seals and that do not require applications such as the need to use moisture-resistant (green board) and fire-resistant (pink) boards.

These become viable only after parts of these costs are passed on to the client. As noted earlier.

V. CONCLUSION

This study brought to light the discussions on the use of Drywall, as an innovative and viable constructive method in constructions in regions such as the Amazon, where high temperatures and humidity tend to affect the durability of materials.

The study was limited to comparing similar studies in relation to data collected in an enterprise in the city of Manaus (AM), which, due to the sanitary crisis resulting from COVID-19, created an additional challenge for data collection. At the request of the companies, neither the project nor the study company is identified.

It was demonstrated in this study, both with the data brought by the authors of this article and the comparison of similar studies, that there is a growing demand for construction methods that allow faster execution of works, implying process optimization and cost reduction, within the scope Drywall has been widely used for internal fences, despite the resistance of some consumers to use this constructive method.

It was found that the use of Drywall boards in interior fences has very satisfactory results. This is due to the basic advantages of using the Drywall system, which include a light structure, ease of adjustment of interior design, speed of installation which reduces the delivery time of the work.

It is concluded that the use of Drywall is viable and safe, as long as it is applied technically and economically and by trained personnel. Likewise, Drywall tends to become more popular as features such as fragility to impacts and abrasion are being remedied, as well as the use of techniques for fixing heavy objects are evolving.

Finally, it is concluded that despite the positive facts previously highlighted, the sustainable appeal of the use of Drywall must be added, which allows us to conclude that there is still a arduous path to be taken as a way to overcome the stigmas that Drywall is a price product it elevates (and it is in the case of small purchases) and does not offer adequate resistance and isolation, a fact that is not supported as an argument, due to numerous studies in the area.

Far from exhausting the subject, the quantitative comparison of the cost of the square meter of internal fences, built in Drywall in a house and in an apartment of equal dimensions, is left as suggestions for further studies.

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Physiological characterization in varieties of the genus *Schizolobium* under water deficit

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Abstract— *The genus Schizolobium has a species divided into two varieties: Paricá belonging to the Amazon forest and Guapuruvu belonging to the Atlantic Forest, both of importance for ecology and forestry due to the quality of the wood. As they are values-adding varieties, information on the physiological mechanisms that regulate the metabolism of plants in a particular environment becomes important to establish their level of adaptation. Thus, the aim was to analyze the possible physiological and biometric differences between the two varieties regarding the tolerance to drought when submitted to the water deficit. The work was developed in nursery, in the experimental field of the State University of Bahia. The design was completely randomized – CRD with 2 treatments and 200 replicates. Statistical analyzes were performed by software R (R CORE TEAM, 2017). The results showed that the growth analysis through the physiological indexes was efficient to identify differences in the initial growth of Schizolobium plants and the physiological characteristics of gas exchanges were negatively affected by water stress in both varieties during the days of stress.*

I. INTRODUCTION

The genus *Schizolobium* is composed of trees characterized by the fast growth and good quotation of the wood in the market. The varieties of this genus are found from Central America to the South of Brazil, presenting a wide distribution Neotropical with two varieties of very similar characteristics and difficult to distinguish. They are divided in S. *parahyba* var. *parahyba* (guapuruvu) and S. *parahyba* var. *amazonicum* (paricá) (Turchetto Zolet et al., 2012).

The use of *Schizolobium* occurs mainly in the North and Northeast of the country. These regions are historically recognized as having a poor annual rainfall distribution. Thus, the newly installed seedlings in the field are subject to water deficit. According to Carvalho (2005), empirical observations have shown that in the periods of irregular rainfall the recently installed plants in the field undergo severe water deficiency, caused by high levels of incident solar radiation and the characteristics of their leaves. As they are bipinnated, they present lower values of resistance of the boundary layer and thus submitted to great loss of water.

According to Pimentel (2004), water is the fundamental substance to life. There are strong indications that there will be greater climatic variations with more frequent droughts that will cause a great effect in the relation of the plant with the environment. It becomes indispensable to obtain varieties more tolerant to the drought with high

productivity, aiming the planting in adverse conditions with water economy. Some studies have been conducted with the objective of discovering the physiological bases that would explain the differences in photosynthetic yield among varieties (Verissimo, 2010).

The water balance of the plant is controlled by leaf transpiration and the absorption of water in the soil that under adverse conditions such as water deficiency decreases the relative water content and leaf turgor. The water potential of the leaf also reduces with the decrease of the availability of water in the soil, leading to the loss of turgescence and stomatal closure (Mansur & Barbosa, 2000). Therefore, leaf water content in conditions equal to or lower than 75% significantly diminishes the photosynthetic activity (Smit & Singels, 2006). It is known that there is great intra and interspecific variability regarding the adaptability of species to drought. Thus, it is important to evaluate the physiological behavior of different genetic materials against water deficit, in order to allow a subsequent recommendation of their cultivation.

As they are value-adding varieties, this information is useful for improvement of character selection and foment cultivation in arid and semi-arid regions. According to the above facts, the aim was to analyze the possible physiological and biometric differences between the two varieties regarding the tolerance to drought when submitted to water deficit.

II. MATERIAL AND METHODS

The experiment was carried out in the Experimental Field nursery of the Federal University of Recôncavo of Bahia. After obtaining lots of seeds of each variety, both from Penápolis - SP, 200 seeds of each variety were removed and they were submitted to the overcoming of dormancy by mechanical scarification (manual friction of the seed on both sides above the radicle in iron sandpaper nº 60). After scarification they were soaked in water for 24 hours (Carvalho, 2005)

The sowing occurred in a polyethylene bag with a size of 24 cm in height and 12 cm in diameter containing as a substrate a mixture of soil and manure (bovine manure) in a ratio of 2:1. Manual irrigation was performed once a day and when necessary, twice (morning / afternoon). The mean temperature and relative humidity of the air (RH) were recorded inside the nursery during the whole conduction of the experiment, recording a minimum temperature of 21.6 ° C and a maximum of 30.5 ° C with a mean RH of 79.5 in the morning.

At 15 days after the complete appearance of the two pairs of leaves the growth analysis evaluations were started, being again performed at 30, 45, 60, 75, and 90 days. We selected 05 plants of each variety and determined stem height (SH), neck diameter (ND), leaflet numbers (LN), leaf area (LA). The SH was obtained with a graduated ruler, in which the distance between the surface of the substrate and the apex of the plant was measured. The ND was measured with a pachymeter on the surface of the substrate. The LN was obtained by direct counting and the leaf area was obtained by scanning all leaflets (HP scanjet 8300®), in tiff format with 200 dpi and processed in ImageJ® software (Rasband, 2011). After measurements, all the material was placed in a forced circulation air oven at 65 ºC until its complete drying and then weighed in analytical balance (in the initial phase at 15 days) and precision scale (during the experiment) to obtain the Dry mass of the different organs (DM).

The experimental design was completely randomized to a factorial of 2 x 6. The Dickson Quality Index DQI = TDM / (PH / SD) + SDM / RDM) was used to evaluate the quality standard of the seedlings. Statistical analyzes were performed by software R (R Core Team, 2017). The Pearson correlation test was performed. The results were submitted to analysis of variance, where the effects of the varieties of the days of evaluation and the interaction between the factors varieties and days were analyzed by the F test at 5% of probability. The effect of the varieties according to the days of evaluation was verified through regression analysis. In the choice of model, the biological explanation and the significance of the coefficient of determination R^2 were taken into account.

At 60 days after emergence (DAE), the seedlings were transplanted to black vases of 35 cm height x 14 cm in diameter and capacity for 4.65 liters containing soil. Then foliar fertilization was done with N sol. 14% H_2O (189 g / l), P2 O5 sol. 7% H_2O (94.5 g / l), 3% as phosphite, K 2 O sol. 5% H_2O (67.5g / l), Mg sol. 1.5% H_2O (20.25 g / l), B1 sol. 0.1% H_2O (1.35 g / l), Mn sol. H_2O 1.5 (20.25 g / l), M.S. 0.05% H_2O (0.675 g / l), Zn sol. H_2O 2% (27g/l) and 20 days were expected for root accommodation.

The physiological characters were measured with the aid of an infrared portable gas analyzer (LcPro +, ADC, UK.). The plants of each variety were selected according to the uniformity in height and number of leaves. Liquid photosynthetic rate (A), transpiration (E), stomatal conductance (gs) and concentration of CO_2 (Ci) were evaluated and measured in fully expanded leaflets of the most recent mature leaf for a period of 1-2 minutes to allow equilibrium of the photosynthetic rate. These evaluations were done in 5 replicates of each treatment.

For carrying out the curves of response to radiation and CO_2, the methodology of Long & Hallgren (1993) was used with modifications in the radiation sequence (monitoring time and integration of the 3 minutes readings, with temperature of the leaves kept at 25ºC and radiations of 0, 30, 80, 130, 250, 450, 650, 850, 1100 and 1500 mol.m². s⁻¹) . For the CO_2 response sequence were used concentrations of 410, 200, 50, 350, 500, 750, 1000 and 1300 ppm of CO_2, with leaf temperature of 26ºC and radiation saturation of 750 mol.m².s⁻¹ with monitoring and integration time of 5 minutes.

Initially the original response data to the radiation and CO_2 were used to calculate some parameters and these parameters were used for the adjustment curve. For the radiation was used the model of Smith of 1936, because this model gives a correlation (R) of 99.73%. For the CO_2 adjustment curve, the model of Ethier & Livingston (2004) was used through the A/Ci Curve Fitting program 10.0 xls, version 11 December 2013 (available at www.landflux.org/tools.php).

Soil moisture was monitored volumetrically (m^3/m^3), using the Decagon system (Pullman, WA, USA) with a 5TE probe that monitors the dielectric characteristics of the soil. In order to measure tolerance to water deficit, daily evaluations of the changes were carried out, starting with the fully irrigated seedlings and finalized after photosynthesis reached close to zero. All evaluations were performed at 8:00 a.m., 12:00 a.m. and 17:00 p.m. and the readings recorded after A and gs stabilized and when the coefficient of variation, measured by LcPro +, was less than 1.0. The results were submitted to analysis of variance. The standard error of the samplings was used in the graphs.

III.   RESULTS AND DISCUSSION

In the present work, the behavior of Paricá (*Schizolobium parahyba Var. Amazonicum*) and Guapuruvu (*Schizolobium parahyba var. Parahyba*) showed different by analyzing of parameters biometric. There were statistical differences between the varieties and throughout the growing days during the evaluation period for the following variables: leaflet number (LN), leaf area (LA), stem dry mass (SDM) and neck diameter (ND).

Fig. 1 shows the behavior of the number of leaflets per plant and the Leaf Area. A joint analysis of the two parameters shows that initially (up to 30 days) the plants behave very similar with no difference in leaf area or number of leaflets. However, after this period there are differences between these parameters with Paricá presenting a larger leaf area until the end of the study (90 days). As the number of leaflets is different from the 30

days, but similar to the 90 days, the difference in leaf area can only be explained due to Paricá presenting larger leaflet size. It is clearly observed a compensation between leaf area and number of leaflets between the two varieties.
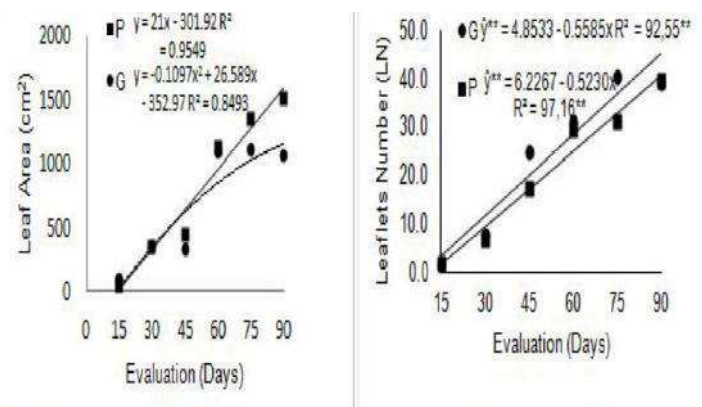
Fig.1 – Leaf area cm2 (AF) and leaflets number (LN) between paricá e guapuruvu varieties and throughout growing at 15, 30, 45, 60, 75 and 90 days. UFRB, Cruz das Almas, BA. 2020.

The relationship between leaf area and number of leaves is also known in several species, although it is complicated and difficult to understand due to the participation of other parameters of growth and response to environmental factors. By increasing the leaf area, the surface of absorption of total light radiation and the accumulation of photosynthetically active radiation (Caron, 2012) are increased. According to Barbieri Júnior *et al.*. (2007) when working with Jatobá, the high leaf area at the beginning of the development of the plants indicated that, there was investment in the development of the leaves for the capture of light radiation. Later, due to the maturation of the leaves and the direction of the photo-assimilates to other parts of the plant occurred the decrease of the photosynthetically active leaf area.

Fig. 2 shows the relationships between plant height and neck diameter for Paricá and Guapuruvu. There was no statistical difference for the height parameter among the varieties but for the parameter of neck diameter, there were observed significant differences between the varieties from 60 days with Guapuruvu having a larger neck diameter. The results of height and diameter are in agreement with those obtained by Caron (2010), evaluating *S. parahyba.* The neck diameter is considered a significant parameter to estimate the survival in the field of several forest species. The quality standard of the seedlings ready for planting correlates with this parameter, and this can be verified by significant increases in survival rates and plant growth in the field, according to a study by Binotto (2010) for eucalyptus.

Height and diameter showed a negative correlation by Pearson's correlation (Fig. 5), showing that smaller plants presented larger diameter. Similar results were found by Rego & Possamai (2006), evaluating the growth of the Jequitibá-Rosa. In Binotto's work (2010), he analyzes growth variables in forest species and shows that the height variable was only efficient to indicate the quality of seedlings when analyzed along with the diameter. According to Rosa (2009), the root collar diameter and the total dry matter are important morphological parameters together with the Dickson quality index (DQI) to evaluate the quality of Paricá seedlings produced under nursery conditions.

In order to avoid errors in selecting higher but weak seedlings, by discarding smaller ones but with greater vigor, the morphological parameters and the relationships used to evaluate the quality of seedlings should not be used in isolation. Thus, a good indicator of seedling quality is DQI, since in its calculation several important parameters used for quality evaluation are considered (Fonseca, 2002).
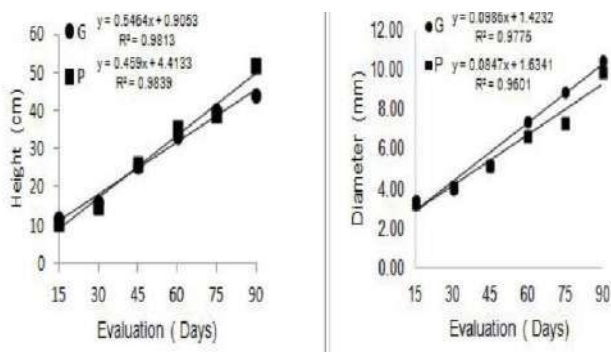
Fig.2: Height (cm) Neck diameter (mm) between Paricá e Guapuruvu varieties and throughout growth at 15, 30, 45, 60, 75 and 90 days. UFRB, Cruz das Almas, BA. 2020.

Fig. 3 shows the behavior of the biometric parameter of Stem Dry Mass for the Paricá and Guapuruvu varieties. There were differences in the accumulation of dry mass of the stem (Fig. 3), which was higher in guapuruvu from the 30th day, which is probably justified because it also has a larger diameter from this period.
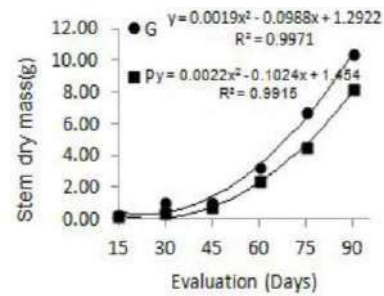
Fig.3: Stem dry mass (g) between Paricá and Guapuruvu varieties and throughout growth at 15, 30, 45, 60, 75 and 90 days. UFRB, Cruz das Almas, BA. 2020.

In the Dickson Quality Index (DQI) evaluation, no significant difference was observed between treatments, indicating that both varieties presented quality seedlings (Table 2). The higher the value of this index, the better the quality standard of the seedlings (Gomes & Paiva, 2012). For the parameter (H/D) R there was a significant difference between the treatments.

Table 2 – Mean seedling test of S. parahyba var. amazonicum and S. parahyba var. parahyba. UFRB, Cruz das Almas, BA. 2020.

Varieties	Parameters used to evaluate seedling quality		
	DQI	R (SDM/RDM)	R (H/D)
Paricá	1,59 a	5,39 a	5,20 a
Guapuruvu	1,74 a	6,80 a	4,20 b

Dickson quality index (DQI), shoot dry mass / root dry mass ratio (SDM / RDM) R, height / diameter ratio (H / D) R. Means followed by the same letter do not differ statistically from each other by the F test at 5% significance.

There was greater height/diameter ratio for Paricá 5,20 R (H/ D). According to Araújo (2017), the lower their value, the greater the ability of the seedlings to survive. Jose *et al.* (2009) consider that seedlings of high quality forest species should present H/ D indexes lower than 10, and when they meet these indexes, they present higher survival after planting. According to Araújo (2017), this method of non-destructive evaluation represents the balance of plant growth. The author, when evaluating the quality of Paricá seedlings, obtained H/ D ratio (5.47), (6.98), (6.29) and (6.35).

Rossa *et al.* (2013) evaluated the growth of Paricá seedlings for the same parameter and obtained results between (6, 31) to (7,18) and considered these values as a good development in height in detriment of the neck diameter. In this study, both varieties had a value lower

than 10 with a lower average for Guapuruvu with 4.20. Garcia (2015) evaluating Guapuruvu seedlings, obtained a better H / D ratio of 3.23.

There was no statistical difference for (SDM /RDM) R. Caione (2012) obtained results ranging from 3.18 to 3.64. According to the author, there is no standard index, which is the most indicated for seedlings of *Schizolobium*. In this work, results of 5.39 were obtained for Paricá and 6.80 for Guapuruvu. Importance should be given to the variables of the root system of seedlings together with the study of their morphological parameters to ensure better performance in the field (Binotto, 2010).

According to Pearson's correlation analysis (Fig. 5), the dry matter variables are the most strongly correlated with the Dickson quality index (DQI), followed by the base diameter in agreement with the results obtained by Binotto (2010) in seedlings of eucalyptus. According to Fonseca *et al*. (2002), in order to obtain a quality parameter of the seedlings, it is necessary to take into account the evaluation of some variables of the morphological and physiological characteristics of the seedlings because they significantly influence in the quality standard.
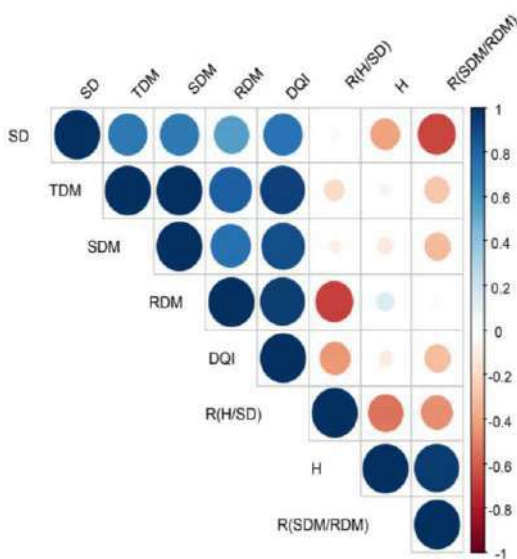
Fig.4: Correlogram based on Pearson's correlation in seedlings of S. parahyba var. amazonicum and S. parahyba var. for biometric variables: Stem Diameter (SD), Total Dry Mass (TDM), Shoot Dry Mass (SDM), Root Dry Mass (RDM) Dickson quality index (DQI), Height (H). UFRB, Cruz das Almas, BA. 2020.

Observing the parameters of gas exchanges (fig. 6), there was interaction between the varieties and the evaluation schedules for the gas exchanges A (Photosynthesis), gs (Stomatal Conductivity) and Ci (Internal CO_2 Concentration) with greater assimilation of CO_2 and greater stomatal conductivity in the morning for the two

varieties. The stomatal conductivity drops at noon for both varieties, but there is a more significant decrease in gs in Paricá.

According to Taiz *et al.* (2017), the stomatal activity is an important variable in the balance between the gain of photosynthesis and the loss of transpiration. The loss of turgidity causes the closure of the stomata and this is one of the first adjustments developed by the plants to avoid the continuous loss of water.

Fig. 6 shows the behavior of photosynthesis and transpiration for both varieties. We can observe that already at 8 o'clock in the morning, both varieties present high photosynthetic and transpiratory rates. In the interpretation of these data, it can be noted that Paricá maintains the highest photosynthetic rates of Guapuruvu during the morning, but this changes at midday (Fig. 6). Such behavior of photosynthesis between the two varieties may have been possibly due to the reduction in stomatal conductance (Fig. 7), which was significantly lower in Paricá at noon, limiting the assimilation of CO_2.

Radiation intensity may also cause differences in the photosynthetic rate between varieties. However, in this case the two varieties have the same availability and luminous intensity as can be evidenced in Figure 8. It can be seen that the varieties received almost the same amounts of photosynthetically active radiation for all data monitoring schedules of gas exchanges. Data on the photosynthetic behavior of the genus *Schizolobium* practically do not exist in the available scientific literature.

However, Marenco *et al.* (2014) working with species of the Amazon forest, observed that the photosynthesis of these species remains high in the morning until reaching a peak, which occurs before noon, steadily declining in the afternoon. According to the authors, this occurs because at the leaf level the photosynthesis increases with the irradiance until reaching saturation point (SP). From this point, increases in irradiance do not cause increases in photosynthesis. Santos Lopes *et al*. (2015a and 2015b) while studying the behavior of S. *parahyba* under different shading intensity, obtained photosynthetic rates lower than those found in this work for plants of similar ages. Cordeiro (2006) found oscillation of 8.85 mmol CO m²s¹ at 10.45 mmol CO m²s¹, evaluating physiological characteristics of paricá seedlings from different sources.

Considering the behavior of the transpiration (Fig. 6), it can be noted that there was no difference between the varieties during the evaluation periods, being at 12 a.m. the period of greatest loss of water by transpiration for both varieties as well as of the highest luminous intensity (Fig. 8). Such behavior is discussed in the relevant literature and is a reflection of the increase in the water demand of the

plant for the 12 o'clock time, where the plant undergoes a heat load and the increase of evaporative demand. Interesting to observe the reduction of stomatal conductivity between the two varieties, which affected the photosynthetic rate of Paricá, does not seem to have affected the transpiration of the varieties. In this case, the plants were in good availability of water because this is the period where they were being irrigated, which makes us understand that the absorption of water from the soil was sufficient to maintain the rates of transpiration. The action of stomata seems to be of great importance for the Paricá variety in the maintenance of transpiration rates. According to Kramer (1983) the stomatal conductivity can affect transpiration and photosynthesis differently. The influence of conductivity on transpiration is mainly stomatal, but for photosynthesis, it may be both stomatal and non-stomatal.
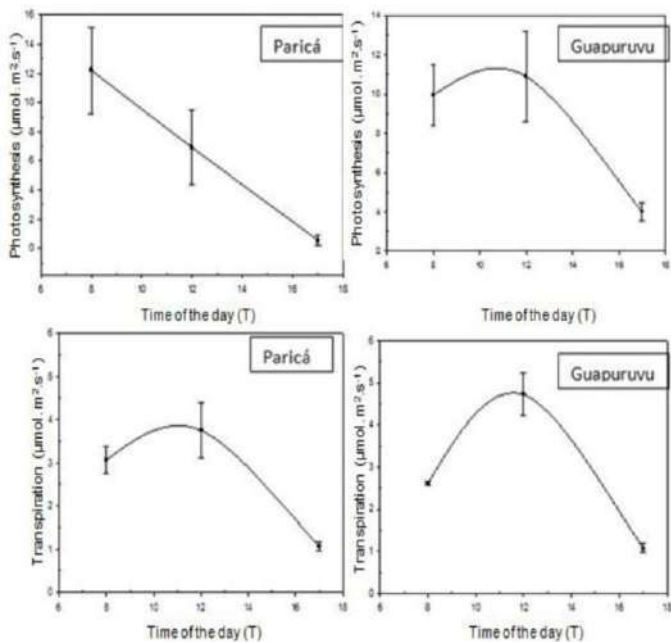
Fig.6: Behavior of photosynthesis and transpiration at 08:00 a.m., 12:00 a.m and 17:00 p.m. in Paricá and Guapuruvu seedlings, respectively. UFRB, Cruz das Almas, BA. 2020.

Figure 7 shows the behavior of the internal CO_2 concentration (Ci) in the leaf stomatal chambers of the two varieties. It can be noted that Guapuruvu has a higher internal concentration of CO_2 than Paricá. This is because Paricá has always presented lower stomatal conductivity, except 5 p.m. when the two varieties are practically equals. Thus, the higher rate of photosynthesis at noon in Guapuruvu is linked to a considerable amount of internal CO_2 concentration now that the plants were with greater stomatal conductance.
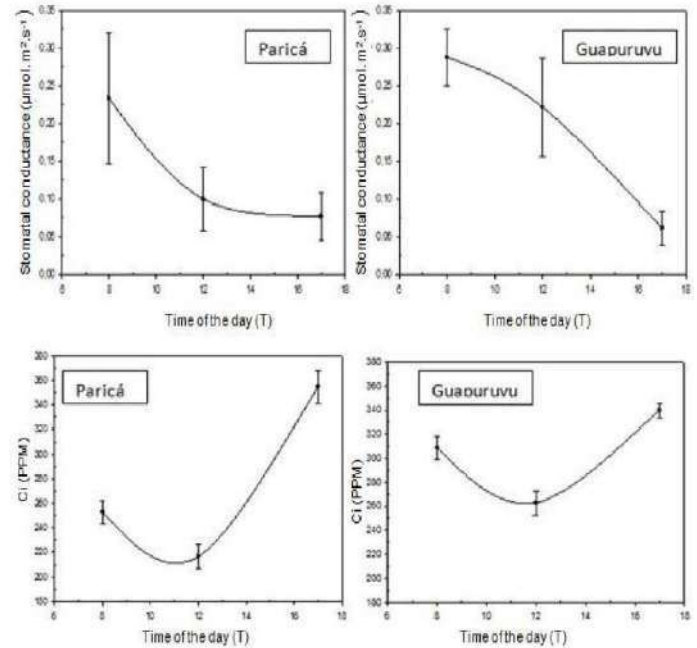
Fig.7: Stomatal conductivity and internal CO_2 concentration (Ci) at 08:00 a,m,, 12:00 a,m, and 17:00 p.m. in Paricá and Guapuruvu seedlings, respectively. UFRB, Cruz das Almas, BA.2020.
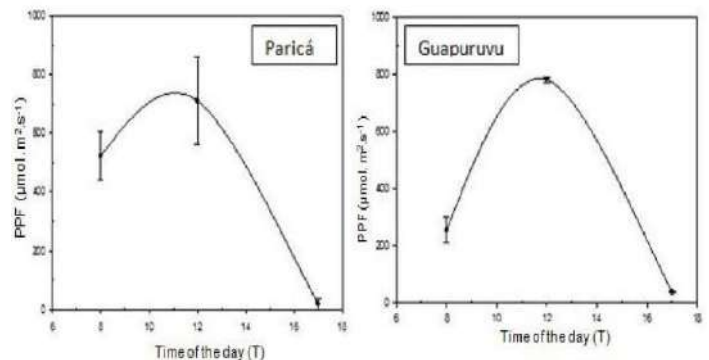
Fig.8: Photosynthetic photon flux (PPF) at 8:00 a.m., 12:00 p.m. and 5:00 p.m. in Paricá and Guapuruvu seedlings, respectively. UFRB, Cruz das Almas, BA. 2020.

The soil moisture condition during the study that started with wet soil with values of 0.150 m3 / m3, which indicates the field capacity (with a tension of 0.1 atm). After 5 days of water deficit, it presented values near zero with a water content of 0.050 m3 /m3, reaching the permanent wilting point (PWP) (with a tension of 15 atm). The scientific literature suggests that in the permanent wilting point the amount of water that is in the soil can no longer be absorbed by the plant (TAIZ *et al*., 2017).

When submitted to the water deficit, it was possible to observe that, for the evaluated parameters of gas exchanges, the varieties presented similar behavior, reaching values of photosynthetic rate close to zero during

the afternoon with five (5) days of water deficiency. The values of A and E presented by the varieties decrease as the water deficit progresses, reaching values close to zero when the water restriction is more severe.

The interactions of varieties x evaluations (hour) were not significant for any of the varieties tested during the evaluation days. Thus, regardless of the varieties, the period that gave the greatest CO_2 assimilation was at 8 a.m. and the highest transpiration rate was at 12 a.m., differing statistically from the other periods evaluated. For stomatal conductance (gs), the highest value was observed in the period of 8 a.m. and at 5 p.m. These two periods did not differ statistically. The lowest value for Ci was in the 12-hour period due to the decrease in stomatal conductivity.

At 5 days of stress the net assimilation rate of CO_2 reached values close to zero and the seedlings showed partial fall of the leaflets. According to Rocha (2017), when evaluating the development of Paricá seedlings under the effect of water stress, it was observed that from 7 days there was a decrease in the number of leaflets. This shows that when subjected to periods of drought the plant first reduces its individual leaves to stabilize its metabolic process, ensuring their survival before aborting the other vegetative parts.

According to Duarte (2016) and Rocha (2017), paricá seedlings present low tolerance to water deficit and because of stress, reduce leaf numbers in order to maintain water. Chaves *et al.*, (2004) points out the reduction of leaf area as one of the first forms of defense of plants against water deficiency in order to decrease the photosynthetically active area and thus reduce transpiration.

There were no statistical differences in the chlorophyll content of the varieties studied for Chlorophill A and B. The determination of the chlorophyll content in the leaves is important to estimate the photosynthetic potential of the plants by their direct connection with the absorption and transfer of light energy that will reflect in the growth (Rego & Possamai, 2006).

The curves in response to photosynthetically active radiation are shown in Fig. 9 and 10. These are important because they show various aspects of photosynthetic apparatus and how they react to the radiation absorption condition. In Fig. 9 and 10 it can be seen that the Paricá reached a higher photosynthetic rate when the saturation of the radiation of photosynthesis occurs. However, practically the two varieties had this point reached at 200 mol.m^2.s^{-1}.

These varieties saturate with a much lower radiation availability than most tropical forest species, as stated by

Marenco (2001) and Taiz *et al.*, (2017) most plants saturate at irradiances of 500 to 1000 µmol m^2 s^{-1}. According to Kerbauy (2008), when the luminous intensity exceeds 200 µmol m^2 s^{-1}, (10% of full solar radiation), the increase in luminous intensity does not entail anymore a proportional increment up to about 500 to 1000 µmol m^2 s^{-1}. However, we must admit that species with the potential for rapid growth take advantage of presenting such response mechanisms because they are constantly in competition with other species by radiation and are able to take advantage of low incidences.

Another important aspect is that, according to Long & Hallgren (1993), the slope of the exponential part of the curve response indicates the carboxylation rate of Rubisco. For this reason, Paricá presents a slightly higher carboxylation rate than Guapuruvu and, therefore, may have a higher respiration rate as evidenced in Figure 16, because the rubisco reacts with both CO_2 and O_2.

The study of the A/Ci response curve (Fig. 11 and 12) shows that these varieties suffer a reduction of photosynthesis caused by a resistance effect of CO_2 diffusion in the mesophile, which reduces its photosynthesis rate by approximately 1 µmol. m^2.s^{-1} (compare the value indicated by the arrow and the value of the origin of the slope of the curve). Study according to Farquhar & Sharkey (1982).
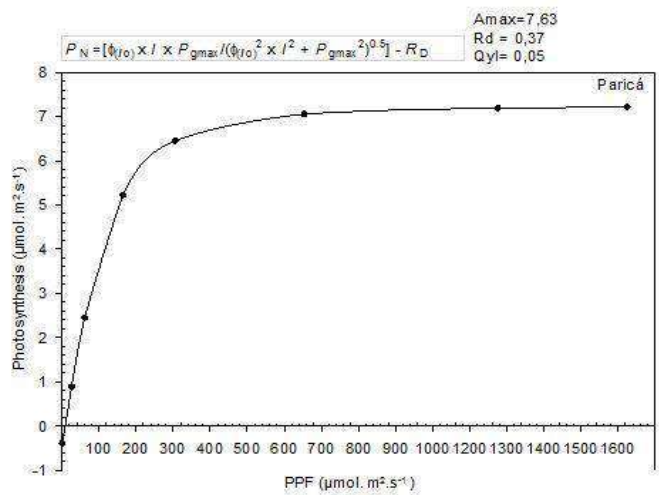
Fig.9: Response of paricá to the variation of the photosynthetically active radiation. Curve adjusted according to the formula in the graph. UFRB, Cruz das Almas, BA. 2020.
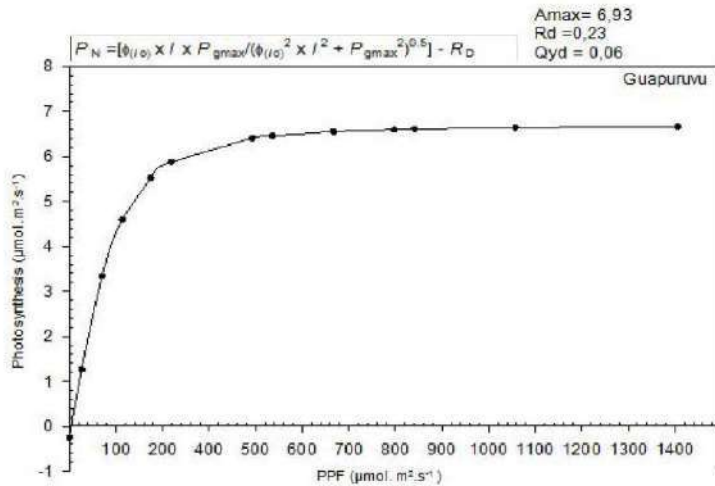
Fig.10: Response of guapuruvu to the variation of the photosynthetically active radiation. Curve adjusted according to the formula in the graph. UFRB, Cruz das Almas, BA. 2020.
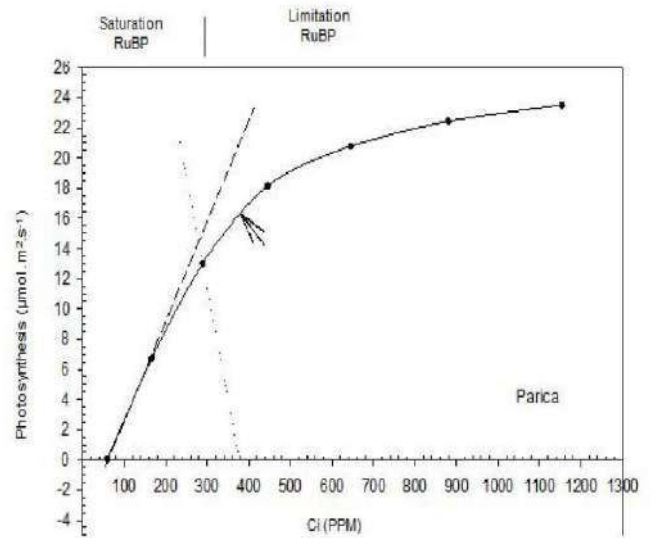
Fig.12: A / Ci response curve for Paricá seedlings. UFRB, Cruz das Almas, BA. 2020.

IV. CONCLUSION

Growth analysis through physiological indexes was efficient to identify differences in the initial growth of *Schizolobium* plants.

The physiological characteristics of gas exchanges were negatively affected by water stress in both varieties throughout stress days.

Although the curves of radiation response and CO2 concentration can serve to identify genetic differences between varieties, the *Schizolobium* varieties used in this study had similar behavior and did not serve as an evaluative parameter.

Fig.11: Figure 16 - A / Ci response curve Guapuruvu seedlings. UFRB, Cruz das Almas, BA. 2020.

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Perspective around Sustainability in Civil Construction

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Abstract— The concept of sustainability is characterized as a condition where there is a desire to make available to society and future generations the same resources that are currently being appreciated, considering the integration of economic, cultural and especially environmental aspects, in order to preserve these environmental resources, respecting their production and consumption limits, to prevent compromising negatively. The objective of this article is to demonstrate the viability of sustainable proposals in the field of civil construction and the contributions of this practice to the conservation of the environment and the availability of resources for other generations. A systematic literature review study was carried out, using articles published between 2010 and 2020, covering a period of ten years, in order to comprise current research and contemporary information's around trends and perspectives on sustainability in civil construction. For the construction of this article were used Google academics and Scielo (Scientific Electronic Library Online) databases from pre-selected authors. Eight scientific articles were gathered from the search in the databases, which 2 were excluded for being outside the pre-determined period for the research, 1 was duplicated, 1 was eliminated for presenting the topic outside the specified by this project, 1 was excluded after the analysis of results and discussions, therefore leaving only 3 articles for discussion. The most important way to carry out a sustainable construction is to determine measures and factors that can stipulate the concepts defined as ecologically viable for civil construction. The practices raised and determined for these projects addressed the thermal comfort with the use of the green roof cover, the renewable electricity through photovoltaic plates, the use of water from the cistern, among others.

I. INTRODUCTION

The environmental impacts caused by the absence of conscious projects or proposals on construction grow significantly in Brazil, reaching high proportions that cause deforestation, migration of animal species and, consequently, the extinction of species, in addition to contamination of water bodies, which significantly decreases the availability of resources for future generations. Knowing this, the competent organs in the

inspection demand adopted as a mitigating measure the mandatory presentation of construction projects that emphasize sustainability, highlighting ecologically correct practices such as recycling and reusing materials, as well as solid waste management plan, area degradation recovery

plan and percentage of suppression and species management.

According to [1], the concept of sustainability is characterized as a condition where there is a desire to make available to society and future generations the same resources that are currently being appreciated, considering the integration of economic, cultural and especially environmental aspects, in order to preserve these environmental resources, respecting their production and consumption limits, to prevent compromising negatively.

An assured business segment that presents an appropriate environmental conservation plan is major considered mainly in the civil construction sector, being recognized as a reducer in the face of environmental impact [2]. This assessment is based on four main aspects: sustainable planning in the built area, economy and efficiency in the use of water, use of renewable energies, conservation of materials and preservation of the asset's resources. It is believed that this item coupled with an environmental conservation plan helps in the interior and exterior quality of the environment to be built. Include sustainable activities in civil construction is a future trend, just like the government the investors also pay attention and position themselves inside the construction sector under the issue of creating sustainable properties capable of continue to exist while simultaneously preserving the environment, as quoted [3]. The author also states that adding these practices encourages environmental adequacy, social justice and economic possibilities, due the real objective of constructions considered sustainable is to contemplate the environment, economic and sociocultural areas.

As mentioned, [4], the civil construction industry in Brazil is characterized as one of the largest producers of solid waste and the main prompter of environmental impacts, since most of these generated wastes are available in the environment for a longer time until they reach total degradation. Most of the construction projects available in the country do not presents an adequate disposal plan and, for this reason, these wastes are disposed incorrectly. Some materials even have in their composition synthetic substances that affect not only the development of plants, but also promotes human diseases, in behalf of the inclusion of technological actives widely used in these materials.

[5] discusses that, behalf this scenario, the civil construction tries to position itself efficiently in the face of the environmental sector requirements. Therefore, in the last 10 years, most of the environmental conservation plans presented by civil engineering have highlighted as a suggestion for a sustainable perspective the practices of recycling and reuse of materials. Recycling is the last phase

that solid waste must go through during its reuse process, because this is where it acquires a different form and property from the initial one, being able to be reused in other ways in projects and other civil construction services. This method is defended by several environmental laws, being considered a sustainable and ecologically correct practice. To complete the recycling process, first is necessary to separate and select these wastes according to their composition, this way generating the correct disposal of these materials, reducing impact events evaluated by environmental experts in their totality.

[5] indicates that one of the techniques that has stood out in the field of civil construction in the last seven years is the tendency to increase the recycling and reuse of concrete. This process consists in gathering the wastes that eventually remains at the end of processes such as construction or demolition, with other aggregated compounds. In such way, the recycling of this material can generate, for example, structures or even decorative objects for the facades of buildings and constructions. Other materials such as sand, gravel and crack, for example, also have recycling models proposed in construction projects. Thus, they can go through the recycling process together or separately.

The awareness of sustainable practices within civil construction must be linked to any type of project, regardless of what it proposes to be done. In every detail of the work, environmental responsibility must be emphasized, so that everyone involved is aware of the environmental impacts that that activity can cause. For this reason, sustainable housing projects have been gaining proportion in the ideas of large national construction companies. For this reason, the objective of this article is to demonstrate the viability of sustainable proposals in the field of civil construction and the contributions of this practice to the conservation of the environment and the availability of resources for future generations.

II.　MATERIALS AND METHODS

It was carried out a systematic literature review study, using previous articles published between 2010 and 2020, covering a period of ten years, in order to comprise current researches and contemporary informations around trends and perspectives on sustainability in civil construction. For the construction of this article were used Google academics and Scielo (Scientific Electronic Library Online) databases from pre-selected descriptors: Sustainability, Civil Construction, Environment, Environmental Preservation and Natural Resources.

To fulfill this research, were selected five articles in Portuguese language, published in the period 2010 to 2020,

in which were analyzed the abstract, title and year of the publication in front of the fulfillment of the predetermined parameters in the experimental outline of this review. The inclusion criteria were previous published articles of case study type, and observational studies, as well as monographs and master's dissertations that correlate the proposed theme with the research presented in the literature.

After the stage of identifying the sources, it was necessary to analyze the material, starting as: reading the titles found and excluding those that do not fits to any of the inclusion criteria; reading the abstracts of the studies selected in the previous step, and excluding those that were not in agreement with the topic addressed.

III.   RESULTS AND DISCUSSIONS

Eight scientific articles were gathered from the search in the databases, which 2 were excluded for being outside the pre-determined period for the research, 1 was duplicated, 1 was eliminated for presenting the topic outside the specified by this project, 1 was excluded after the analysis of results and discussions, therefore leaving only 3 articles which are presented in the table below, according to the analysis criteria of Authors/Year, Results and Suggestions (Table 1).

Table 1. Reviews of Sustainability´s constructions.

AUTHOR/YEAR	RESULTS	SUGGESTIONS
GOULART, I. A. S., 2015. [7]	The viability analysis of three sustainability methods for the Lajes Residential Building consisted of the introduction of methods such as solar heating, rainwater harvesting and waste reuse, where it was possible to observe that there were financial savings, installation feasibility and significant reduction of environmental impacts in just one. As for the other two, the installation and permanence of the method in the construction would greatly increase the	The replacement of electric showers by a solar heating system would bring a high reduction in the value of the energy bill per family, however, the high cost of installation could make the adoption of the solar heating system unfeasible. The reuse of waste in the construction would also have reduced too many impacts, in addition to diminished costs, if it had been used to the construction reuse.
DANTAS, M. J. F.; MAIA, F. C. P., 2018. [8]	acquisition value for maintenance, which should be replaced by other alternatives. The building analyzed draws a market differential, for implementing equipment to reduce environmental impacts, worrying about its maintenance, distributing guidebooks to residents and explaining the need to raise awareness of the importance of maintenance and permanence of its original characteristics.	Can be used as a solution the implementation of at least one sustainable method per construction, and the entrepreneur must inform his client about the extra amount to be spent and the advantages that this can generate during his/her dwelling. Continuing this process can generate a residence with most of the sustainable items foreseen by green works in civil construction, reaching the goals proposed by this type of building.
AIRES, E. K. S., 2019. [9]	From a financial point of view, entrepreneurs have always questioned the high costs involved in a green project. The most important benefits that green buildings offer are related to the climate and the natural environment. Green buildings not only reduce or eliminate negative impacts on the environment, using less water, energy or natural resources, but also positively impact it, generating their own energy or stimulating the growth of biodiversity.	In this study, it is possible to propose as a solution the adhesion of thermal comfort with the use of the green roof cover, renewable electricity through photovoltaic plates, the use of water from the cistern through the storage of rainwater, the floors from the civil construction waste and other components that have implemented sustainability in the building.

The adherence of sustainable practices in civil construction can be varied, leading to the adoption of

practices that must reach from the construction assistants to the engineer responsible for the project. [10], discuss about highlighting various methods of starting the use of sustainability concepts in a construction, however, claims that the most important, in the initial term, may be the organization of events that generate, like seminars or lectures, the theme "Environmental Responsibility" because it is an idea that should be taken in consideration not only in the professional view, but even more as a citizen. For the professional coordinators of constructions, must be emphasized the procedures, objective and practice of licensing, as well as intervention projects that help in the treatment of waste and in the supervision of renovations, repairs, excavations, besides the vegetal suppression, if necessary, with the critical and professional look of specialists who serve as great allies in this process. Only from that is it possible to insert educational materials, such as booklets and manuals, so the awareness of environmental responsibility can be established in the understanding of all those involved.

With all the knowledge offered, it is possible that the engineers and others responsible for the work create inspection and support groups to supervise the environmental responsibility practices, must be an employee who knows the main techniques of environmental preservation, presented in the initial training of their work. Data estimate that developed countries, such as the United Kingdom, have housing constructions that yield around six tons of carbon dioxide per year, a total of approximately 27% of emissions compared to global data for other countries like the United States. In this country, domestic life has become synonymous of heating, as simple activities, such as cooking or putting appliances to work, represent around 78% of heating throughout the region.

Some methods of reusing materials in civil construction, such as the reuse of construction and demolition waste, known as RCD, is a sustainable and environmental preservation alternative that can be practically used in all sectors that involve a construction process. Currently, the biased idea of reusing materials, such as concrete, is one of the most used recycling processes. Classified in the waste group A, concrete can be found like the rest of construction in the form of fresh or hardened tailings and its recycling process follows procedures such as sorting, which assesses the material situation; crushing which constitutes breaking into smaller pieces if it is in solid state and the sieving. In view of the execution of these steps, the RCD are classified as recycled concrete or mixed recycled, considering that concrete can be applied in different ways, including in industrial processes that produce mortar, asphalt paving base, sidewalks, among several other applications [10].

[11], address in their studies evidences those sustainable constructions add benefits to the preservation of the environment in different ways, and for this type of enterprise the acquired methods must be used with a long-term use project. This way, installations, exchanges and maintenance should already be easily thought out and pre-established.

Some sustainable methods, such as solar panels, water collection facilities and even encouraging residents as reforestation helps to improve their quality of life, which enhances the pleasure of living in the area and enjoying nature in an unparalleled way. The fewer artificial resources, the greater the support for the environmental cause.

The Resolution Nº 307 instituted by the National Council for the Environment (CONAMA) conceptualizes recycled aggregate as a granular material from the processing of construction waste that has technical characteristics for application in building constructions, infrastructure, landfills and other engineering works, being considered a sustainable practice in the context of civil construction and currently treated as an alternative to reduce waste arising from constructions that cause significant impacts to environmental conservation, according to [12].

Recycled aggregates can have various uses ranging from the making of concrete to what is known as the deformation module. However, it is noteworthy that it is necessary to evaluate possible risks of environmental contamination during the material's half-life cycle until its destination. The literature emphasizes the decrease of impacts through the reduction of construction aggregates, which are left over after its completion, on the other hand some scientific studies point out certain products and their excessive marks, such as cement, for example, which cause contamination in the soil due to their degradation after the end of its half-life.

Taking into account the rational use of raw materials, the recycling of waste arising from construction and the reduction of waste, sustainable construction offers significant advantages to the enterprise, highlighting what the literature points out as the better acquisition during construction, such as the reduction of spending, increased tax incentives for the sustainable practice of construction, comfort and life quality for residents, conscious use of light, water and other factors that interfere with environmental suitability, besides helping to increase sales in the civil sector, as this practice is already considered of great value in contemporary society.

[13] mentions that all over the world it is possible to observe tax incentives for the development of sustainable construction projects. One of the countries that invests the

most in this type of project is Germany, as in addition to encouraging green construction, it remunerates residents for respecting consumption limits and adherence to sustainable methods, which in the country is already a measurable practice. In Brazil, this action was implemented a few years ago through the "Green IPTU" program, whom offers discounts on the urban property and land tax rate that adhere to eco-efficient methods in construction or renovation. Some of the methods that can offer discounts on the "Green IPTU" rate are the capture and reuse of water, the recycling and reuse of construction waste, the use of solar panels to heat water and photovoltaic panels to generate electricity in the home.

Carefully analyzing all the results presented, it is possible to observe that the capacity to implement sustainable projects in the scope of civil construction and housing buildings is still restricted to many ways, sometimes failing to reach energy demands and sustainable installations. Besides, there are some limitations that prevent these methods from being adhered to, such as architectural incompatibility, high costs and unavailability in the built-up area. Thus, it is necessary to plead for more advanced technological measures in the field of engineering, so that in the near future there may be constructions that contain 100% sustainability, with affordable costs for acquisition in the market. It is evident that the adhesion of equipment for a sustainable construction requires high financial capital for the installations and other objectives to be completed. In this way it is possible to say that high budgets are also defined as an obstacle to sustainable constructions today.

Regarding possible budgets, it appears that for each sustainable project executed, the value of the work rises to almost 36% more compared to the values of conventional constructions. Among the practices to be acquired, the one that generates the most cost is the acquisition of photovoltaic panels that make up electrical system from the solar energy. What must be taken in consideration is that solar energy can be made viable in an interval of approximately 7,15 years, however due to its useful lifetime is not a long period. For this reason, large projects are not executed when analyzing these cost/benefit criteria, even more so when the family calculates the period of residence in the place [14].

Nonetheless, in order to conserve the environment, all the alternatives presented so far are green construction methods, ensuring the continuity of generations and the conscientious use of the resources available in it. Thus, this practice becomes essential, advantageous and adds value in terms of reducing ecological impacts, which in fact is the central concern of all humanity when it comes to building and suppressing nature to make room for large projects.

IV. CONSIDERATIONS

It is concluded that the influence of sustainable development in the aspects that concern the realization of a building, from the planning stages to its execution, benefit the environment. Therefore, it is possible to define that the presentation of measures that can be adopted for the practice of sustainable development in civil construction, at this time, implies introducing the practice of sustainability in all sectors, influencing since the choice of construction materials to the analysis the use of energy, in the importance of controlling water resources, and more.

The most important way to carry out a sustainable construction is to determine measures and factors that can stipulate the defined ecologically viable concepts for civil construction. The practices raised and determined for these projects addressed thermal comfort with the use of the green roof cover, renewable electricity through photovoltaic plates, the use of cistern water through the storage of rainwater, floors from waste of civil construction and other components that implemented sustainability in the building and with the constructive elements determined.

In fact, the capacity to implement sustainability in housing buildings is still limited, not complying with the energy demands of its facilities, with little water reuse; incompatibility in some architectural structures; high costs and unavailability of space, which are essential requirements for a sustainable building. In this context, this research pleads for the technological advancement of engineering, so that, in the future, there may be buildings, which present an increasing percentage, with affordable costs, in the market.

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Occupational Safety Analysis at a Construction Site in the City of Manaus/AM

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Abstract—The object of this case study is the analysis, according to regulatory norms, of the construction site located in the city of Manaus/ AM. The study begins with the approach of concepts and norms related to occupational health and safety inside the construction site environment. An inspection was held, through a questionnaire, of the measures taken by the company about occupational safety at the construction site. Lastly, it was possible to verify the conditions of the site concerning the safety established by the responsible company. Therefore, what could be seen was the lack of organization and cleanliness of the site. It was identified the lack of concern with regard to safety equipment by the employees themselves. But still, it was seen a great concern with the employees' safety by holding of meetings and lectures on accident prevention.

I. INTRODUCTION

Currently, civil construction has been standing out as an area of great labor risks. According to data from the Statistical Yearbook of Work Accidents (AEAT), in 2018 there were about 576,951 injuries in Brazil, an increase of approximately 3.34% compared to 2017. In the area of civil construction, there were about 29,612 accidents, corresponding to 5 .13% of thetotal.

Even with the increase in accidents, companies have not paid due attention to employee safety, bearing the economic and social costs of accidents on site.

The research will address occupational safety through a case study of the construction site located in the Industrial District of Manaus / AM. An analysis will be carried out, according to regulatory norms, which will define whether that environment can be considered safe or whether measures need to be taken to improve its safety.

The objective of the work is to address the concepts and norms related to Occupational Safety at the construction site, the inspection of how and what measures are taken to establish safety at the construction site, and the presentation of a report demonstrating the improvements that must be implemented to comply with legislation.

II. THEORETICAL REFERENCE

In order to theoretically substantiate this case study, concepts on the topic of Occupational Safety and Environment Analysis at a Construction Site in the City of Manaus/AM will be undermentioned in this item, notes referring to the historical context of Occupational Health

and Safety, Legislations, Brazilian norms that must be followed and indications on procedures to be adopted at a construction site to meet the Occupational Safety Norms.

2.1 Health and Safety of Work - Historical Context

There was already long before Christ the safety concern, for example, in the construction of pyramids. Considering this, in the book of Deuteronomy, chapter 22, verse 8 of the bible, there is the text, "When you build a new house, you shall make a parapet for your roof, so that you will not bring bloodguilt on your house if anyone falls from it."

The history of occupational safety begins around 1700, with the publication of the book "Diseases of Workers" in Italy, written by physician Bernardino Ramazzini, the work describes numerous diseases related to some professions at the time. The repercussion was worldwide, making Ramazzini "the father of occupational medicine".

In England, around 1760 and 1830, the relevant Industrial Revolution took place. The historical factgave rise to an increase in health problems related to work activities.

"The bosses stayed, without restrictions, the daily working hours. They took the liberty of defining, according to their own needs and interests, the number of hours of work, without distinction among adults, minors, and women, and not even between painful activities or not." (OLIVEIRA, JoãoBosco de Castro)

Thus, with so many alarming situations, the work environment becomes hostile, marked by typical accidents and illnesses or aggravated by activities performed at work. Furthermore, there were no laws to support workers in those situations and, without receiving their wages, they felt insecure in the context they were in. It was then that, in the mid-1800s, in England, France, Germany, and Italy, the first labor protection laws were created.

In Brazil, in January 1919, the first law related to occupational medicine was created, providing for the concept of the accident at work, legal action, and other general provisions. So, the advent of these facts contributed to the existence of occupational health and safety.

According to the World Health Organization, safety is understood as "the state of being free from unacceptable risks of harm" and health "the state of physical, mental and social well-being, and not merely the absence of disease or infirmity".

Therefore, it can be said that Occupational safety is the set of measures adopted to minimize accidents at work, occupational diseases, as well as protect the integrity and work capacity of the worker.

On the other hand, health at work, or occupational health, is the way to promote and protect the health of workers in the workplace, enabling a better quality of life in three general aspects of well-being: physical, mental, and social.

All activities related to safety are extremely important, but at the construction site, they are indispensable for a construction project to be successful in all aspects. Valuing the health and well-being of the workers involved in this process is not only an obligation of the construction company but also brings several advantages to the work environment and the results delivered (Figure 1).

Fig. 1: Construction Site Environment. Font: Correios do MS, 2019.

Regardless of the size of the site and even the number of professionals involved, effective management of what happens at the construction site ensures not only the increase of productivity. But also, higher quality deliveries, reduction in the number of accidents at work and cases of occupational diseases, security of legal approvals, and resource savings.

2.2 Laws and Regulatory Standards - Safety at Work

The Brazilian Legislation and Norms aim to ensure that buildings and installations, as well as the constructive and maintenance process, have minimum conditions of safety, hygiene, health, aesthetic harmony, and accessibility, so that constructions and renovations are executed in a coherent and non-disorganized manner, and also for the technical characteristics to be maintained under the relevant Brazilian Norms.

For this case study, we are mentioning the Laws that apply to the Municipality of Manaus/AM, and the Brazilian Norms that instruct on safety at a construction site.

• Law No. 3724, of January 15, 1919, regulates the resulting obligations from accidents at work;

• Decree No. 5.452, of January 15, 1919, regulates the resulting obligations from accidents at work.

- Decree No. 5.452, of January 15, 1919, regulates the resulting obligations from accidents at work. This approved the Consolidation of Labor Laws – CLT, where chapter V refers to Occupational Safety and Medicine.
  - NR-01;
  - NR-04;
  - NR-05;
  - NR-06;
  - NR-07;
  - NR-09;
  - NR-10;
  - NR-12;
  - NR-13;
  - NR-15;
  - NR-17;
  - NR-18;
  - NR-21;
  - NR-23;
  - NR-26;
  - NR-33;
  - NR-35;
  - Fire Department;
  - Works Code.

2.3 Safety Management at Construction Sites

2.3.1 Relevance and Compliance with Legal Aspects of OSH: Disobedience and Impacts on Vast Legal Sectors.

Companies suffer serious penalties when there are accidents. One of the consequences is media exposure that weighs negatively on the image of any company. In addition, there may be legal proceedings involving the Ministry of Labor by workers or family members when it is a fatal case. In this sense, companies will have high expenses and may have a tarnished image, failing to conquer new customers.

To avoid all these consequences, the construction site must be seen very carefully, observing the so-called risk agents. They are present in equipment, machines, materials, whether small or large sites.

The Occupational Health and Safety Management – OSH must step in to ensure that the risk agents are removed. There must be a lot of effort and observation on the part of all involved because the health and physical integrity of workers must be the greatest responsibility.

2.3.2 Construction Site Management: SESMT, PPRA, PCMAT, PCMSO E CIPA.

The Occupational Health and Safety Management of every company has a mandatory mission to work with the participation of all employees through CIPA; the clarity of the actions planned through the Medical Control and Occupational Health Program (PCMSO), Environmental Risk Prevention Program (PPRA), and the Construction Industry Conditions and Environment Program (PCMAT); the implementation of the planned measures; and verification and analysis of results.

The Specialized Service in Safety Engineering and Medicine at Work - SESMT is organized with the beginning of the hiring of an occupational safety technician and as the company's employees grow, new professionals specialized in the area are employed, maintenance required by Regulatory Norm No. 4 .

It is common for accidents to occur due to a lack of understanding or the fact of disobedience to orders on the part of construction workers. There are still command failures on the part of those responsible for the execution of services that do not give the required orders for the safety of those involved.

For good OSH management, must be drawn up strategy plans that enable to evaluate and correct acts of insecurity, and in some cases being necessary to transmit knowledge of the procedures to the company's employees.

It is also essential that there is full participation by employees, designating some as responsible for security actions (with a focus on CIPA members) to keep themselves informed.

2.3.3 Internal Accident Prevention Commission - CIPA.

CIPA aims to prevent accidents and occupational diseases. It is also responsible for assisting the SESMT, formed by professionals specialized in occupational safety, while the CIPA is constituted by generally lay employees in accident prevention.

For better management, CIPA's actions extend to observing and exposing existing risk conditions to solve the problems encountered by creating measures to prevent future accidents.

2.3.4 Environmental Risk Prevention Program - PPRA.

The Environmental Risk Prevention Program - PPRA is established through the regulatory norm NR-9, which are drafted by companies and employers aiming at the health and safety of their employees, through a planning of control of environmental risks that may exist within the workplace.

For the preparation of the PPRA, the technical content must be expressed clearly and objectively, having the

company's presentation, clearly pointing out the risk agents within their sectors and their form of exposure.

2.3.5. Occupational Health Medical Control Program – PCMSO.

2.3.5.1.Regulation and fundamentals.

Regulatory Norm No. 7 establishes the implementation of the occupational health medical control program, which is the set of medical, preventive, corrective and analysis and tracking actions to monitor and ensure the maintenance of healthy physical conditions of each employee of the company, in all its sectors, locations and activities and should not be understood or confused as medical care, analogous to that provided by physicians contracted by the company.

The PCMSO is mandatory for all companies, regardless of the activity fields and the number of employees, and shall comply fully in its preparation and implementation with the PPRA.

2.3.6. Conditions and Environmental Program of work in the Construction Industry - PCMAT.

2.3.6.1.Regulation and fundamentals.

PCMAT should be understood as a specific OSH project for a particular construction site and not as a manual or a collection of rules and figures of the "can", "cannot" type to be presented in an inspection. Obviously, it must be kept at the construction site.

According to Regulatory Norm No. 18, the PCMAT is a set of documents composed of:

- Memorial properly updated about the analysis of all risk agents present at the construction site;
- Specifications and projects of collective and individual protections;
- Initial and posterior layout of living areas;
- Training program, and
- Schedule of all planned actions.

It is not an immutable document and neither can it block the activities of the construction site. On the contrary, it must be revised and updated as often as necessary due to the dynamics of the site, which is a non-delegable obligation of the company that is the main technical person responsible for the project, the one that will command the works from its first day.

2.3.7. Relationship between Contracting Party and Contractors: Duties and Obligations of the Parties Faced with OSH Requirements - Regulation and Fundamentals.

In the set of NRs, the most explicit requirement for articulation between the hiring company and its contracted,

with regard to OSH legal obligations, is contained in NR-5, with the most relevant items being:

CONTRACTORS AND CONTRACTED:

5.48 The contracting part and the contractors, who work in the same establishment, shall implement, in an integrated manner, measures to prevent accidents and occupational diseases, resulting from this NR, in order to ensure the same level of protection in terms of safety and health to all employees of the establishment.

5.49 The contracting company will adopt the necessary measures so that the contracted companies, their CIPAs, the nominees and the other workers allocated in that establishment receive adequate protection.

5.50 The contracting company will take the necessary measures to monitor compliance by the contracted companies that work in its establishment with safety and health measures at work.

By applying item 5.50, any irregularity committed by the contracted company, when diagnosed by the inspection, may generate two notices of infraction: one against the contracted company, for objective failure, and another against the contracting company, for not having prevented it.

2.3.8. Approach and Analysis of the Main Causes of Accidents in the Construction Industry.

Accident at work is the one that occurs during the exercise of an activity, in the service of the company or as a self-employed worker, causing:

- Death;
- Bodily injury;
- Functional disturbance;
- Loss of ability to work, temporary or permanent, and
- Reduction of ability to work, temporary or permanent.

Occupational diseases, work-related illnesses and accidents on the way ("in itinere") are equated with accidents at work.

The most frequent typical accidents in CI activities around the world are:

- Levels different drops - NR-35, item 35.5.8.1;
- Burials – NBR 9061/85 – Safety for Open Pit Excavation, by ABNT and NR-18, item 18.6;
- Contacts with electricity - NBR 5274 - Electricity Graphic Symbols and NR -10.

2.3.9. Collective Protections - Regulation and Fundamentals

The legal provisions on collective protections required for IC construction sites are disseminated in many items of the NR-18 and also in other NRs, such as, for example:

- Nº 10 - Security in Installations and Services in Electricity;
- Nº 12 – Safety at Work in Machinery and Equipment;
- Nº 33 – Occupational Safety and Health in Confined Spaces;
- Nº 35 – Workiat height.

Collective Protections (PCs) must be provided for installation before having workers at risk in a particular activity, location, or any other, potentially hazardous exposure. Most of the time, the implementation should be preceded by the elaboration of a consistent project and appropriate to the desired protection (Figure 2).

However, before the project, it must have a process of analysis and selection on which PC will be chosen, because different strategic options involve significant differences in cost, implementation time, durability and possibility of reuse of materials and effectiveness of the intended objective.

Fig. 2: Collective Protection Equipment. Source: Meelco, 2019.

2.3.10. Individual Protections.

The specific norm for the theme EPI NR-06, together with the NR-18 norm regulate the use of personal protective equipment.

Other norms that can assist in individual protection, guiding the use of protective equipment, are:

- NR-09 – item 9.3.5.5
- NR-10 – Safety in Installations and Services in Electricity: item 10.2.9
- NR-35 – Work at height: Item 35.5.

Within the legislation we highlight the following precepts:

The use of PPE is the last of the measures that an employer should consider in its strategy of eliminating or minimizing the harm that a particular risk agent may cause to the health and/or physical integrity of its employees.

As a priority, all alternatives should be exhausted in combating the risk agent using collective protections. If they are technically unfeasible or insufficient, administrative or work organization measures should be implemented and only in the last case should personal protective equipment (PPE) be used.

It should be emphasized that when implementing disproportionately costly solutions, the cost factor is not considered as a valid justification by the supervisory agents when it is detectedthat collective protection appropriate to the risk are not implemented and counting only on the use of PPE.

Fig. 3: Personal Protective Equipment. Source: Saúde e Vida Group, 2020.

2.3.11. Activitiesin Machinery and Equipment.

2.3.11.1 Movement and Transportation of Materials and People - Regulation and Fundamentals

The regulatory norm that guide the movement and transport of materials and people are:

- NR-18 – Item 18.14 - Movement and Transportation of Materials and People;
- NR-12 – General use of machinery and equipment;
- NR-12 – Item 12.85 - Material conveyors;
- NR-12 – Annex II, programmatic training content for safe operation of machines;
- NR-35 – Work at height;
- NBR 16200/2013 – Elevators of sites.

2.3.11.2 Material Handling

On a construction site, there are several options for moving materials: belt conveyors, elevators, platforms on tower and rack, column winches (Velox), cranes, pulley/trouble system, and other assemblies.

In these operations, there is almost always involvement of large materials and/or weight that, poorly moved can cause serious accidents both material and personal. Adding also the height factor, characteristic of CI, there is a worsening of the risk, and it should be remembered that

even smaller loads, when falling from high heights can motivate even fatal accidents.

For such reasons, the list of requirements, recommendations, and normative precepts contained in the legislation indicated above is justified.

2.3.11.3 Movement of People

For the exclusive movement of people in an IC construction site the equipment used is the elevator, pulled by steel cables or moved through the rack pinion system, usually identified only as a rack elevator.

The legislation relevant to elevators has been the subject of intense analysis, discussion and alterations since 1998 and with the objective of minimizing as much as possible the probability of new accidents and easing the highest level of safety for elevator users at the CI construction sites, the NBR 16200 / 2013 norm was elaborated.

2.3.12. Guindar Equipment – Regulations and Fundamentals

The regulatory norms that guide the use of hoist equipment are:

- NR-11: Item 11.1.3 e 11.1.3.1;
- NR-12: Use of energized machines and equipment in general;
- NR-18: Item 18.14;

In common, all hoist equipment (cranes, cranes, column winches, electric hoists, gantries, cranes...) must take special care for their load lifting components according to the guidance of nr-2, NR-11, NR-12, NR-18 and NR-35 norms.

2.3.13. Acidentes no Canteiro: Procedimentos Legais e de Emergência - Regulamentação e Fundamentos.

The regulatory norms that guide the occurrences of accidents at the construction site are:

- NR-07;
- NR-18;
- Ordinance MTE. 589 of 28/04/2014;
- NR-35.

In case of accidents, the determinations of the norm regarding initial care and filling of pertinent documentation must be followed.

In case of fatal accidents, immediate care of the injured and the isolation of the accident must be made, preserving the area of the accident until the performance of the investigation.

In case of finding occupational diseases, it should be treated as an accident at work and procedures should be adopted according to the guidelines of the norm.

III.   METHODOLOGY

The methodology for completing this course conclusion paper was developed through a case study.

To base this case study, we present in the Theoretical Framework the literary content, Brazilian laws and norms that govern the study in question.

This research is exploratory and explanatory, because initially we will take note of the current conditions of the object of study, and later we will deepen into a specific condition of the problem to which we expose our theme.

The Case Study includes making face-to-face visits to the Construction Site with questionnaires applied to security officers and technicians involved in the site, with analysis in the environment that the site was located and is being executed.

3.1 Description of the Work

The site held is located in the Industrial District neighborhood in the city of Manaus / AM inside a factory having industrial character belonging to a large construction company active in the market since 1973, which has 2 civil engineers, 1 pointer, 1 master builder, 2 in charge, 2 engineering interns, 10 servants, 10 bricklayers and 4 carpenters for the site in question.

The construction company also works with outsourced companies that contribute to the execution of excavation services and the assembly of metal structures. With about 30 employees of the company X, 25 employees of the company Y and 20 employees of the company Z.

The site has approximately 2,300 m² and an area formed by 2 assembly lines as can be seen in Figure 1. During the visit, the site was in the stages of foundation execution, masonry execution, floor concreting and metal structure assembly.
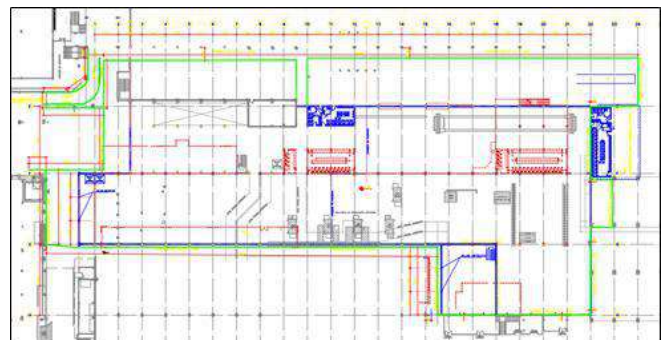
Fig. 4:Layout oftheWork

3.2 Application of the Questionnaire

During the visit, the questionnaire was answered by the security technician who worked on site. The questions were elaborated for the analysis of some points that were

considered more important and that make it easier to see clearly the application of work safety in a construction site.

1 - According to NR-4, does the company have SESMT?

Due to the great demand of employees (both the company and outsourced), the company had professionals specialized in Work Safety, these being members of SESMT. The company contracted by the services of the construction company also worked with a SESMT team that helped significantly in the work.

2 - According to NR-5, does the company have CIPA?

The contracting company of the construction company's services had CIPA, and registrations were made for employees and elections for the commission. The construction company also has CIPA formed by employees who meet once a month to discuss the problems found to prevent similar situations in the future.

3 - Does the company offer PPE? Under what conditions?

The construction company made personal protective equipment available to each of its employees. For greater control of the equipment provided, each employee had a control form, the so-called "PPE Sheet", which contained which equipment were delivered and also the serial number. This was important for possible accidents in which the equipment proves to be defective.

4 - According to NR-7, does the company have aPCMSO document?

The company has a document of the Program for Medical Control and Occupational Health. The company performs all admission, periodic, dismissal, and role-changing exams. All employees had their occupation health certificate up to date and are renewed within one year. The contracting company also required these documents for greater control of employees who worked at the factory, even so, that their health was intact.

5 - According to NR-9, does the company have a PPRA document?

The company had in the site a document referring to the Environmental Risk Prevention Program. The outsourced companies involved also had documentation about the program.

6 - According to NR-18, the company had PCMAT?

The documents related to the Program of Conditions and Work Environment in the Construction Industry were present in the site. Thereby, have the prevention of accidents and identifying the risk factors found in the construction site.

7 - Did the construction site have sanitary facilities? What are your conditions?

Yes, there were two sanitary facilities in containers. Both were in good condition and the environments were well lit. Cleaning was realized daily and twice a day. There was also a control of the day and time that the facilities were clean, contributing to the health of employees.

Fig. 5: Sanitary construction site installation

8 - Were there measures to protect against height fall?

With regard to the prevention against fall from height, training was carried out that guided the employee to use the safety equipment correctly, since learning how to put the safety belt on a paratrooper type until climbing on a scaffold properly as shown in Figure 6. And lifelines and signs were also found that warned of the dangers that could be encountered as ahead in Figure 7.

Before performing the work at height, the employee underwent screening with the measurement of pressure to evaluate his conditions of doing the service and ensuring the health and well-being of the worker.

Fig. 6: Practical NR-35 Training

9 - How did the transport of materials and movement of people work?

For the transport of materials, a truck-crane was used for vertical transport and also for hoisting. The truck was a vehicle rented by a carrier company that performed these services.

For the movement of people, safe passages were always created with indications and signs so that there were no overtaking and so that they could be respected.

10 - Under what conditions were the scaffolding?

The company had its own scaffolding and also rented by a outsourced company that also did service on the site. Some scaffolding were without footers and without sufficient platforms for the worker's locomotion, although there were lifelines fixed throughout the site, yet there was a risk of high-level accidents.

Fig. 7:Scaffolding of the work.

11 - Under what conditions were the electrical installations of the construction site?

There were electric distribution board arranged by the site to facilitate the dynamics of each service. But in the area of the construction site were found many electrical cables on the floor that were being used or not. The danger was that many vehicles and machines passed over the cables and this could lead to accidents by damaging the cables, especially due to the existence of wet lands in the construction site.

Fig. 8: Electrical cable found in the worksite.

12 - Were there equipment, machines and tools being used at the time of the visit? Under what conditions?

Backhoes, articulated platforms and lifts, hammers were used. All these were rented by companies that offered the equipment and machines and were in good condition. There was also a concrete mixer that had all its safety and protection devices.

13 - How are safety signs made at the construction site?

In the site there were accident prevention signs that allowed the safety of the construction site to be emphasized. Places with ditches were isolated with cerquites at a safe distance.

Fig.9: Sign board for risk of fall

3.3 Results Analysis

It was observed in the analyzed site that there are some forms of safety implementation that actually work for accident prevention. The company has qualified people in the area who are attentive to everything that happens in the site.

Something that was noticed during the visit was the so-called DDS - Daily Security Dialogue, which aims to talk to employees before performing their activities reminding them of the use of PPE and some safety care. Also performing labor gymnastics with all workers.

Another habit is once a week, two or more professionals of the specialized area walk through the construction site analyzing the situations and supervising the safety issues on site, generating a photographic report that allows the visualization of the issues that need to be improved and the advances within the work.

As soon as the employee arrives at work, training and integration are carried out (according to NR-18 norm) so that he is aware of his/her abilities and behaves safely. It is a way to raise awareness of the employee to understand the importance of his life.

Although many favorable things have been noticed regarding security, some problems have still been noticed. Like the electrical cables that circulated through the lower part and can be damaged and thus generating accidents such as electric shocks. Another factor was the random assembly of scaffolding that did not promote safety in relation to work at height, due to the lack of footers and platforms.

The solution that can be executed, is the creation of poles located in the course of the entire site for the passage of electrical cables through the top, allowing the safety of the movement of vehicles.

For the scaffolding, having the greatest control of their assemblies, inspecting and placing signs that signalizes their incomplete assembly.

For significant improvements, the company can invest in awareness lectures about the importance of acting safely and obey all the guidance given by technicians and professionals in the field of Occupational Safety. These lectures can be held once a month and highlighting employees who act according to safety standards.

Another improvement would be the daily supervision of the site, observing what can be considered a risk on the place. The safety technician would evaluate both the location and the employees. Checking that everyone is cooperating for safety such as the use of safety equipment and even the status of the used machines. About the machines, it is necessary to perform check-lists that enable daily care, seeing if it is necessary to perform maintenance or exchange.

IV. CONCLUSION

The objective of this work was to address the concepts and regulatory norms related to Occupational Safety and Environment within a construction site. And to see in the field, how a construction company behaves with the rules and norms for accident prevention. It was possible to understand the importance that the theme has over a general context, which includes from awareness so that workers realize how essential it is to return home alive to the practice of supervising unsafe work practices.

It is clear to note that without security there is no job well performed. For a long time, there was a concern for Health and Safety. But there was only greater awareness and knowledge when accidents and occupational diseases began to emerge.

For this reason, it is the duty of each company to focus on these crucial points to make them well evaluated. A company that seeks to have security in the first place begins to be respected by standing out as an example for others who are starting in the labor market.

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Effectiveness of Manual Therapy in Treating Myofascial Pain Related to Temporomandibular Dysfunction: Systematic Literature Review

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Abstract—To evaluate the effectiveness of manual therapy in the treatment of myofascial pain related to temporomandibular disorders (TMD) through a systematic literature review. A systematic electronic search and manual of controlled and randomized clinical trials was carried out. Included articles were published between the years 2004 and 2021. Search was conducted in the Cochrane Library, MEDLINE, Web of Science, Scopus, LILACS and Scielo databases. Results: were found 145 titles and abstracts in the search, and 10 articles were included. A total of 493 individuals were assessed. 241 received only manual therapy or manual therapy associated with counseling as treatment. The other patients were a control group, patients undergoing other treatment modalities or patients who did not receive any treatment. Manual physical therapy is effective in the treatment of myofascial pain related to TMD. Thus, this treatment modality must be considered as one of the therapies in reducing muscle pain related to TMD.

I. INTRODUCTION

Myofascial pain in the masticatory muscles is the most common form of Temporomandibular Disorder (TMD) mentioned in the literature. This dysfunction, according to Guarda-Nardini et al, 2012, is responsible for more than half of the cases seen in clinics around the world [1]. The treatment is a challenge for clinicians, due to its multifactorial etiology and the extensive amount of therapeutic approaches reported in the literature. Among the most reported therapies for myofascial pain, are physical therapy or manual therapy, muscle relaxants, occlusal devices, counseling and behavioral therapies, acupuncture and botulinum toxin injections [2].

In view of so many treatment options, conservative and non-invasive ones are generally recommended for the initial treatment of TMD, as they are effective in reducing painful symptoms and giving comfort to the patient [3, 4]. Thus, manual physical therapy is addressed in the literature as a viable therapeutic option and capable of restoring function under normal conditions [5].

Manual physical therapy is a therapeutic modality within the field of physical physiotherapy, commonly used to treat, for example, painful symptoms in the spinal joints, and can also be used in the treatment of TMD. Thus, for the treatment of this condition, manual therapy includes mobilization of the TMJ, soft tissues of sore muscles, passive or active stretching exercises and gentle isometric tension against resistance exercises and guided opening and closing of mandibular movements [6].

Manual therapy has been the subject of many studies in the literature over the years. However, due to the variability and methodological limitations of the studies,

this type of treatment becomes confusing and often with little credibility in the dental environment. This happens due to the recurrent association of this therapy with other types of treatment, absence of a control group and absence of homogeneity in the type of TMD being treated. Consequently, some results become limited and not reproducible for the treatment of myofascial pain, making it difficult to apply this therapeutic modality in the dental clinic.

In view of this scenario, the objective of this study was to evaluate the effectiveness of manual therapy in the treatment of myofascial pain related to temporomandibular disorder through a systematic review of the literature on controlled and randomized clinical trials in order to better target the treatment of patients with this disorder.

II. MATERIALS AND METHODS

This review followed the recommendations of the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-analyzes) [7]. The question that was intended to answer was: "Is manual therapy effective in the treatment of patients with TMJ-related Myofascial Pain?".

A) Eligibility criteria

Controlled and randomized clinical trials that met the following criteria were included in the review:

- Assessment of patients, adolescents, adults and the elderly with a positive diagnosis of myofascial pain using the Research Diagnostic Criteria for TMD questionnaire (RDC / TMD);

- Presence of at least one intervention group in which manual therapy was applied. This aspect includes: mobilization of the TMJ and / or soft tissues of muscles, passive or active stretching exercises, gentle isometric tension against resistance exercises, guided opening and closing of the mandibular movements and massage.

- Presence of at least one control group, with some other type of treatment (home physical therapy, guidance / counseling, photobiomodulation, botulinum toxin and occlusal devices) or, if applicable, no intervention.

- Studies in which patients had headache associated with myofascial pain and patients diagnosed with a questionnaire other than RDC / TMD were excluded. In addition, when patients were diagnosed with myofascial pain associated with pain of neurogenic origin and cases in which there was an association of drugs and physical therapy in the test group, studies were excluded.

Table 1: Exclusion criteria and articles excluded after reading in full.

Chart 2 - Exclusion criteria and articles excluded after reading in full.

Did not use RDC / TMD for diagnosis (10)
Greene CS, Laskin DM, 1974
Kraaijenga S, et. al., 2014
Nicolakis P, et. al., 2002
Oliveira-Campelo NM, et. Al., 2010
Bae Y, Park Y, 2013
De Paula Gomes CAF, et. al., 2014.
Maluf SA, et. al., 2010
Talaat AM, et. al., 1986
Grace, et. al., 2002
Magnusson, et. al., 1999
Study written in a language other than English, Portuguese and Spanish (2)
van der Glas HW, et. al., 2000
Michelotti, et. al., 2000
Associates manual therapy with the use of medicines (2)
Carlson CR, et. al., 2001
Mulet, et. al., 2007

B) Search strategies

The electronic search strategies were conducted by three researchers (CSG, DCO, MPSN) in isolation during the period from March to July 2020, in the databases: Cochrane Library, MEDLINE, Web of Science, Scopus, Pubmed, LILACS and Scielo, using the following descriptors and / or words: Temporomandibular Joint Disorders "," Craniomandibular Disorders "," Myofascial Pain Syndromes "," Myofascial Pain "," Exercise Therapy "," Myofunctional Therapy "," Physical Therapy Modalities "," Clinical Trial ", "Prospective Studies" and "Longitudinal Studies." The strategy using these descriptors was adequate for each type of database (Table 1). In addition to the electronic search, references to original articles, potential systematic reviews and controlled clinical trials were checked.

C) Selection of studies and data collection

After searching the databases, the titles and abstracts were organized in a standardized form. Then, the three researchers, using the same eligibility criteria, made the selection of those studies with the potential to be read in full and included in the review.

The data from the studies read in full and included in the review were noted on a data extraction sheet by the three researchers individually (CSG, DCO, MPSN) and checked to verify the agreement of the findings for each study (sample, country where the study was conducted, age and sex distribution of patients). In addition, the diagnosis, intervention and details of the control, follow-up group and their results were also extracted.

In the presence of disagreements, the authors consulted a fourth researcher and, through consensus, reached a common decision.

D) Bias risk assessment

The "A Cochrane Risk of Bias Tool - ACROBAT" [8, 9] is a tool that assesses six sources of biases: sequential generation, concealment of allocation, masking of participants, personnel and outcome assessors; incomplete data, selective results reporting and other potential sources of bias. It was used in order to assess the quality of the studies included in the review, classifying them in studies with "low risk of bias", "confused risk of bias" and "high risk of bias".

III.   RESULTS

The electronic and manual search strategy used resulted in 145 titles and abstracts. Of these, 27 were selected from the inclusion and exclusion criteria and read in full. At the end, 10 were elected to be included in the review (Figure 1 and Table 2).
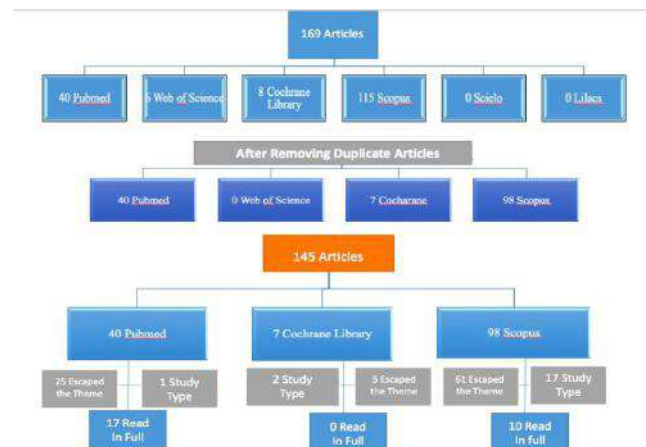
Fig.1: Study Flowchart

Table 2. Risk of bias in articles selected for systematic review.

Study	Generation of the random sequence	Allocation concealment	Blinding of participants and professionals	Blinding of outcome evaluators	Incomplete outcomes	Report of selective outcome	Other sources of bias	Study classification
De Laat et al[4]	Uncertain	Uncertain	Low	Low	Low	Low	Low	Uncertain
Michelotti et al[5]	Uncertain	Uncertain	Low	Low	Low	Low	Low	Uncertain
Kalamir et al[10]	Low	Low	Low	Low	Low	Low	Low	Low
Kalamir et al[11]	Low	Low	Low	Low	Low	Low	Low	Low
Wahlund et al[12]	Low	Low	Low	Low	Low	Low	Low	Low
Guarda-Nardini et al[1]	Low	Low	Low	Low	Low	Low	Low	Low
Tuncer et al[6]	Low	Uncertain	Uncertain	Uncertain	Low	Low	Low	Uncertain
Brochado et al	Uncertain	Low	Low	Low	Low	Low	Uncertain	Baixo
Calixtre et al	Low	Low	Low	Low	Low	Low	Low	Uncertain
Nagata et al	Low	Low	Low	Uncertain	Low	Low	Uncertain	Baixo

High - Indicates a high risk of bias, which weakens confidence in the results of the articles; Low - Indicative of low risk of bias, which is unlikely to compromise the results of the articles; Uncertain - Presence of biases that raise doubts about the results of the articles.

In the selected studies a total of 493 individuals were assessed, with ages ranging from 12 to 69 years. Of these participants, 148 received only manual therapy and 93 received manual therapy associated with counseling. The other 252 individuals corresponded to the control group, 15 of whom were treated with botulinum toxin injections, 50 with home physical therapy alone, 31 with manual therapy and home physical therapy, 18 with photobiomodulation, 17 with photobiomodulation and manual therapy, 31 without any treatment, 57 with advice only and 33 with occlusal plates.

In general, studies have assessed differences in reporting myofascial pain intensity and mouth opening amplitude. De Laat et al[4] carried out a randomized

clinical trial, evaluating the effectiveness of manual therapies in reducing myofascial pain and mandibular function. All research participants received counseling related to relaxation and use of the jaw. They were divided into two groups, in which Group I (n = 13) received 4 weeks of physiotherapy and Group II (n = 13) 6 weeks of treatment. Manual therapy resulted in significant improvements after treatment in pain parameters (p <0.001) for both groups, reaching an average of 60% of pain reports. There were no statistically significant differences between the groups that received 4 or 6 weeks of physical therapy.

Michelotti et al[5] conducted a randomized clinical trial, which compared the effectiveness of educational counseling and manual therapies associated with counseling in the treatment of myofascial pain. In the group that received only educational counseling (n = 34), the success rate in reducing pain was 57%, while the group that received manual therapies associated with counseling (n = 36) obtained a rate of 77%. Although the results were numerically better for the association of education with home physiotherapy, this difference was not statistically significant (p = 0.157).

One of the reasons that may explain this result is the possibility that the patients did not perform the home physiotherapy exercises in the correct way as they were instructed, which may have compromised the evolution of the condition.

Kalamir et al[10] evaluated whether there were differences in the results of the treatment of myofascial pain when comparing individuals who received supervised manual therapies in isolation (n = 31), manual therapies associated with counseling (n = 31) and non-treatment, as a control, (n = 31). For this, a randomized clinical trial was carried out. They observed statistically significant differences (p <0.05) in pain reduction in both groups that received interventions compared to controls at 6 months and 1 year of treatment. There were also significant differences (p = 0.016) between the two groups that received treatment in 1 year, with greater pain reduction in the group that received manual therapies associated with counseling compared to the group that received only manual therapies alone.

Another randomized clinical trial also carried out by Kalamir et al[11], assessed the differences between supervised manual therapies and short-term counseling on myofascial pain. Individuals who received manual therapies (n = 23) obtained statistically better results (p <0.001) in reducing myofascial pain when compared to the group that received only counseling (n = 23).

Wahlund et al[12] conducted a randomized clinical trial in 64 adolescents. This study compared the effectiveness of a group that performed manual therapies, through supervised relaxation training (n = 31) with another group, treated with occlusal splint, (n = 33) in reducing myofascial pain. When comparing the groups, a statistically significant difference (p <0.001) was observed in the reduction of myofascial pain in the group treated with splint. A 62.1% success rate in reducing myofascial pain was observed in the group treated with occlusal splint, while in the group treated with supervised relaxation there was only a 17.9% reduction during Phase 1 of the study. This discrepancy was also observed in Phase 2 of the study. To conclude, in the 6-month follow-up, around 2/3 of the participants reported improvement in their pain. The article reports that there was a slightly higher motivation and longer treatment time in the group treated with occlusal splint. The lower adherence of adolescents to the supervised relaxation group can be explained by the fact that it requires greater commitment on the part of the patient in the daily routine.

In the study by Brochado et al [13], a randomized clinical trial was compared to the efficacy of photobiomodulation (n = 18) with manual therapy (n = 16) or treatment using the two devices (n = 17) in 51 patients. They concluded that both photobiomodulation and manual therapy were effective in reducing pain (P <0.001), improving mandibular function (P <0.001). The treatment with photobiomodulation and photobiomodulation associated with manual therapy reduced the depressive symptoms of the patients. However, the combined treatment of the two therapies together did not perform better than the therapies individually on the analyzed variables.

Calixtre et al [14] in their clinical trial performed only manual therapy in 12 patients for 9 weeks. The protocol was always performed by the same professional, in 35-minute sections, twice a week for 5 weeks. The sections consisted of 20 minutes of manual therapy, followed by 10 minutes of muscle conditioning and 5 minutes of stretching, a protocol established by La Touche et al (2009). As a result, this study noted that there was an improvement in mandibular function (P = 0.019). Self-reported pain was significantly reduced (P = 0.009). The maximum painless opening range increased from an average of 32.3 mm to 38 mm. There was also an increase in the pain-pressure threshold in the masseter and temporal muscles on both sides (P> 0.05). Despite the good results, the clinical relevance of the study is questionable.

Nagata et al [15] evaluated in their randomized clinical trial patients undergoing treatment with manual therapy + home physical therapy (n = 31) with patients who

underwent only home physical therapy (n = 30). In addition, all patients in the research received counseling guidance regarding the control of tightness in wakefulness, diet and posture. Home physical therapy was stretching exercises and manual therapy was performed by a trained professional. There was an improvement in all parameters evaluated (limitation of opening, orofacial pain and joint noise) in both treatment groups. The group that combined manual therapy with home physical therapy showed a better performance than the group that performed only home physical therapy in the variable limitation of mouth opening and TMJ noise. However, this difference was not statistically relevant (P> 0.05).

Guarda-Nardini et al [1] compared the effectiveness of manual therapy in several sections with a single injection of botulinum toxin in the masseter and temporal muscles in reducing myofascial pain. In their results, they found that both treatments improved pain levels, with facial manipulation slightly higher in reducing the perception of subjective pain and applying botulinum toxin slightly higher in increasing mandibular range of motion. However, this difference was not statistically significant (p> 0.05).

Finally, Tuncer et al [6] evaluated the effectiveness of manual therapy and compared it with physical therapy at home in patients with muscle TMD. These patients were divided into 2 groups. The first group (n = 20) received detailed guidance on the etiology of pain, ergonomics, breathing exercises, relaxation techniques, postural correction exercises, mandibular exercise, repetitive stretching, opening and closing exercises and resistance exercises. The other group (n = 20), in addition to these guidelines, patients received manual therapy performed by a specialist. In their results, the effectiveness of the treatment used in the group that received the guidelines and manual therapy was significantly greater for pain, both at rest and in stress, when compared to the group that received only the guidelines (p <0.001).

IV. DISCUSSION

This study looked at the scientific evidence to assess the effectiveness of manual therapy in the treatment of myofascial pain related to TMD. For that, only controlled and randomized clinical trials were included, with a high level of scientific evidence. The studies included in this review were standardized by the use of RDC / TMD in order to guarantee the validity, similarity and reproducibility of the studies, as well as to avoid the confusing result with the diagnosis of joint pain. Despite this, it was not possible to perform a meta-analysis of the articles, since the studies were considerably heterogeneous

methodologically and manual therapy was compared with different interventions (physical therapy, guidance / counseling, botulinum toxin, photobiomodulation, occlusal devices or without intervention).

It was possible to observe, after the search strategies, a low number of randomized controlled clinical trials that evaluated the effectiveness of manual therapy in the treatment of myofascial pain related to TMD. This fact demonstrates that studies are still needed to have sufficient scientific evidence in the literature to support the effectiveness of this treatment. Associated with this, 4 of the 10 studies included in the review have a dubious methodological quality, since they presented an uncertain risk of bias (Table 2). Therefore, it is necessary to exercise caution when analyzing and inferring the results.

9 studies included several manual therapy techniques applied by a specialized professional and 1 study included home manual therapy techniques. They consisted mainly of self-relaxation exercises with diaphragmatic breathing, self-massage of the masticatory muscles (mainly masseter and temporal), stretching, coordination exercises and intraoral massage techniques. In the works by Kalamir et al [10, 11], Wahlund et al [12], Guarda-Nardini et al [1], Brochado et al [13], Calixtre et al [14], Nagata et al [15], Tuncer et al [6] and De Laat et al [4] the therapy was instituted by a specialist and, in all cases, an effective reduction in pain perception and improvement in mandibular function over time was observed, ensuring better opening levels . The study by Michelotti et al [5], in which the patient was instructed to perform manual home therapy, despite also showing results of improvement in pain and mandibular function, the results are more limited, since home therapies depend a lot of patient education and collaboration in performing the exercises frequently and correctly.

In their study, Tuncer et al [6] compared supervised manual therapy with home therapy, providing patients with very complete instructions, not only on how to perform exercises and frequency, but also on the etiology of pain, postural influence and techniques of breathing and relaxation, which makes us see the importance that a correct and detailed instruction to the patient is an important factor in the success of the treatment.

It is important to consider that when its effectiveness was compared to that of other therapeutic interventions, limitations of this therapeutic technique were found when used alone [5] and reduced scientific evidence of its effectiveness. In the study by Wahlund et al [12], the occlusal splint obtained results superior to those of TM. One of the reasons that can justify this finding is the population studied, who were teenagers, with little

commitment in their efforts during therapy sessions and in the frequency with which they perform home exercises. In addition, it may be possible that TM is less effective in treating TMD in this group. The authors suggested increasing therapeutic support and the number of therapy sessions in this group of patients [12]. However, a more in-depth discussion is limited by the reduced amount of work in this field and further studies, which consider a longer treatment interval and / or a greater number of sessions, are necessary.

In this review, it was observed that the effectiveness of manual therapy was closely related to counseling techniques. Its effectiveness was superior when these two types of treatment were associated [6, 11]. In some cases, no difference was found between the effectiveness of the two [5]. This highlights the importance of talking and guiding the patient during the treatment of myofascial pain. Thus, patient education and collaboration plays an important role in improving symptoms. In addition, the increased responsibility of the patient in addressing the psychosocial factors of the disease can be an important tool during treatment [15]. However, there is still no clear evidence on the effectiveness of one treatment over the other for the control of myofascial pain, since studies report divergent data, in which TM is superior to counseling [10] or not [5].

V. CONCLUSION

In conclusion, despite the low scientific evidence, most studies have shown that manual physical therapy associated with educational counseling was more effective in treating myofascial pain related to TMD. Thus, since it is a low-cost, non-invasive, and reversible therapy, this treatment modality must be considered as one of the therapies in reducing muscle pain related to TMD.

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Cost-Benefit Analysis between Conventional Concrete and High Performance Concrete: Case Study of a Residential Building

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Abstract— The present study makes a comparative analysis of the cost-benefit ratio between Conventional Concrete (CC) and High Performance Concrete (HPC). To obtain the consumption rates of concrete, steel and shape of each case, two studies of the same structure out changing only one variable were carried: the characteristic strength of concrete to compression (fck). In the first case, the fck 25 Megapascal (MPa) representing the CC was applied, and in the second case, fck 50 MPa corresponding to the HPC. To analyze the structural elements, it was used the software Cypecad. It was confirmed one of the initial hypotheses (the consumption of concrete, steel and form would decrease with the use of High Performance Concrete). The second hypothesis was not confirmed (the HPC would be more financially advantageous than the CC), but factors that may have led to this non-confirmation were pointed out.

I. INTRODUCTION

The cost-benefit discussion is widely used in our lives and in several areas and it would be no different in the area of civil engineering, where the evolution is always towards a better quality and behavior of the structures, coupled with the reduction of expenses.

[7]. Botelho et.al. (2006) Conventional Concrete (CC) is currently one of the most widely used and widespread construction materials in Brazil. [11]. Accordingly to Metha and Monteiro et.al. (1994) it is a composite material that essentially consists of a continuous agglomerating medium (hydraulic cement + water) within which particles or fragments of aggregates are immersed (granular material such as sand, gravel, crushed stone), forming a block monolithic. When used with reinforcement it's called reinforced concrete.

[9]. For Geyer and Sá et.al. (2005) High Performance Concrete (HPC) is a special concrete in order to improve existing results. [1]. As for Aitcin et.al. (2000) it differs from Conventional Concrete in terms of the addition of active silica and superplasticizers, materials capable of significantly improving the performance of concretes, changing their chemical and mechanical properties.

Each work has particular characteristics, and the choice of the most appropriate concrete in the execution of the project according to the existing need is decisive. Be your interest the lowest cost, the lowest consumption of reinforcement, more slender structures, a decrease in the structure's own weight or even an increase in the execution speed and greater durability. It is up to the structural engineer together with the architect and the builder engineer to make the most appropriate option for a given type of work.

This work presents a comparison between Conventional Concrete and High Performance Concrete in a case study of a Residential Building through computer simulations using the software Cypecad version 2014, based on the Brazilian standard [12]. NBR 6118 et.al.

(2014) from the Brazilian Association of Technical Standards (ABNT). The calculations of the efforts and dimensioning were obtained by means of lists issued by the program, which after being verified and analyzed, allowed the obtaining of the quantities related to the volume of concrete, the weight of steel and the area of forms.

II.   LITERATURE REVIEW

1. ARMED CONCRETE

1.1. Conventional Concrete

[16]. Pinheiro et.al. (2007) say that Conventional Concrete is a building material from the mixture, in an appropriate proportion of binders, aggregates and water. [11]. While for Metha and Monteiro et.al. (1994) it is a composite material that essentially consists of a continuous agglomerating medium (hydraulic cement + water) within which particles or fragments of aggregates are immersed (granular material such as sand, gravel, crushed stone) forming a monolithic block. When armed with ironware it gets the name of reinforced concrete.

1.1.1. Benefits

[18]. Accordingly to Süssekind et.al. (1980) the main advantages responsible for the true growth of concrete and absolute dominance of the world market are: economy, freedom in project design, safety, obtaining a monolithic structure, infrequent maintenance, and not least, resistance to effects thermal, atmospheric and mechanical wear.

[6]. Barata et.al. (1998) add "[...] the economic repercussion related to the high incidence of pathological manifestations in the constructions with this material implies in huge amounts of resources in the recovery".

1.1.2. Disadvantages

[18]. Süssekind et.al. (1980) affirm that the great disadvantage of conventional reinforced concrete is its own weight, in the order of 2.5 t/m³, demolition difficulties (renovation), low degree of thermal protection (this requires mainly in roofing, application of products to avoid this problem) and last but not least, the inevitable cracking of the concrete in the parts in tensioned areas.

1.2. High Performance Concrete

[1]. Aitcin et.al. (2000) understand that the high performance concrete differs from Conventional Concrete in terms of the addition of active silica and superplasticizers, changing their mechanical and other properties. [16]. Where as for Pinheiro et.al (2007) the HPC can be obtained by mixing cement and conventional aggregates with active silica, metakaolin and plasticizer additives. Instead of active silica, it can be used fly ash or blast furnace residue.

[6]. Barata et.al (1998) affirm that active silica is a by-product of metallurgical industries that produce metallic silicon and silicon iron. The metakaolin is an aluminosilicose material from calcination of kaolinitic clays at temperatures between 600ºC and 900ºC. As for superplasticizer additives, they are chemical additives that allow the complete dispersion of the cement grains, thus allowing obtaining fluid mixtures with a low water/cement ratio, ensuring substantial increases in strength and durability.

1.2.1. Benefits

[16]. Pinheiro et.al (2007) argue that its characteristics are better than Conventional Concrete, such as: high initial and final mechanical resistance, low permeability, high durability, low segregation, good workability, high adhesion, reduced exudation, lower deformability due to shrinkage and creep, among others.

Another factor worth mentioning as an advantage of HPC and quite valid is its application. [10]. Mendes et.al (2002, p. 1) mention: "The main applications of HPC in civil construction have been in tall buildings, underwater platforms, bridges, viaducts, road pavements and industrial floors, both Conventional Concrete and High Performance Concrete are indicated. However, HPC stands out in the slimmer and bolder structures, with greater spans, located in densely urban or industrial atmospheres loaded with aggressive agents. Where the interest is to reduce the structure's own weight, load the foundations, increase the floor area and/or significantly reduce the columns."

[8]. Gamino et.al (2003) report that the increasingly frequent use of High Performance Concrete (HPC) is fundamentally centered on the following aspects:

- High resistance to compression that allows the reduction of cross sections, obtaining more slender structures and with less own weight providing savings in formwork and lower costs with the foundation.

- Less instantaneous deformations due to its high modulus of elasticity.

- Reduction of the fluency phenomenon.

- Lower permeability of hardened concrete contributing to a slower carbonation process that causes corrosion in the reinforcements.

- Greater durability.

- Good compressive strength achieved at low ages that can provide shorter stripping times and shorter execution times for reinforced concrete works.

[6]. For Barata et.al. (1998), the use of mineral additions in HPC concrete, in addition to improving its technological characteristics, reduces considerably the consumption of cement for the same resistance or permeability level.

1.2.2. Disadvantages

[1]. While for Aitcin et.al. (2000), what can be considered as disadvantages and some reasons for not using this material is that high performance concrete requires greater technical and scientific rigor in its preparation and greater care in its preparation, requiring a hand of more specialized work, increasing the cost of producing the final product. [16]. Pinheiro et.al (2007) confirm by mentioning that Conventional Concrete has low labor cost, in general, it does not require a highly qualified professional, as well as low cost of materials (water and coarse and fine aggregates).

[1]. Aitcin et.al. (2000) bring another disadvantage, it would be regarding the economic value of production, since the selection of materials for the production of HPC is more complicated. It must be done carefully, since the cements and aggregates available present great variations in their compositions and properties, and there is no clear system that facilitates the choice of the most appropriate type and aggregate yet.

However, accordingly to [8]. Gamino et.al (2003, p 4) the fragile behavior of this material can be an inconvenience, for example, in regions of high seismic risk or places where differential repression occurs.

1.3. Mechanical and Rheological Properties of CC and HPC

[11]. Metha and Monteiro et.al (1994) say that the performance and durability are linked factors that determine whether a material has quality or not. The performance of the material means its behavior in use, and the durability of a material refers to the conservation of its performance throughout its useful life.

[8]. Gamino et.al (2003) add that the ductility is: "The measure of the ability of a material, section, structural element or structural system to undergo inelastic deformations in the vicinity of a possible rupture, without substantially losing its resistant capacity. It is an important property given to elements, it introduces with respect to the capacity to redistribute efforts when acting, for example, of differential settlements or earthquakes on the structure.".

After analysis through the stress-strain curve, it is noticed that concretes with higher strengths have stress-strain curves that are more accentuated and linear when compared to concretes with lower strengths. It is also

added that Conventional Concretes tend to have higher ductility compared to High Performance Concretes, noting that this observation is fully valid only for the concrete material, and cannot necessarily be extended to individual parts, such as, conventional and reinforced concrete beams and high performance. It is also added that, however, ductility is directly affected by quantities of a physical order in relation to the dimensions of the structural element and by quantities of a mechanical order with regard to the materials that comprise the structure.

[15]. Neville et.al (1982) mention that durability means that a given concrete structure will have satisfactory continuous performance for the purposes of which it was designed, this is to say that it will maintain its resistance and normal service conditions during the specified or expected useful life.

Strength and durability depend on the proportion between the materials that make it up. To obtain a good concrete, whether conventional or high-performance, the basic operations of material production must be carried out with perfection: cement, water, fine aggregates (sand), coarse aggregates (stone) and the basic operations of concrete production, which are: dosage or mixing, mixing, densifying and curing, as it is the sum of all these factors that differentiate the CC and HPC [16]. Pinheiro et.al (2007).

Basic operations for the production of concrete are also essential for assessing the strength of the concrete. The dosage or trace is the indication of the proportions and quantification of the materials that make up the mixture in order to obtain a concrete with certain previously established characteristics. A highlight in the preparation of the concrete is the care that must be taken with the quality and quantity of the water used. Both excess and lack are harmful to concrete, as water is responsible for activating the chemical reaction that transforms the cement into a binding paste. Lack of water leaves the concrete full of holes, if its quantity is very small, the reaction will not occur completely. If it is higher than ideal, the resistance will decrease depending on the pores that will occur when this excess evaporates.

The ratio between the weight of water and cement used in the dosage is called the water/cement factor (w/c). [15]. Neville et.al (1982) inform that the relationship between water and aggregate is essential for the evaluation of resistance, because the larger the aggregate particle, the smaller the area to be wetted per unit of mass, that is, the larger the aggregate size, the smaller the water demand. With the reduction of the water/cement ratio, there is an increase in strength, as they are inversely proportional.

[3]. Alves et.al (2005) add that in addition to the care that must be taken with the choice of aggregate, HPC differs from CC, since in the dosage the active silica is added between 5% and 10% of the cement mass and superplasticizer additives with a dosage between 0.5% and 3% of the binder. Active silica is an ash collected in the electrostatic filters of silicon iron production kilns, whose grains are 100 times larger than cement, exerting influence on the properties of fresh concrete and on the hydration of cement compounds. It is a use of industrial waste, thus presenting a high ecological potential for the incorporation of this material, since the use of concrete that has a socioenvironmental character is extremely important nowadays. Superplasticizers make it possible to reduce the factor (w/c) from 0.40 to 0.24 with perfectly viable mixtures for applying the techniques available in the current construction sites.

The resistance rises with active silica due to the greater formation of C-S-H and the addition of superplasticizers, making it possible to reduce the factor (w/c). Durability improves with a reduction in permeability and factor (w/c). The active silica does not contribute to the elevation of the heat of hydration. It reduces to factor (w/c) less than 0.40. Concluding that the active silica increases the resistance, without increasing the heat release [4]. Alves et.al (2006).

Due to these additions, it is possible to obtain better characteristics in HPC than in traditional concrete, such as: high initial and final mechanical strength, low permeability, high durability, low segregation, good workability, high adhesion, reduced exudation, less deformability due to shrinkage and creep, among others [16]. Pinheiro et.al (2007).

[15]. For Neville et.al (1982), resistance depends on only two factors: water / cement ratio as already mentioned above and the degree of density. Densification is the compacting of the concrete mass, seeking to remove from it the largest possible volume of voids - gain of resistance. The usual means of densification is vibration. Vibration has the effect of fluidizing the mortar component of the mixture, reducing internal friction and accommodating the coarse aggregate. Concrete must have a good particle size distribution in order to fill all voids, as porosity in turn influences the permeability and strength of concrete structures. The low quality in the concrete densification process results in a decrease in mechanical strength, increased permeability and porosity, and lack of homogeneity in the structure.

Curing is the name given to the procedures used to promote the hydration of the cement and consists of controlling the temperature and the outlet and entry of moisture into the concrete [15]. Neville et.al (1982). Water curing should be continuous and last at least seven days, although it is preferable to reach twenty-eight days. If the curing with water is done properly, problems that will affect the volumetric stability and the mechanical strength of the concrete can be avoided. Failure to comply with the cure leads to a decrease in the final strength of the concrete and the possibility of cracking in the structure [5]. Azevedo et.al (2005).

Care must be taken when selecting the material and when preparing concrete, whether conventional or high-performance, as all these steps affect the result, changing its properties: strength, durability and performance. As for the economic value of production, HPC is more expensive than Conventional Concrete. Because the selection of materials for the production of HPC is more laborious, it must be done carefully, since the available cements and aggregates vary widely in their compositions and properties and there is still no clear system that facilitates the choice of the type of cement and the most appropriate aggregate for HPC [1]. Aitcin et.al. (2000).

Additives, although not always cheap, do not necessarily represent an additional cost because it can result in savings, such as, for example, in the cost of labor required for densification, the possibility of reducing the cement content or improving durability [17]. Silva et.al (2014).

Therefore, it is possible to note that HPC requires greater technical and scientific rigor in its elaboration and greater care in its preparation when compared to Conventional Concrete [1]. Aitcin et.al. (2000).

The application of concrete is quite wide, ranging from the construction of buildings, warehouses, industrial floors, highways, hydraulic and sanitation works, to various structures. Most of the time it is the need for the project that determines the choice of concrete to be used [16]. Pinheiro et.al (2007).

2. Cost-benefit of Conventional Concrete and High Performance Concrete

[1]. Aitcin et.al. (2000) say that there are many advantages that justify the increasing use of HPC in the construction sector. In Brazil, it is possible to highlight three fundamental factors: the high durability, the possibility of building slimmer structures and the strength of the material in particularly aggressive regions. The use of active silica in concrete in marine atmosphere environments guarantees environmentally compatible porosity levels to minimize the hydraulic retraction of the concrete, thus ensuring greater durability in the structure.

Planning is inherent in construction. It is necessary to compare technical alternatives, and the cost, nowadays, it

is an essential factor for verifying the feasibility of the project and for carrying it out. The cost-benefit ratio or CBR is an indicator that lists the benefits of a project or proposal and their costs. In the first instance, the use of Conventional Concrete would be more interesting, but when analyzing all the factors together, it is not only a determining factor, but also the sum of all of them, in choosing the most appropriate concrete.

[6]. Accordingly to Barata et.al. (1998) concrete is undoubtedly one of the most commonly used construction materials in engineering, as it has a low acquisition cost, flexibility of execution and is water resistant.

Some of the advantages of using Conventional Concrete (CC), [16]. as brought by Pinheiro et.al (2007) would be: low cost of materials (water, cement, coarse and small aggregates), low labor cost, as in general it does not require professionals with high level of qualification, reduced maintenance costs, as long as the structure is well designed and properly built, and finally, ease and speed of execution, because time is money.

[6]. Barata et.al. (1998) also mention the production of HPC is usually linked to the use of mineral additions, which in general are tailings, residues or by-products from other industries. There are numerous mining and metallurgy industries across the country that release significant amounts of waste into the environment that cause serious pollution and deforestation problems. Based on this, we can affirm that the HPC in addition to the aforementioned has the benefit of the facility of obtaining the material that composes it, with the use of industrial waste, associated with the sustainability of the environment.

As for HPC, even though it has a higher cost in the production of materials and labor, as it requires greater technical rigor and selection of materials, the so-called direct costs, the higher strengths brought significant changes in the use of the concrete material. The possibility of slender shapes, a decrease in the volume of concrete, a smaller shape area, a reduction in the steel rate, savings in maintenance, a reduction in the structure's own weight or even an increase in the speed of execution, the so-called indirect costs, is possible thanks to the adoption of higher resistance resulting in economic viability [14]. Neto et.al (2002). [10]. Mendes et.al (2002) come up with the affirmation that although the cost of HPC is slightly higher than the conventional one, it can be properly used when the benefit becomes greater than the cost.

This work was supported by the use and importance of concrete, be it conventional or high performance, in search of improving the mechanism of the structures in the face of the interest of lower expenses. The cost-benefit ratio is

important to actually cooperate with the applicability and feasibility of the technological alternative proposed by this research. Technological advances would be useless if it is not possible to use these resources in favor of a compensating cost associated with consumption on a large scale.

III. METHODOLOGY

For the development of this research, an analysis of a structural model by comparative method was carried out. The structural model is a residential building and for the purpose of comparison, only one parameter was changed in order to differentiate them, as there are countless factors that influence the properties of this material, such as: water/binder ratio, type and consumption of cement, mix composition, type and quantity of mineral additions as well as additives, particle size, shape and maximum characteristic of coarse and fine aggregate, degree of cement hydration, type of cure, among others.

The research does not address aspects consistent with dimensional stability, such as the modulus of deformation, a property that is strongly influenced by the characteristics of the coarse aggregate.

The evaluated and modified variable was a mechanical property, the fck (characteristic compressive strength of concrete), starting from the need to set parameters as factors to limit this research, and as a consequence of the higher strengths, there were changes in the sections of the columns.

At first, the fck used was 25 MPa, the same used in the building already constructed, corresponding to Conventional Concrete. And in the second moment, for High Performance Concrete (HPC), the fck adopted was 50 MPa, in order to continue to use the Brazilian Standard (NBR 6118) [12] which limits the concrete class to C50.

Where the fixed parameters, that is, those that were not modified in the two analyzes were: overload (SCU), permanent load (CP), coverings (column, beam and slab), beam and slab dimensions and wind action, based on NBR 6123 de 1988. [13].

The experimental research was divided into three stages. The first consisted of defining the entire structure of the case study in the software, after running, all security checks and analyzes were performed in the Ultimate (ELU) and Service (ELS) Limit States. The second consisted of obtaining quantitative data, extracted from the program, in order to be able to assemble graphs in order to be able to make analyzes of the indices of inputs, such as concrete in m³, steel in kg and shape in m², contemplating for the main objective of this research. Finally, the third

stage consisted of the evaluation and judgment of the technical and economic possibility of using concrete with a performance far superior to that normally employed.

After calculations were performed in Cypecad, and their consumption indexes were obtained, graphs of the structures were made, analyzing the costs of each one. For the cost calculations of the structures, the following values were adopted (in reais R$ - Brazilian currency) based in the metropolitan region of the city of Salvador, Bahia, Brazil:

- Conventional Concrete: R$ 300.00/m³

- High Performance Concrete: R$ 500.00/m³

- Folded steel: R$5.00/kg

- Form for solid slab: R$40.00/m²

IV. CASE STUDY

4.1. Presentation of the Structural Model

To carry out these analyses, a real structure project was used, provided by the Francisco Peixoto Engenheiros Associados structural project office. The residential building analyzed comprises 18 floors, being: basement, ground floor, 1st floor, type - 2nd to 10th floor, lower roof, upper roof, engine room, barrel and elevated reservoir. Next, for a visualization and presentation of the Structural Model analyzed and worked on, it follows the types of floors for each case, structure, which was launched in the program.
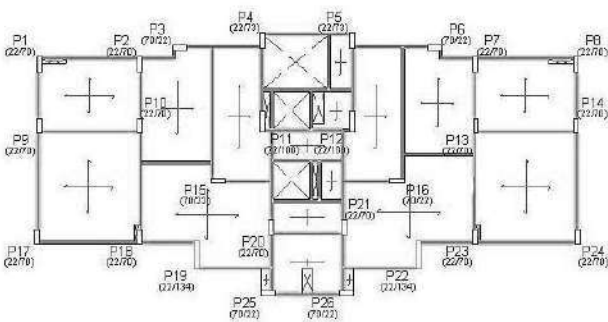
Fig. 1: Structural model - Conventional Concrete.
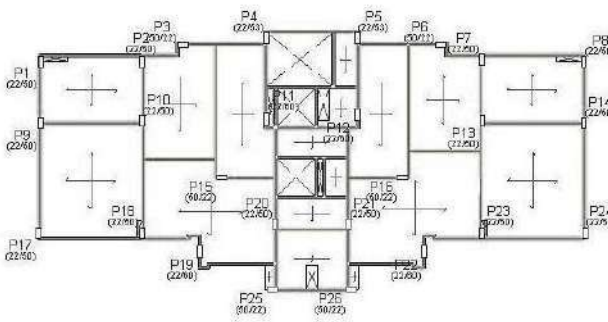
Fig. 2: Structural model - High Performance Concrete.

4.1.1. Coverings

- Pillars: 3.0 cm

- Beams: 3.0 cm

- Slabs: 2.5 cm

4.2. Actions Considered

4.2.1. Vertical

Table.1: Vertical actions.

Group's name	S.C.U	C. Permanents
Coverage, Barrel and Reservoir	0.15	0.10
Type Floors	0.25	0.10
Garages and Play Ground	0.30	0.10

4.2.2. Wind

2nd order effects analysis - value: 1.43, applied as a factor for increasing displacements.

Load Coefficients:

+ X: 1.00 -X: 1.00

+ Y: 1.00 -Y: 1.00

Basic Speed: 30.00 m/s

Roughness: Category: III; Class: B

Probabilistic factor: 1.10

Topographic Factor: +X: 1.00 -X:1.00 +Y:1.00 -Y:1.00

4.3. Resulting Global Stability (Gamma z)

According to NBR6118: 2014, the Gamma z coefficient has the main objective, for calculation purposes, to classify the structure as to the displacement of the nodes; with this, it is possible to assess the importance of global 2nd order efforts. It is determined from the results of a 1st order linear analysis, for each loading case considered in the structure.

Its value is calculated and compared with the limit values from which the structure must be considered as a mobile node. The Gamma z value is defined by:

$$(1) \quad \text{Gamma } z = \frac{1}{1 - \frac{\Delta M_{tot,d}}{M_{1,tot,d}}}$$

$\Delta M_{tot,d}$ - It is the sum of the products of all vertical forces acting on the structure, with their calculation values, by the horizontal displacements of their respective points of application, obtained from the 1st order analysis

M1,tot,d - It is a tipping point, that is, the sum of the moments of all horizontal forces, with their design values, in relation to the base of the structure.

The structure is considered to be of fixed nodes if the condition Gamma z ≤ 1.1 is established.

4.3.1. Conventional Concrete C25

Table.2: Gamma z (CC)

Wind + X	1.064
Wind − X	1.064
Wind + Y	1.046
Wind − Y	1.046

Analysis and Verification:

Wind + X and –X: Gamma z = 1.064 ≤ 1.1 Ok

Wind +Y and –Y: Gamma z = 1.046 ≤ 1.1 Ok

4.3.2. High Performance Concrete C50

Table.3: Gamma z (HPC)

Wind + X	1.070
Wind − X	1.070
Wind + Y	1.048
Wind − Y	1.048

Analysis and Verification:

Wind + X and –X: Gamma z = 1.007 ≤ 1.1 Ok

Wind +Y and –Y: Gamma z = 1.048 ≤ 1.1 Ok

V.   RESULTS OF STRUCTURES

5.1. Input Collections

After analyzing the structures in the software, Cypecad, it was possible to extract from it the results of the following values of the total consumption of steel (kg), shape (m²) and concrete (m³) of each case, Conventional Concrete and High Performance Concrete, explained in the tables below, for a better quantitative analysis of the inputs.

Table.4: Total consumption of inputs (CC)

Conventional Concrete	
Steel (kg)	65815
Form (m²)	6843
Volume (m³)	618

Table.5: Total consumption of inputs (HPC)

High Performance Concrete	
Steel (kg)	58204
Form (m²)	6660
Volume (m³)	519

5.2. Input Cost Percentages

With the figures shown in tables 4 and 5, it was possible to make percentage graphs, of the cost of the inputs of each of the structures separately and respectively, Conventional Concrete and High Performance Concrete, using the values in reais (R$), indicated in the methodology.
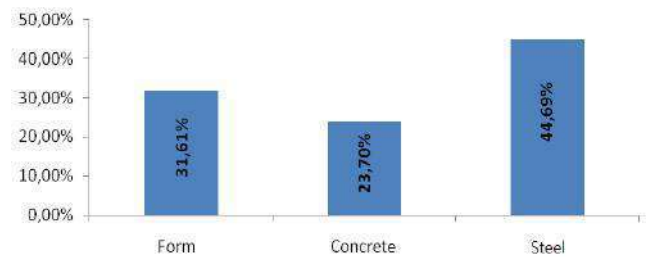
Fig. 3: Percentage graph of CC inputs.
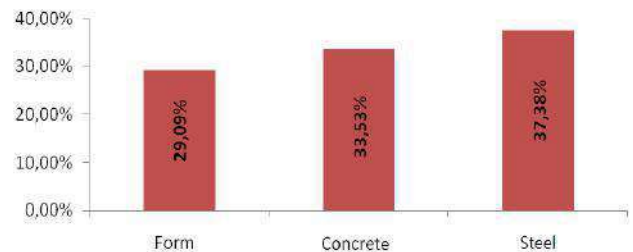
Fig. 4: Percentage graph of HPC inputs.

After analyzing each of the structures in isolation, for a better comparative analysis and visualization, a graph of the two cases was made together of the input costs of each concrete, as it can be seen below.
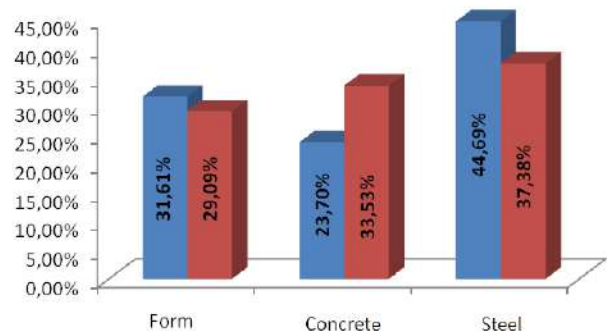
Fig. 5: Comparative graph of the percentage cost of inputs between CC and HPC.

5.3. Cost of Inputs in Reais (R$) per Square Meter

In terms of variable costs, costs that change according to production or quantity, materials (form, concrete and steel) fall into this category, hence the need to set monetary values, see Item III (Methodology) , to be able to evaluate and compare, from the financial point of view, the real financial difference between the concrete analyzed here. The comparative graph of the cost of inputs in reais (R$) per square meter is shown on the following page.
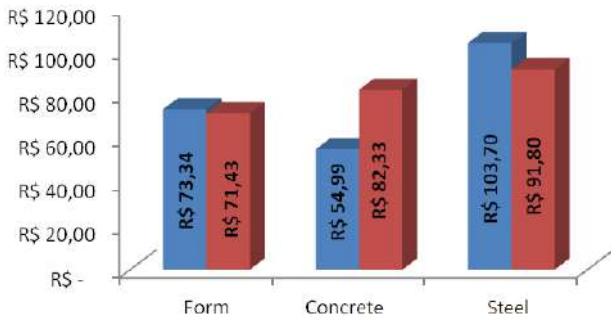
Fig. 6: Comparative graph of the cost in R$/m² of inputs between CC and HPC.

With these data it is possible to make a global analysis of the inputs (form, concrete and steel) that are the most important in the financial expenses of a work and are the conditioning parameters of this research. When making the sum of these inputs, we quantify the expense for each case (work) analyzed. Which results in the comparative graph of the total cost of the works that is explained below (Fig.7).

It is worth noting that the projected real structure was only the target for motivating the study analysis carried out here. The total financial cost of the work presented here does not correspond to the total cost of the work actually built, as the cost of each material used in the work discussed here was not taken into account, but rather the values addressed and portrayed in Item III (Methodology).
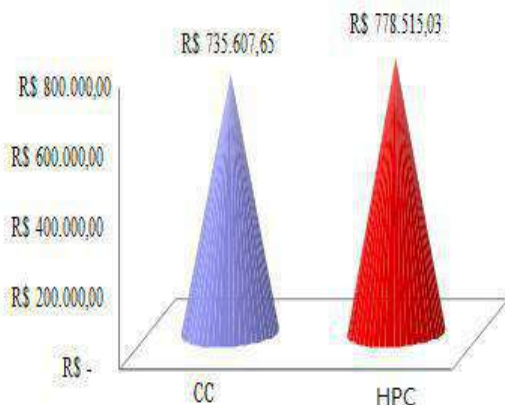
Fig. 7: Comparative graph of the total cost of works.

VI.   ANALYSIS OF RESULTS

Based on the results provided by the Cypecad software and observing the resulting graphs generated above, it was possible to arrive at the following analyzes.

6.1. Differences in Input Costs

6.1.1. Form

Conventional Concrete (CC) was 2.67% more expensive than High Performance Concrete (HPC), corresponding to a cost difference of R$ 1.90/m² and totaling a difference in final expenditure on the work of R$ 6.036,33.

The importance of obtaining a smaller quantity, in m², necessary to be used in a work is indisputable, as they are temporary structures and cannot always be reused. Currently, with the high cost of wood, the need for higher quality (technological control of materials), reduction of losses (materials and labor productivity), reduction of delivery times (competitiveness) etc., it is imperative that the engineer gives due importance to the dimensioning of the temporary formwork and shoring, considering the assembly and disassembly plans and their reuse in the same work.

6.1.2. Steel

When analyzing the steel, the Conventional Concrete (CC) was 12.96% more expensive than the High Performance Concrete (HPC), thus corresponding to a cost difference of R$ 11.90/m². Totaling a difference in final expenditure on the work of R$ 37.727,05.

The decrease in the amount of steel, in kg, in the work ends up leading to other factors here that are not possible to be considered quantitatively, but it will have as consequence: lower labor costs and faster construction.

6.1.3. Concrete

When analyzing the concrete, the high performance (HPC) was 49.71% more expensive than the conventional (CC). Corresponding to a difference in cost of R$ 27.34/m², totaling a difference in final expenditure on the work of R$ 86.670,75.

However, when analyzing the volume of concrete, the High Performance Concrete (HPC) was 19.08% lower than that used in the structure made with Conventional Concrete (CC). Therefore, we know that there will be, consequently, other cost reductions in the work, such as: reduction in execution time, reduction of costs with employees (labor), with rent and/or purchase of forms, equipment and several other productivity gains.

6.2. Difference in Total Cost of Work

With that it was possible to account for the sum of these three inputs analyzed here, form, steel and concrete and we arrived at the following quantitative result: the structure in which the High Performance Concrete (HPC) was used was 5.83% more expensive than the structure where Conventional Concrete (CC) was used. Thus, corresponding to a difference in the total cost between the two works of R$ 42,907.38. This value can be easily deducted in other activities existing in a work such as those already mentioned here in this research in Item 6.1. But we will leave to delve deeper and list these concepts later.

6.3. Analysis of the Type Floor Pillars

Through the visualization of the floor plan of the type floor of each structure, where the dimensions of the columns used are shown, it is possible to perceive that there is a great reduction in the dimension of this structural element in the building in which the High Performance Concrete was used, as can be seen in Fig.8 and Fig.9.
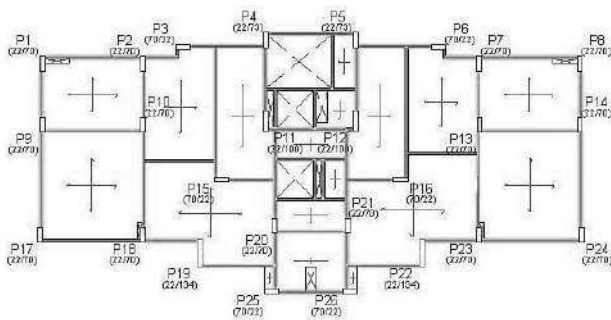
Fig. 8: Dimension of the pillars (CC)
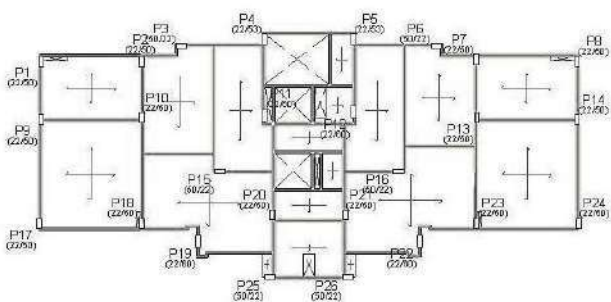
Fig. 9: Dimension of the pillars (HPC)

There was a reduction in cross-section in all pillars in the structure in which High Performance Concrete was used. The vast majority of this reduction was 28.6%, with the exception of the P11 and P12 pillars, where this reduction reached 40%, the section of which was (22x100) passing to (22x60). And two other pillars, which are worth mentioning, were the P19 and P20 pillars, which reduced by 55.22%, more than half, reducing the section from (22x134) to (22x60).

The reduction in the dimensions of the columns is one of the great advantages of using High Performance Concrete, because with the reduction of the section of the columns, in addition to reducing the volume of concrete, the amount of steel and shape, as mentioned earlier, is totally interesting to increase the useful area, a factor of indisputable importance, since the entrepreneur always aims at a larger useful area aiming at the sale of the property. This factor also stands out in the parking areas, because most of the time there is always a concern of the design engineer to adapt its structure to meet the architect and / or entrepreneur's will, which is the gain of vacancies in the parking area.

VII.　CONCLUSION

It is not an easy task to determine which of the concretes is the most advantageous and the most economically viable in the execution of the design of a residential building in the face of so many variables involved. However, for this case study, by restricting the variation only to the fck and keeping the other variables constant, it was possible to determine, through the analysis of quantitative-financial results, which of the solutions is more economical.

In the study, it considered a conventional building using the fck of 25 MPa and in a second moment the same building with the fck 50 MPa. At the end of it, a comparative graph was elaborated containing the value of the total cost of each work of the analyzed structures, in this, it was clear the difference in cost of each analyzed case.

With the analysis of comparatives through the refinement of data obtained by the Cypecad program, it was possible to see the confirmation of one of the hypotheses. There was a decrease of the gross values of form, concrete and steel in High Performance Concrete. However, it was not determinant for this to be more financially advantageous, as HPC has a higher cost per cubic meter compared to Conventional Concrete.

It was assumed that with the use of High Performance Concrete, the costs with materials and labor would be more advantageous than Conventional Concrete, since the high cost of HPC would be easily eliminated when compared to the good results achieved with the decrease of concrete volume, smaller form area, reduction of steel rate and economy with maintenance. However, the results showed that in the total cost of the works, the use of Conventional Concrete was more economically viable. Thus, the hypothesis that the structure made with the HPC would be more economical has not been confirmed, even

with a decrease in the consumption inputs of the HPC compared with the CC.

Through this study, it was possible to reach the conclusion that the percentage cost with the shape of the CC was 2.67% higher than the HPC. In the analysis of steel, the percentage cost was that the CC is 12.96% higher than the HPC. In the concrete analysis, the percentage cost of HPC was 49.71% higher than the CC. Lastly, in the structure in which the HPC was used, the total value of the percentage cost was 5.83% higher than the structure in which the CC was used, corresponding to a difference in the total cost of the works of R$ 42,907.38. [2]. Accordingly to Albuquerque et.al (1998) a 10% reduction in the cost of the structure can represent a decrease of 2% in the total cost of the building. In other words, for the case study analyzed, with the use of HPC there may be an increase of approximately 1.2% in the total cost of this building.

On the other hand, there was a significant reduction in the sections of the pillars. In some cases, reaching more than half. What weighed heavily in this analysis, because it is not just the cost that is in focus, but also cost-benefit. As currently the usable area as the quantities vacancies is a constant concern of engineers, it has become a crucial factor in the decision. An additional cost of 1.2% becomes small when compared to the gain in the usable area added to the gain in construction speed, as time is money.

The benefit involves major technical and economic responsibilities, so the execution of works must take advantage of all the possibilities available. Therefore, incorporating the preparation of a preliminary project, careful laboratory studies, monitoring of the executive phases, control of materials, and training of qualified labor for the works is a way of implementing quality assurance procedures and achieving benefits in favor of its interests.

It must be thought that currently there are impositions of more modern structures, in the sense that larger spans and little interference of the structure itself in their use are desired, for this reason, they already need a higher strength concrete.

Therefore, it is essential to carry out studies and quantify the real behavior of these parameters for the conditions available at the first moment before the work begins. These studies would be in form of analyzes: of the appropriate materials, correct proportions and monitoring of results, the costs of implementing the methodologies for the desired work, remuneration of specialized professionals involved in technical and economic studies in the design and execution, resulting in the viability of the choice adopted.

Thus, it is worth noting that the choice of concrete to be used depends on a large number of variables, some of which are not included in this work, such as execution time, foundation costs, among others. Therefore, this study did not intend to present valid results for all types of structures, but it serves as a parameter to assist professionals in the area during the preparation of a preliminary project.

VIII. FUTURE SCOPE

Suggested as subjects of studies for future works some subjects related to the adopted approach:

- Make a parametric study varying the lengths of the spans and the number of floors.

- Add cost of foundations.

- Quantify the production time of the execution of the structure.

- Include other structural systems, such as ribbed slabs.

ACKNOWLEDGEMENTS

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Error Analysis in the Resolutions of 1st Year High School Students in the Study of Notable Products and Polynomial Factoring

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Abstract— The present research had as objectives: to analyze successes and mistakes committed in the resolutions of 36 students of a class of the 1st year of High School, of a Pernambuco state school in the city of Petrolina; as well as, to present suggestions for investigations/ explorations, so that teachers who teach Mathematics can contemplate Error Analysis both in the methodological alternative of research, as in teaching, in Mathematical Education. For this aim, a student diagnostic questionnaire was proposed, from which 3 open questions were analyzed, the first sought to probe students' affirmations about the contents of polynomials and the last two of which dealt, in particular, with the contents of Notable Products and polynomial Factorization. From this analysis, 6 categories were created. By results, Categories D, C and B presented, respectively, the highest number of appearances, revealing a large number of mistakes in the distinction between polynomials and equations, in various algebraic manipulations and in the use of practical rules for the development of Notable Products.

I. INTRODUCTION

The present work is an extension of the scientific initiation research of the first author, by the Institutional Program of Scientific Initiation Scholarships (PIBIC) (PIBIC 2018 - 2019), funded by the National Council for Scientific and Technological Development (CNPq), a research that analyzed the contributions of the game Polinoquiz for the review of polynomial contents, in the 1st year of high school.

Regarding the contents of polynomials, the Parameters for Basic Education of the State of Pernambuco (Pernambuco, 2012) provide that these are initially seen, in the 8th year of elementary school, a constituent to the axis of Algebra and Functions. However, studies show (Booth et al., 2014; Cury, 2018; Guillermo, 1992; Nogueira et al., 2018; Ribeiro, 2001) that, often, these contents generate gaps, whether conceptual and/or procedural, in students, at the end of the final cycles of elementary school. Consequently, these gaps reflect on the learning of algebra in the later years of students' schooling, including higher education.

Thus, it is observed the importance that a teacher who teaches Mathematics knows both to identify the difficulties of students in the contents of polynomials, from their initial contact with such contents, and to choose appropriate teaching strategies in order to be met with such misunderstandings.

Thus, this research aimed to analyze correct answers and mistakes made by students of a class of the 1st year of high school, before their resolutions in a questionnaire containing 3 open questions, addressing, specifically, the contents of Notable Products and Polynomial Factoring. For the analysis of the resolutions of the students present in such questionnaires, we chose to use the trend in

Mathematical Education of Error Analysis, according to what the author Cury (2018) recommends. As well as, we sought to present suggestions for investigations/ explorations, so that teachers who teach Mathematics can contemplate Error Analysis in both the methodological alternative of research and teaching (Cury, 2018).

Regarding the structure of this research, initially, there is a brief presentation of the Analysis of Errors, followed by a discussion on this theme focused on the axis of Algebra and Functions, more specifically, with regard to Notable Products and Polynomial Factoring. Furthermore, the methodological paths of the research are explained. Soon after, the results and discussions are presented. Finally, a conclusion was made.

II. ERROR ANALYSIS AS A METHODOLOGY FOR RESEARCH AND TEACHING IN MATHEMATICS EDUCATION

Error Analysis is a research trend in Mathematics Education that has been consolidated in several countries throughout recent decades. In Brazil, there is a strong representation by the author Helena Noronha Cury who, since the second half of the 1980s, researches and guides in this area.

For Cury (2018), the Analysis of Errors, or rather, the Analysis of written productions of students, consists of a methodological alternative of research and teaching, in Mathematics Education. As a research methodology, it allows the teacher to take an in-depth and comprehensive look at the students' responses, both to the correct answers and to the errors, in the various resolution strategies presented by them, which reveal their forms of appropriation of a certain mathematical content (Cury, 2018; Lima & Moreira, 2019).

Concomitantly with the use of Error Analysis as a research methodology, it can unfold in a teaching methodology, since, in view of the errors and misunderstandings of the students' resolutions, it is possible that the teacher proposes investigations/explorations in the classroom, so that it is possible for students to use the error as a springboard for learning (Cury, 2018).

It is also a communication (often the only way) between the teacher and his students, in which the teacher has the opportunity to know the particularities of his students and to practice a relationship of companionship towards them (Lima & Moreira, 2019).

In this respect, the reflections of the author Luckesi (1999), about the role of error in school practice and in the evaluation of learning, add to the relevance that Error Analysis can assume, to break the paradigm that the mistakes made by students must result in punishments applied by teachers; punishments that generate, for example, feelings of tension, fear, anxiety and guilt, which imply traumas and limitations in learning and that mark the students' own lives.

On the other hand, according to Luckesi (1999), when students' mistakes are seen as sources of virtue, of growth, there is a fertile environment for learning, because: "The errors of learning [...] they serve positively as a starting point for advancement, to the extent that they are identified and understood, and their understanding is the fundamental step for their overcoming" (Luckesi, 1999, p. 57).

Thus, the use of Error Analysis in its entirety by teachers who teach Mathematics, that is, initially as a research methodology and, later, as a teaching methodology, can positively resignify behaviors in the face of errors in school practice.

III. A LOOK AT ALGEBRA ERROR ANALYSIS IN NOTABLE PRODUCTS AND POLYNOMIAL FACTORIZATION

The Common National Curriculum Base (BNCC) of Elementary School (Brasil, 2018, p. 268) recommends, for the thematic unit of Algebra, the development of students, of the so-called Algebraic Thought, concomitant with "the development of a language, the establishment of generalizations, the analysis of the interdependence of quantities and the resolution of problems through equations or ineptitudes". For this, for example, it is necessary that students establish "connections between variable and function and between unknown and equation" (Brasil, 2018, p. 269).

Thus, elementary part of the curricular requirements for the development of this Algebraic Thought comes from the study of polynomials (initial idea, sum operations, subtraction, multiplication, division, including Notable Products and Factoring) which, according to the Parameters for Basic Education of the State of Pernambuco (Pernambuco, 2012), are expected to be seen, initially, in the 8th year of Elementary School, being found in the axis of Algebra and Functions.

From the learning of polynomials, a student can procedurally learn other contents, such as equations, inequations and functions, in his other years of schooling; and also, possibly, in higher education, such as the disciplines of Algebra and Differential and Integral Calculus.

However, studies conducted from the perspective of Error Analysis reveal conceptual and procedural

misconceptions in the learning of polynomials, either in the Final Years of Elementary School (Booth et al., 2014; Ribeiro, 2001), in High School (Booth et al., 2014) or higher education (Booth et al., 2014; Cury, 2018; Guillermo, 1992; Nogueira et al., 2018).

Like Booth et al. (2014) point out that many higher education students in the United States present unsatisfactory results in the discipline of Algebra. The authors complement that one of the reasons for such a discipline is particularly challenging, is the fact that there is a deepening of the conceptual misconceptions that students have rooted in previous years of schooling. Hence, we notice the importance and relevance of an effective learning of polynomials in school mathematics.

Still, as for the results of Booth et al.'s research. (2014), these suggest that misconceptions related to the most persistent errors observed in students should be the targets of investigations, inside or outside the classroom; this is because, such misconceptions have shown that they are not simply addressed in a usual approach: a more directive approach is needed. Thus, the potentiality is reinforced, both for teaching and for mathematical learning, of the use of Error Analysis as a methodology of research and teaching.

IV.   METHODOLOGICAL PATHS

The present research is classified as the data collection procedures used as field, since it required "the realization of an experiment or the collection of empirical information/data or insertion/intervention in the environment to be studied" (Fiorentini & Lorenzato, 2012, p. 61). Also, regarding the nature of the data, the research had a qualitative approach. This choice proved to be adequate, because "understanding, with the interpretation of the phenomenon" (Gonsalves, 2011, p. 70) was sought.

The subjects involved with the research were 36 students from a 1st year high school class, from a school in the state school of the municipality of Petrolina, state of Pernambuco. Regarding the instrument used in data collection, a student diagnostic questionnaire was proposed, containing open questions. There was no interference from the researchers regarding the assistance to students in the resolution of the questions. In this work, we will only deal with three questions (see Appendix A): the first, concerning the students' statements about polynomials; the second, on Notable Products; and the third, regarding the contents of Polynomial Factoring.

For the interpretation of the data, Questions 2 and 3 of the student diagnostic questionnaire were analyzed through the theoretical perspective of Error Analysis, as a research methodology, proposed by Cury (2018). For this, as well as Cury (2018), a methodology of data analysis called Content Analysis was adopted. Regarding this analysis, the three stages proposed by Bardin (1979 as cited in Cury, 2018) were followed, which are: pre-analysis, exploration of the material and treatment of the results. Thus, 6 categories of analysis were created, based on student resolutions, as observed in Table 1.

Table. 1: Description of the categories of analysis

ANALYSIS CATEGORY	DESCRIPTION OF THE CATEGORIES OF ANALYSIS, WHICH CORRESPOND TO STUDENTS WHO:
Category A	They've reached correct resolutions.
Category B	They misused the practical rules to calculate the Notable Products of the Square Sum of Two Terms, the Square Difference of Two-Terms, or the Product of a Sum and Difference of Two Terms. For example, they summed or subtracted the square from the two terms inside the parentheses, in the calculation of the Square Sum of Two Terms and/or in the Square Difference of Two-Terms
Category C	They performed erroneous algebraic manipulations, either in the grouping of monomials, in the use of the distributive property, in the use of the "signal rule" or by Factoring polynomials using the method of factoring numbers into prime factors.
Category D	They found the right result, however, equaled it to zero in the end. Furthermore, in the Polynomial Factoring, in particular, they matched the polynomial given to zero and/or tried to calculate, whether right or wrong, the roots of this supposed equation.

Category E	Incorrect use of Polynomial Factoring by the cases of Common Factors, Perfect Square Trinomial and Factoring of the Trinomial Type: $x^2 + Sx + P$, in which S = sum and P = product of the two numbers chosen.
Category F	They presented erroneous resolutions, whose analysis was inconclusive.

Also, in the interpretation of the data, during the analysis made, some suggestions of teaching strategies were given that, perhaps, will help teachers who teach Mathematics to propose investigations/explorations, in order to reduce the mistakes made by students. Thus, it would be possible to glimpse, in fact, the Analysis of Errors as a methodology of Mathematics teaching, as Cury (2018) recommends.

V.   RESULTS AND DISCUSSIONS

In Question 1, in their first part, 29 students stated that they had already studied the contents of polynomials in their Mathematics classes, as opposed to 7 students, who left the question blank. However, 19 of the 29 students who claimed to have studied the contents of polynomials in the second part of the question said they did not remember such contents. Also, in relation to the second command of Question 1, 10 students presented a variety of statements about the contents of polynomials, such as:

"Yes, they are operations that involve letters and numbers, in which notable products are also presented that make it possible to develop the issues." (Student 2).

"These are operations that involve expressions." (Students 4 and 21).

"Polynomials are geometric shapes, by which we can define their area." (Student 22).

"Yes. They are calculations/resolutions, which use numbers and unknowns for their resolution." (Student 24).

"Polynomials are expressions that can have two or one variables. *I don't remember 🙁" (Student 27).

"It's a form of calculation using more than one 'letter' (I forgot the name)." (Student 30).

"Yes. They are variable terms that replace values in a mathematical expression." (Student 31).

"Polynomials are operations involving expressions with variables." (Student 32).

"Yes, in eighth grade. It is an equation that is squared and has two parentheses with numbers, variables and signs." (Student 36).

From these statements, it is observed that there are many misconceptions regarding concepts belonging to the contents of polynomials, such as: considering a polynomial as being an equation and, consequently, not distinguishing variable from unknown; this is different from what the BNCC (Brasil, 2018) recommends, because most of these students revealed that they did not establish the connections between variable and function; and between unknown and equation.

Starting with the analysis of Questions 2 and 3, Table 2 presents a number of blank questions, correct answers and errors by categories; in the latter, specifying the categories found in each item. Note that the number of correct answers per item was low, considering the total of 36 students in the class who answered the questionnaire. Furthermore, for a more detailed analysis of errors of Question 2, Table 3 provides examples for each of the items and categories found in them.

Table. 2: Quantitative of blank questions, correct answers and errors in the student diagnostic questionnaire

QUESTION	BLANK	HITS	ERRORS
2	a) 5 b) 3 c) 2	a) 13 b) 12 c) 13	a) 18 (11 Category B, 4 Category C, 2 Category D and 1 Category F) b) 21 (14 Category B, 1 Category C, 2 Category D and 4 Category F) c) 21 (1 Category B, 15 Category C, 2 Category D and 3 Category F)
3	a) 9 b) 14 c) 10	a) 7 b) 0 c) 2	a) 20 (3 Category C, 9 Category D and 8 Category F) b) 22 (3 Category C, 9 Category D, 7 Category E and 3 Category F) c) 24 (3 Category C, 13 Category D, 6 Category E and 2 Category F)

Table. 3: Examples of student resolutions in Question 02 in each of the categories of analysis

ANALYSIS CATEGORY	ITEM A	ITEM B	ITEM C
Category A	a) $(a+b)^2$ $a^2+2 \cdot a \cdot b + b^2$ $a^2 + 2ab + b^2$ The student used the Square Sum of Two Terms practical rule.	b) $(x-2)^2$ $(x-2)(x-2)$ $x^2 - 4x + 4$ The student used the distributive property.	c) $(a+7) \times (a-7)$ $a^2 - 7a + 7a - 49$ $a^2 - 49$ The student used the distributive property.
Category B	a) $(a+b)^2$ $a^2 + b^2$ The student added the square of the two terms inside the parentheses. a) $(a+b)^2$ $\boxed{a^2 + ab^2 + b^2}$ $(a+b) \cdot (a+b)$ The student mistakenly used the practical rule to calculate the Square Sum of Two Terms.	b) $(x-2)^2$ $x^2 - 4$ The student subtracted the square from the two terms inside the parentheses. b) $(x-2)^2$ $\boxed{x^2 - 2x^2 + 4}$ $(x-2) \cdot (x-2)$ The student misused the practical rule to calculate the Square Difference of Two Terms.	c) $(a+7) \times (a-7)$ $2a - 49$ The student misused the practical rule to calculate the Product of a Sum and Difference of Two Terms.
Category C	a) $(a+b)^2$ ab^2 The student performed grouping and erroneous potentiation of monomials.	b) $(x-2)^2$ $(x-2) \cdot (x-2)$ $x^2 + 2x + 2x + x^2$ $x^2 + x^2 + 2x + 2x$ $2x^2 + 2x$ The student was wrong to use the distributive property and grouping monomials.	c) $(a+7) \times (a-7)$ $(a+7)(a-7)$ $\boxed{a^2 - 7a} \times \boxed{7a - 49}$ a^2 Misuse of distributive property.
Category D	a) $(a+b)^2$ $\boxed{a^2 + b^2 + 2ab = 0}$ $(a+b) \cdot (a+b)$ $a^2 + ab + ab + b^2$ The student has correctly developed the Square Sum of Two Terms. However, it equaled the result found to zero.	b) $(x-2)^2$ $x^2 - 4x + 4 = 0$ $(x-2) \cdot (x-2)$ $\Delta = (-4)^2 \cdot 4 \cdot 1 \cdot 4$ $x^2 - 2x - 2x + 4$ $\Delta = 16 - 16$ The student has correctly developed the Square Difference of Two Terms. However, it equaled the result found to zero and began to calculate the roots of the supposed equation.	c) $(a+7) \times (a-7)$ $a^2 - 7a + 7a - 49$ $a^2 - 49 = 0$ The student has correctly developed the Product of a Sum and Difference of Two Terms. However, it equaled the result found to zero.
Category F	It presented erroneous resolution, whose analysis was inconclusive.	It presented erroneous resolution, whose analysis was inconclusive.	It presented erroneous resolution, whose analysis was inconclusive.

	a) $(a+b)^2$ [handwritten work]	b) $(x-2)^2$ [handwritten]	c) $(a+7) \times (a-7)$ [handwritten] $a \cdot a$

In item A, from the analysis of the resolutions of 31 students, five categories were observed:

Category A: Among the 13 students, 8 did algebraic manipulations that showed mastery of distributive property and the notion of grouping similar terms, presenting the resolution:

$(a+b)^2 = (a+b) \times (a+b) = a^2 + 2ab + b^2$ (whether in this order or not).

Also, it was possible to observe that two students (Table 3) used the practical rule to find the Square Sum of Two Terms. Still, three students presented the resolution $(a+b)^2 = (a+b) \times (a+b)$, which reveal the understanding of the Square Sum of Two Terms as a power; however, without developing it algebraically.

Category B: 11 students who obtained $a^2 + b^2$, $(a.a) + (b.b)$ and $a^2 + b^2$ (Table 3). This type of error was quite common in student resolutions, as well as the studies of Ponte at al. (2009); Ribeiro (2001) and Nogueira et al. (2018), in calculating the Square Sum of Two Terms.

Thus, as a teaching strategy, in order for students to overcome this conceptual misunderstanding, the teacher could propose an arithmetic analysis for this type of operation, before showing it in its algebraic form. For example: $(2+3)^2 = (2+3) \times (2+3) = 5 \times 5 = 25$, instead of $(2+3)^2 \neq 2^2 + 3^2 = 4 + 9 = 13$. In fact, the teacher could also show the practical rule for the resolution of the Square Sum of Two Terms in this arithmetic approach:

$$(2+3)^2 = (2+3) \times (2+3) =$$
$$(2 \times 2) + (2 \times 3) + (3 \times 2) + (3 \times 3) =$$
$$2^2 + 2 \times (2 \times 3) + 3^3 = 4 + 12 + 9 = 25.$$

The teacher should also show the geometric representations of these cases of Notable Products. In addition to relating two mathematical axes (Algebra and Geometry), the study of this representation contributes to a better understanding of equivalent algebraic expressions, as recommended by Ponte et al. (2009), when observing that, for example, $(x+y)^2 \leftrightarrow x^2 + 2xy + y^2$. This understanding is relevant both for the study of Notable Products and for Polynomial Factoring, especially in cases where these two behave as inverse operations.

There are several methodological alternatives for such geometric representation to be explored, such as the Algeplan didactic material, of accessible preparation, whose main objective is to relate rectangular geometric figures (squares or rectangles) with algebraic expressions (Rosa et al., 2006). To better know about Algeplan, it is recommended to read Rosa et al. (2006).

Still in Category B, 2 students obtained $a^2 + 2a + b^2$ and $a^2 + ab^2 + b^2$ (Table 3). As already said, by teaching strategy, the teacher could approach the origin of this practical rule, showing it arithmetic, algebraic and geometrically.

Through Category B errors, it can be insgiven that, as much as the practical rule can help in the resolution of this type of operation, it is susceptible to forgetfulness or misuse, especially if it has been "learned", initially mechanically, by memorization.

Category C: 4 students presented the result ab^2 (Table 3) revealing an erroneous algebraic manipulation by grouping non-similar terms and trying to square the result found. The error of grouping non-similar terms was also found in the Booth et al. (2014) results, Guillermo (1992) and discussed by Ponte et al. (2009).

Category D: 2 students obtained $a^2 + b^2 + 2ab = 0$ (Table 3). This need that many students have to always equal to zero the polynomial found, error, also, observed in the results of Booth et al. (2014) and Ponte et al. (2009), reveals a misunderstanding by not dissociating the concepts of polynomials and equations, whether in the first or second degree; and, consequently, in not distinguishing variable from unknown (Ponte et al., 2009).

Again, there is a distancing from what the BNCC (Brasil, 2018) recommends. In this case, as a teaching strategy, in view of the errors belonging to Category D, in general, the teacher could resume the concepts of polynomials and equations, so that the students perceive the difference between them.

Category F: 1 student started using the distributive property, but presented the following resolution:

$(a+b) \cdot (a+b) \Rightarrow (a^2 + 2ab) \cdot (2ab + b^2) \Rightarrow a^2 + b^2 = 4ab$

(Table 3). It is also noted that this student interpreted the

polynomial obtained as a second-degree equation. In all errors belonging to Category F, because they are very punctual errors, it is recommended that the teacher, if possible, talk in particular with students who present these types of resolution; this so that he understands the problem-solving processes used and so that he can think of teaching strategies to solve the misconceptions in learning.

Then, in item B, of the resolutions of 33 students, 5 categories were also observed:

Category A: 12 students showed mastery of distributive property and grouping (with the exception of one student, who did not group the similar terms): $(x-2)^2 = (x-2) \times (x-2) = x^2 - 4x + 4$ (Table 3). It was observed that two of these students used the practical rule to resolve the Square Difference of Two-Terms.

Still, 3 students presented the resolution $(x-2)^2 = (x-2) \times (x-2)$, which reveals the understanding of the Square Difference of Two-Terms as a power; however, without developing it algebraically.

Category B: 14 students, who presented, among the resolutions, the following: $(x.x) - (2.2), x^2 - 2^2$ (Table 3), $x^2 - 4$ or $x^2 + 4$. Results of this type were also found by Guillermo (1992) and Nogueira et al. (2018). In this case, also, the teaching strategies dictated in Category B of the previous item are used. Also, 2 students obtained: $x^2 - 2x + 4$ and $x^2 - 2x^2 + 4$ (Table 3), which suggest that the students tried to use the practical rule for the resolution of Square Difference of Two-Terms.

Category C: only 1 student, the result of which was $x^2 + 2x + 2x + x^2 \Rightarrow x^2 + x^2 + 2x \Rightarrow 2x^2 + 2x$ (Table 3). It is noted that the student presented errors in the use of distributive property, as also observed and discussed in Booth et al. (2014) and in Ponte et al. (2009); in addition to grouping non-similar terms.

Category D: 2 students obtained $x^2 - 4x + 4 = 0$ (Table 3). And in Category F, 4 students presented the following answers: x^2 (Table 3), $-x^2$ and $-2x^2$.

Then, in item C, of the resolutions of 34 students, it was possible to observe 5 categories:

Category A: 13 students who, through algebraic manipulations, showed mastery of distributive property and grouping (with the exception of one student, who did not group) of similar terms, reaching resolutions similar to: $(a+7) \times (a-7) = a^2 - 7a + 7a - 49 = a^2 - 49$ (Table 3). Still, one student hinted that he used the practical rule to resolve the Product of a Sum and Difference of Two Terms.

Category B: one student replied $2a - 49$ (Table 3). He may have tried to use the practical rule for the Product of a Sum and Difference of Two Terms by missing the square of the first term.

Category C: 15 students presented most of the errors in the use of distributive property, such as the resolution $a^2 - 7a - 7a + a^2 = a^2 + a^2 - 7a - 7a = 2a^2 - 14a$ and the resolution found in Table 3. In addition to these, 2 students mistakenly grouped the monomials of the factors, obtaining $7a \times (-7a)$. Also, three students presented the following resolution: $(a+7) \cdot (a-7) \Rightarrow (a^2 + 7a) \cdot (7a - 49) \Rightarrow a^2 + 14a - 49$

Still, two students who made incorrect use of the power property $a^m \times a^n = a^{m+n}$, presenting the following resolution: $(a+7) \times (a-7) = (a+7)^2$. Finally, a student, who made incorrect use of the Square Difference of Two-Terms and the Square Sum of Two-Terms for the Product of a Sum and Difference of Two Terms, obtaining:
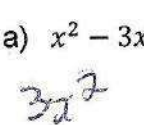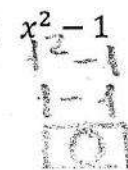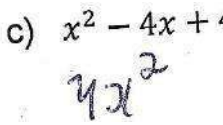
$(a+7) \times (a-7) \Rightarrow (a^2 + 2a + 7^2) \times (a^2 - 2a + 7^2)$.

Category D: 2 students, who obtained $a^2 - 49 = 0$ (Table 3). And in Category F, 3 students, who presented the answers: $a(7-7+a), a = 49/16a \cdot a$ and $a \cdot a$ (Table 3).

Also, for a more detailed Error Analysis of Question 3, Table 4 provides examples for each of the items and categories found in them.

Table. 4: Examples of student resolutions in the face of Question 3, in each of the categories of analysis

ANALYSIS CATEGORY	ITEM A	ITEM B	ITEM C
Category A	a) $x^2 - 3x$ The Common Factor case was used.	Category not contemplated in this item.	c) $x^2 - 4x + 4$ The case of Perfect Square Trinomials was used.
Category C	a) $x^2 - 3x$ Factored the polynomial using the method of factoring numbers into prime factors.	b) $x^2 - 1$ Factored the polynomial using the method of factoring numbers into prime factors.	c) $x^2 - 4x + 4$ Performed erroneous grouping of monomials.
Category D	a) $x^2 - 3x$ Factored correctly. However, it equaled the result found to zero and obtained the roots of the supposed equation. It equaled the polynomial given to zero and calculated the roots of this supposed equation.	b) $x^2 - 1$ It equaled the polynomial given to zero and calculated the roots of this supposed equation.	c) $x^2 - 4x + 4$ It equaled the polynomial given to zero and calculated the roots of this supposed equation.
Category E	Category not contemplated in this item.	b) $x^2 - 1$ Incorrectly used the case of Perfect Square Trinomial Factoring.	c) $x^2 - 4x + 4$ The student misused the case of Common Factor.

Category F	a) $x^2 - 3x$ It presented erroneous resolution, whose analysis was inconclusive.	b) $x^2 - 1$ It presented erroneous resolution, whose analysis was inconclusive.	c) $x^2 - 4x + 4$ It presented erroneous resolution, whose analysis was inconclusive.

In item A of the resolutions of 27 students, it was possible to observe 4 categories:

Category A: 7 students achieved the expected result for item: $x(x - 3)$ (Table 4). It was shown domain of the Common Factor Factoring.

Category C: 3 students, 2 of which understood the act of Polynomial Factoring as a factorization of numbers in prime factors (Table 4) finding varied results, such as $3x^2$. Another student showed knowledge of Common Factor Factoring; however, he performed an erroneous algebraic manipulation, obtaining: $x^2 - 3x = x(x - 3x)$.

Category D: 9 students, especially 2 students who obtained: $x(x - 3) = 0$ (Table 4). Of the remaining 7, 3 of these students (Table 4) came to find the two roots of the supposed second-degree equation. Another student obtained $x^2 = \frac{4}{3}$. And in Category F, 8 students presented the following answers: $(x - 1)^2$, $(x - 3)$, $x = 3$, $3x^2$ (Table 4), $-2x^2$, $2x$ and $-3x = \sqrt{x}$.

In item B of the resolutions of 22 students, it was possible to observe 5 categories:

Category C: 3 students, 2 of which, understood the act of Polynomial Factoring as a factorization in prime factors, finding x^2 (Table 4).

Category D: 9 students and one of them wrote $x^2 - 1 = 0$. Also, 5 students obtained $x = 1$, one of the roots of the supposed second-degree equation found (Table 4). The other students did not find the two roots of the supposed second-degree equation.

Category E: 7 students, 5 of which performed incorrect use of the case of Common Factor Factoring and, the other 2, in the case of Perfect Square Trinomial Factoring, obtaining: $x(x) - 1$; $x(x - 1x)$; $x(x - 0) - 1$ and $(x - 1)^2$ (Table 4). In Category F, 3 students presented the following answers: x^2, x and 0 (Table 4).

Finally, in item C of the resolutions of 26 students, it was possible to create 5 categories:

Category A: 2 students achieved the expected result for the item: $(x - 2)^2$ (Table 4); without showing, however, how they achieved this result. It is noteworthy that the Polynomial Factoring requested in this item consists of the inverse operation of item B of the previous question, to which these two students developed the Notable Product. Thus, it is possible that the hit of the first is related to the hit of the second.

If this was the case, it is observed that the understanding that $(x - 2)^2 \leftrightarrow x^2 - 4x + 4$, in fact, is relevant to the study of Notable Products and Polynomial Factoring, in specific cases in which the latter are reverse operations (Ponte at al., 2009).

Category C: 3 students who understood the act of Polynomial Factoring as a factorization in prime factors, finding $4x^2$; or who performed erroneous groupings between non-similar monomials, obtaining $6x$ (Table 4).

Category D: 13 students, 11 of which obtained at least one of the two roots of the supposed second-degree equation considered (Table 4). Among these, two came to calculate the delta value, but did not continue with the use of quadratic formula.

Category E: corresponds to 6 students, 5 of which made incorrect use of the practical rule of Polynomial Factoring by Common Factor, obtaining: $x(x - 4) + 4$ (Table 4); $x(-4x) + 4$ and one of them tried to solve by the case of Factoring of the Trinomial type $x^2 + Sx + P$. Finally, in Category F, 2 students who presented the resolutions $4x^2$ (Table 4); x^2 and x.

In order to demystify the errors observed in this Question 3, by teaching strategies, in addition to those already exposed in the previous question, the teacher could, as suggested in relation to the Notable Products: propose investigations/explorations regarding the arithmetic, algebraic and geometric representations of the cases of Polynomial Factoring. For geometric representation, it is also suggested the use of Algeplan didactic material (Rosa et al., 2006).

After the analysis of Questions 2 and 3, it was observed, from a general perspective, as revealed in Table 5, that the 3 most frequent types of errors were those belonging to Categories D, C and B, respectively.

Table. 5: Quantitative appearances of the categories of analysis.

ANALYSIS CATEGORY	Category A	Category B	Category C	Category D	Category E	Category F
QUANTITATIVE APPEARANCES	47	25	29	34	13	20

The most frequent errors, belonging to Categories D, C and B reinforce the conceptual misconceptions already observed in the student resolutions and discussed: before polynomials, despite correctly developing the Notable Products and correctly factoring the polynomials, the students, in the end, tend to match the result found to zero and to use resolutive processes to find the roots of the supposed equations; also, they presented several inadequate algebraic manipulations, such as the grouping of non-similar monomials and the use of distributive property; as well as, when using erroneously the practical rules for the development of Notable Products.

Finally, regarding the erroneous statements about the content of polynomials, presented in the answers of the 10 students mentioned at the beginning of this topic, in front of Question 1, it was observed in their resolutions that: only 3 of them fully agreed to Question 2 and one another correctly hit only item C of this question; and practically all of them presented erroneous resolutions to Question 3, except for one student who hit item A of the latter. Thus, before this cut out of 10 students, it can be said that conceptual errors were also accompanied by procedural errors; thus, showing a possible relationship between them.

VI. CONCLUSION

After the research, it is understood that it achieved its objectives, since a detailed and categorized analysis of the correct answers and errors present in the student resolutions was made, in view of the questions about Notable Products and Polynomial Factoring, thus exemplifying how Error Analysis works as a research methodology in Mathematics Education. It is notable that, although it is a particular sample, the categories presented are likely to be observed in other contexts and school grades.

Also, some suggestions of investigations/explorations were presented, so that teachers, who teach Mathematics, can contemplate the Analysis of Errors in their bias of teaching methodology. Thus, it is expected that this research can contribute to the daily professional practice of such teachers.

From perspectives of future work, similar Analysis of Errors, in its methodological bias of research and teaching, could be performed by teachers in the year that initially teaches the contents of polynomials, usually in the 8th grade, because the students' mistakes would be decreased more naturally, so that errors, instead of being condemned and punished, would serve as a springboard for learning (Cury, 2018; Luckesi, 1999) and, possibly, students would bring less of these errors to the other years and/or levels of their schooling.

APPENDAGES

Appendix A - Cut-out of the student diagnostic questionnaire proposed to students

Question 01. Have you ever studied polynomials in math classes? Write down everything you know about polynomials.

Question 02. Develop the following Notable Products:

a) $(a + b)^2$; b) $(x - 2)^2$; c) $(a + 7) \times (a - 7)$.

Question 03. Factor the following polynomials:

a) $x^2 - 3x$; b) $x^2 - 1$; c) $x^2 - 4x + 4$.

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Synthetic applications of Laccase and its Catalytic Potentials

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Abstract— *Laccases benzenediol: oxygen oxidoreductase (EC1.10.3.2), multicopper containing oxidoreductase enzymes, are able to catalyze the oxidation of various low-molecular weight compounds, specifically, phenols and anilines, while concomitantly reducing molecular oxygen to water. Because of their high stability, selectivity for phenolic substructures, and mild reaction conditions, laccases are attractive for fine chemical synthesis. This manuscript provides a discussion of the recent applications of this interesting enzyme in synthetic chemistry, including laccase and laccase-mediator catalyzed reactions. There for fungal laccases are consider as a perfect green catalysts is a prominent biotechnological applications. Thus laccases find potential applications in bleaching of paper pulp, biofuel cells and organic synthesis. They can perform transformations from the oxidation of functional group to the hetero nuclear coupling product of new antibiotics derivative.*

I. INTRODUCTION

Societal interest in green chemistry and advances in biotechnology have brought to the forefront the application of enzymes to address many of the challenges of modern synthetic organic chemistry. This multi-faceted challenge is being addressed by an ever-increasing suite of environmentally benign enzymes. Laccases (benzenediol: oxygen oxidoreductase[EC 1.10.3.2] belong to the multicopper oxidase family, along with such different proteins as plant ascorbic oxidase, mammalian ceruloplasmin ferroxidase from *Saccharomyces cerevisiae*, among others [1]. These copper containing enzymes catalyze the oxidation of various substrates with the simultaneous reduction of molecular oxygen to water [2]. *Yoshida* first discovered laccases in 1883 after observing that latex from the Japanese lacquertree (*Rhus vernicifera*) hardened in the presence of air [3]. This makes laccase as one of the oldest enzymes ever described. Since then, laccase activity has been found in plants, some insects [4], and few bacteria [5]. However, most biotechnologically useful laccases (i.e. those with high redox potentials) are of fungi origin. Over 60 fungal strains belonging to *Ascomycetes, Deuteromycetes* and especially *Basidiomycetes* show laccase activities. Among the latter group, white rot fungi are the highest producers of laccases but also litter decomposing and ectomycorrhizal fungi secret laccases [6].
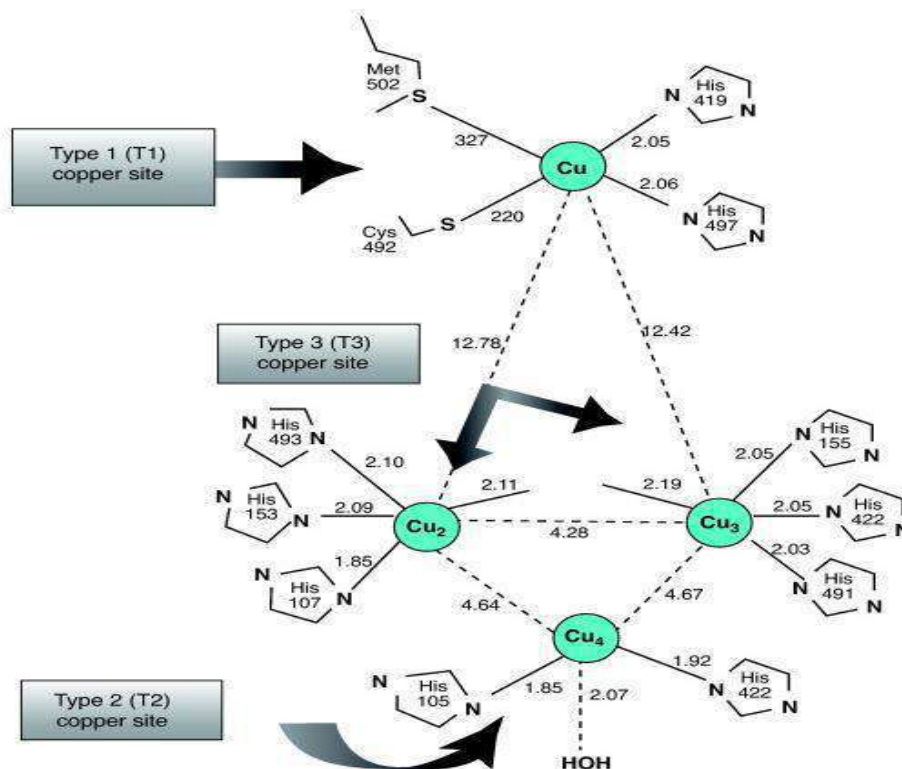
Fig.1: Scheme of Scheme of T1 (Cu1) and T2/T3 (Cu4/Cu2-Cu3) copper sites of laccase Cot A

from *Bacillus subtilis*, with indicated distances between the most important atoms

Laccases are typically monomeric extracellular enzymes containing four copper atoms bound to 3 redox sites (T1, T2 and T3). The termed blue copper at the T1 site because of its greenish blue colour in its oxidized resting state is responsible of the oxidation of the reducing substrate. The trinuclear cluster (containing one Cu T2 and two Cu T3) is located approx. 12 Å away from the T1 site, and it is the place where molecular oxygen is reduced to water [1] figure-1. Laccases catalyze one electron substrate oxidation coupled to the four electron reduction of O_2. It is assumed that laccases operate as a battery, storing electrons from the four individual oxidation reactions of four molecules of substrate, in order to reduce molecular oxygen to two molecules of water. Fungal laccases often occur as multiple isoenzymes expressed under different cultivation conditions. Most are monomeric proteins, although laccases formed by several units have been also described [7, 8]. They are glycoproteins with average molecular mass of 60-70 kDa, and carbohydrate contents of 10-20% which may contribute to the high stability of laccases. The covalently linked carbohydrate moiety of the enzyme is typically formed by mannose, N-acetylglucosamine and galactose. The amino acid chain contains about 520-550 amino acids including a N-terminal secretion peptide [4].

II. CATALYTIC PROPERTIES OF LACCASES AND MECHANISM OF CATALYSIS

Reduction of dioxygen blue copper-containing oxidases including laccases, there is no general opinion about the electron transfer pathway inside the protein globule and the mechanism of dioxygen reduction in the molecule. The T1 site of laccases is thought to accept electrons from reducing substrates, and then they are transferred onto the three nuclear T2/T3 cluster where molecular oxygen is activated and reduced to water. Interaction of a completely reduced laccase with molecular oxygen results in different forms of the enzyme. Two well-studied forms are termed peroxide intermediate and native intermediate. The native intermediate plays an important role in the catalytic cycle of laccase. During reaction with $^{17}O_2$, this intermediate acts as an oxygen radical shown in figure-2.
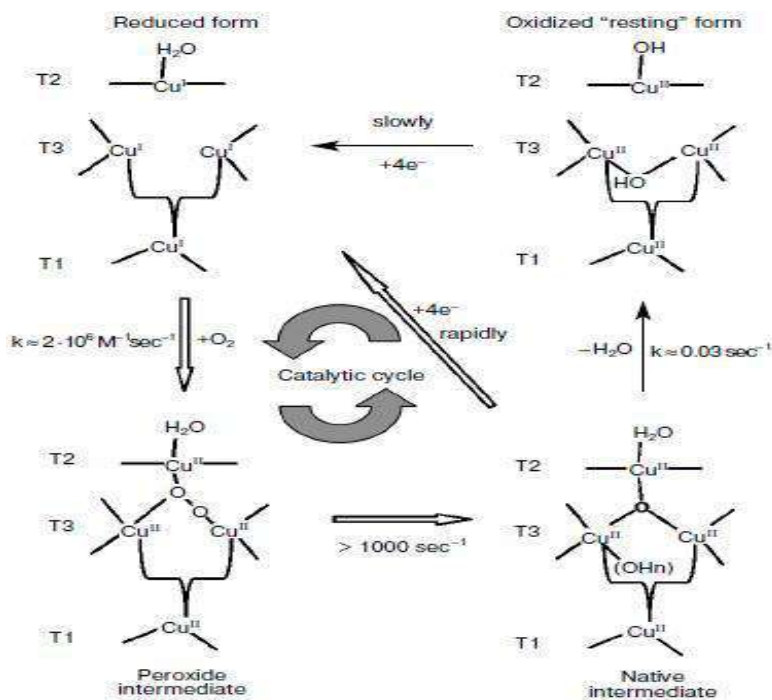
Fig.2: Catalytic cycle of laccase showing the mechanism of reduction and oxidation of the enzyme copper sites

III.   BIOLOGICAL FUNCTIONS AND INDUSTRIAL APPLICATIONS

Biological functions attributed to laccases include spore resistance and pigmentation [9, 10] lignification of plant cell walls [11] lignin biodegradation, humus turnover and detoxification processes [8] virulence factors [12] and copper and iron homeostasis [13]. Laccases exhibit an extraordinary natural substrate range (phenols, polyphenols, anilines, aryl diamines, methoxy substituted phenols, hydroxyindols, benzenethiols, inorganic/organic metal compounds and many others) which is the major reason for their attractiveness for dozens of biotechnological applications [14]. Moreover, in the presence of small molecules, known as redox mediators, laccases enhance their substrate specificity. Indeed, laccase oxidizes the mediator and the generated radical oxidizes the substrate by mechanisms different from the enzymatic one, enabling the oxidative transformation of substrates with high redox potentials otherwise not oxidized by the enzyme, figure 1A. The industrial applicability of laccase may therefore be extended by the use of a laccase-mediator system (LMS) figure-2 (A). Thus, laccase and LMS find potential application in delignification and biobleaching of pulp [15] treatment of wastewater from industrial plants [16] enzymatic modification of fibers and dye bleaching in the textile and dye industries [17] enzymatic cross linking of lignin based materials to produce medium

density fiberboards [18] detoxification of pollutants and bioremediation [19].

Detoxification of lignocellulose hydrolysates for ethanol production by yeast [20] enzymatic removal of phenolic compounds in beverages wine and beer stabilization, fruit juice processing [21] and construction of biosensors and biofuel cells [22]. In organic synthesis, laccases have been employed for the oxidation of functional groups [23] the coupling of phenols and steroids [24], the construction of carbon-nitrogen bonds [25] and in the synthesis of complex natural products [26] and more. As mentioned above, many of these applications require the use of redox mediators opening a big window for new biotransformation of non natural substrates towards which laccase alone hardly shows activity. On the other hand, in most of the cases large quantities of enzymes are required, which makes the efficient expression of laccase in heterologous systems an important issue. Moreover, the protein engineering of fungal laccases with the aim of improving several enzymatic features (such as activity towards new substrates, stability under harsh operating conditions *e.g.* presence of organic co solvents, extreme pH values-, thermo stability, and others) is a critical point in the successful application of this remarkable biocatalyst. All these issues are addressed in the following lines, paying special attention to their application in organic synthesis.

IV.   LACCASE MEDIATOR SYSTEM

The combination of the laccase with low molecular weight molecules such as 2,2'-azino-bis-(3-ethylbenzothi-azoline-6-sulphonic acid) (ABTS) or 1-hydroxybenzotria-zole (HBT) not only lead to higher rates and yields in the transformation of laccase substrates but also add new oxidative reactions to the laccase repertory towards substrates in which the enzyme alone had no or only marginal activity, figure-2 A, B. Thus, LMS enlarges substrate range being able to oxidize compounds with redox potential (E°) figure2(B) higher than that of laccase (typically, laccase E° at the T1 site is in the range +475 to +790 mV but the LMS allows to oxidize molecules with E° above +1100 mV) [27,28]. Besides, the mediator acts as a diffusible electron carrier enabling the oxidation of high molecular weight biopolymers such as lignin, cellulose or starch [1]. Hence, the steric issues that hinder the direct interaction between enzyme and polymer are overcome by the action of the redox mediator. LMS has resulted highly efficient in many biotechnological and environmental applications as regards the numerous research articles and invention patents published [29]. Many artificial mediators have been widely studied, from ABTS the first described laccase mediator [30], to the use of synthetic mediators of the type-NOH (such as HBT, violuric acid (VIO), N-hydroxyphtalimide (HPI) and N-hydroxyacetanilide (NHA), the stable 2,2,6,6-tetramethyl-1-piperidinyloxy free radical (TEMPO), or the use of phenothiazines and other heterocycles (*e.g.* promazine or 1-nitroso-naphthol-3,6-disulfonic acid) [18] figure-2 (A) . More recently, complexes of transition elements (polyoxometalates) have been also demonstrated to mediate lignin degradation catalyzed by laccase [31]. The choice of a proper mediator (over 100 redox mediators have been described [32] represents a key consideration for a given biotransformation. The use of different mediators may yield different final products when using the same precursors. This is basically due to the fact that substrate oxidation in laccase mediator reactions occurs via different mechanisms. The mediator radicals preferentially perform a specific oxidation reaction based on its chemical structure and effective redox potential (or dissociation bond energy) [33].

Despite all the associated advantages of LMS, there are two major drawbacks hindering the use of mediators: they are expensive and they can generate toxic derivatives. Moreover, in some cases, while oxidizing the mediator, laccase is inactivated by the mediator radicals, or the latter can be transformed into inactive compounds with no more mediating capability (*e.g.* generation of benzotriazol from HBT by losing the hydroxyl group). Last trends are focusing in the use of low-cost and eco-friendly alternative mediators in this sense, several naturally occurring mediators produced by fungi (phenol, aniline, 4-hydroxy benzoic acid and 4-hydroxybenzyl alcohol) have been identified. More recently, phenolic compounds derived from lignin degradation (such as acetosyringone, syringaldehyde, vanillin, acetovanillone, ferulic acid or *p*- coumaric acid) have been demonstrated to be highly efficient laccase mediators of natural origin (even better than the powerful artificial ones) for dye decolorization, removal of polycyclic aromatic hydrocarbons, pulp bleaching and pitch removal [34]. These natural compounds can be obtained at low cost due to their abundance in nature and also in industrial paper pulp wastes, smoothing the progress to a more environmental friendly and sustainable white biotechnology processes figure-3.
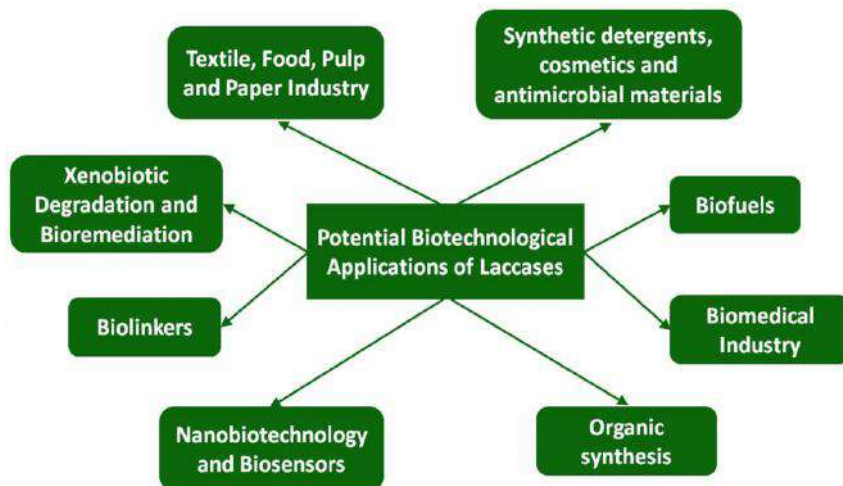
Fig.3: Potential biotechnological applications of laccase enzyme

V. APPLICATIONS OF LACCASES IN ORGANIC SYNTHESIS

Organic synthesis of chemicals suffers from several draw backs, including the high cost of chemicals, cumbersome multi step reactions and toxicity of reagents [2]. Laccases might prove to be very useful in synthetic chemistry, where they have been proposed to be applicable for production of complex polymers and medical agents. Indeed, the application of laccase in organic synthesis has arisen due to its broad substrate range, and the conversion of substrates to unstable free (cation) radicals that may undergo further non-enzymatic reactions such as polymerization or hydration figure-4.
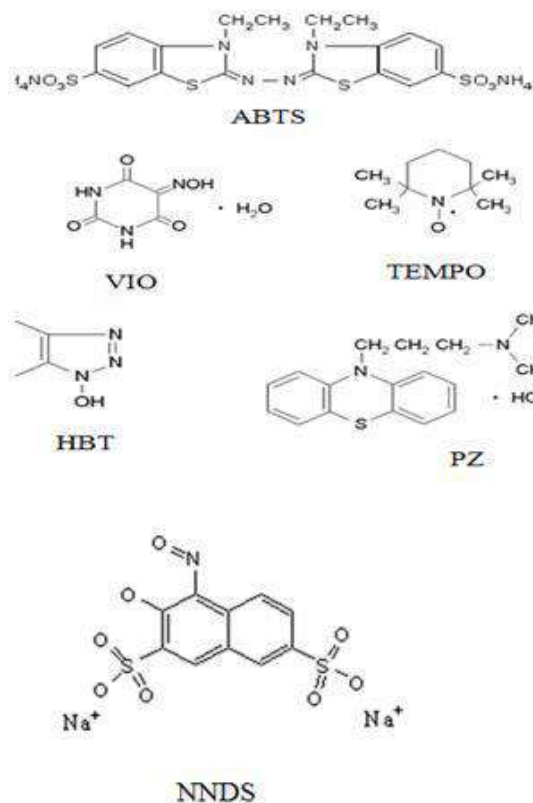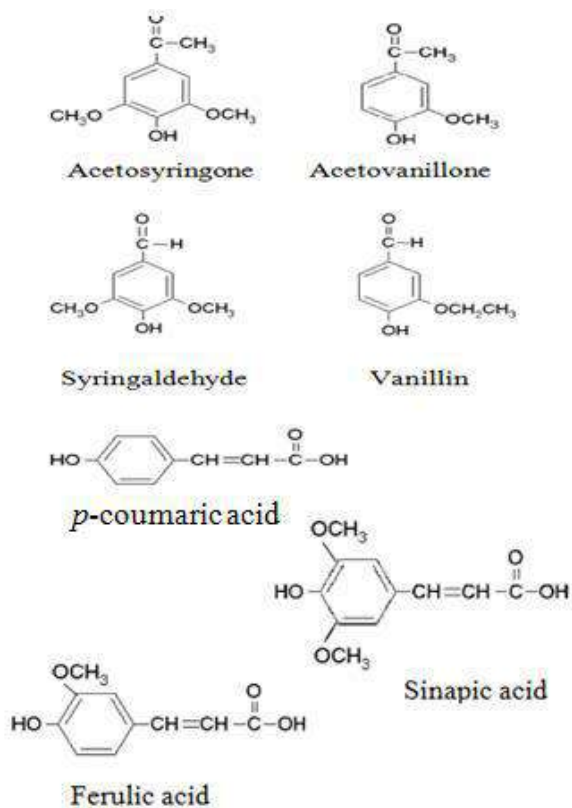
Fig.4: Structure of some artificial [ABTS, HBT, Violuric acid VIO-, TEMPO, pyromazine, 1-nitroso-naphthol-3, 6-disulfonic acid-NNDS] and lignin derive derived natural mediators [acetosyringone, syringaldehyde, vaniline, acetovanlone, p-coumaric acid, ferulic acid and sinapic acid]

VI. LACCASES FOR ENZYMATIC POLYMERIZATION

Enzymatic polymerization using laccases has drawn considerable attention recently since laccase or LMS are capable of generating straight forwardly polymers that are impossible to produce through conventional chemical synthesis [35]. For example, the polymerization ability of laccase has been applied to catechol monomers for the production of polycatechol [36]. Polycatechol is considered a valuable redox polymer; among its applications are included chromatographic resins and the formation of thin films for biosensors. Former methods for the production of polycatechol used soybean peroxidase or horseradish peroxidase (HRP), which suffers from the common suicide H_2O_2 inactivation. The main limitation of all heme containing peroxidases is their low operational stability, mostly due to their rapid deactivation by H_2O_2 with half lifes in the order of minutes in the presence of 1 mM H_2O_2 [37]. Inert phenolic polymers, for example poly (1-napthol), may also be produced by laccase catalyzed reactions [38]. These polymers have application in wood composites, fiber bonding, laminates, foundry resins, abrasives, friction and molding materials, coatings and adhesives [39].

The enzymatic preparation of polymeric polyphenols by the action of laccases has been investigated extensively in the past decades as a viable and non-toxic alternative to the usual formaldehyde based chemical production of these compounds [40]. Poly (2,6-dimethyl-1,4-oxy-

phenylene) poly(phenylene oxide), PPO-, is widely used as high-performance engineering plastic, since the polymer has excellent chemical and physico mechanical properties. PPO was first prepared from 2,6-dimethylphenol monomer using a copper/amine catalyst system. 2,6-Dimethylphenol was also polymerized through HRP catalysis to give a polymer consisting of exclusively 1,4- oxyphenylene units [41]. On the other hand, a small amount of Mannich base and 3,5,3'5'-tetramethyl-4,4'- diphenoquinone units are contained in the commercially.

VII.   OXIDATIVE TRANSFORMATION OF ORGANIC COMPOUNDS BY LACCASE ENZYME

Laccases have been used to synthesize products of pharmaceutical importance. The first chemical that comes to mind is actinocin, synthesized via a laccase catalyzed reaction from 4-methyl-3-hydroxyanthranilic acid as shown in figure 7A. This pharmaceutical product has proven effective in the fight against cancer as it blocks transcription of tumor cell DNA [42]. Other examples of the potential application of laccases for organic syntheses include the oxidative coupling of katarantine and vindoline to yield vinblastine. Vinblastine is an important anticancer drug, especially useful in the treatment of leukemia. Vinblastine is a natural product that may be extracted from the plant *Catharanthus roseus* figure-5 and 6.
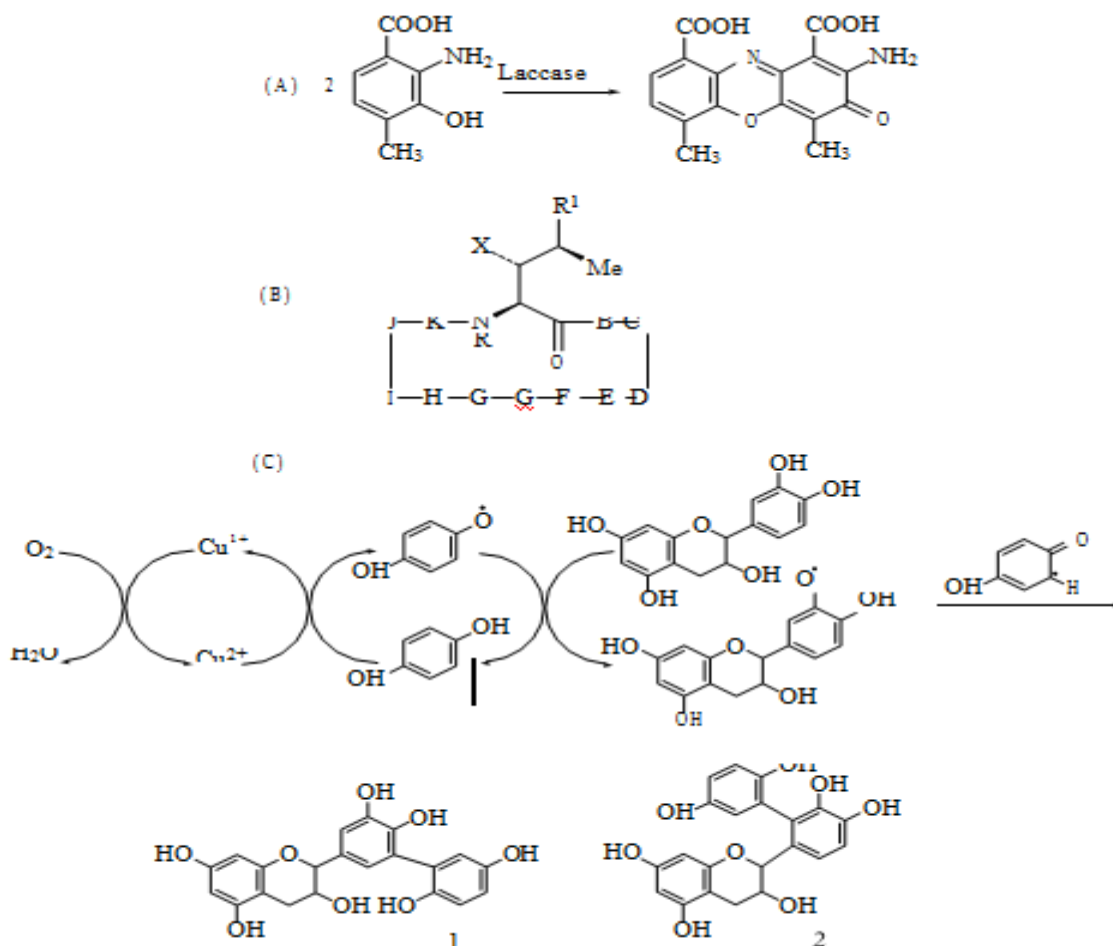
Fig.5: (A) Synthesis of actinocin via a laccase catalysed reaction, (B) Synthesis of novel cyclosporine reaction product obtained from cyclosporine A by HBT mediated laccase oxidation, (C) Products obtained by the laccase/hydroquinone mediated oxidation of (+) catechin.
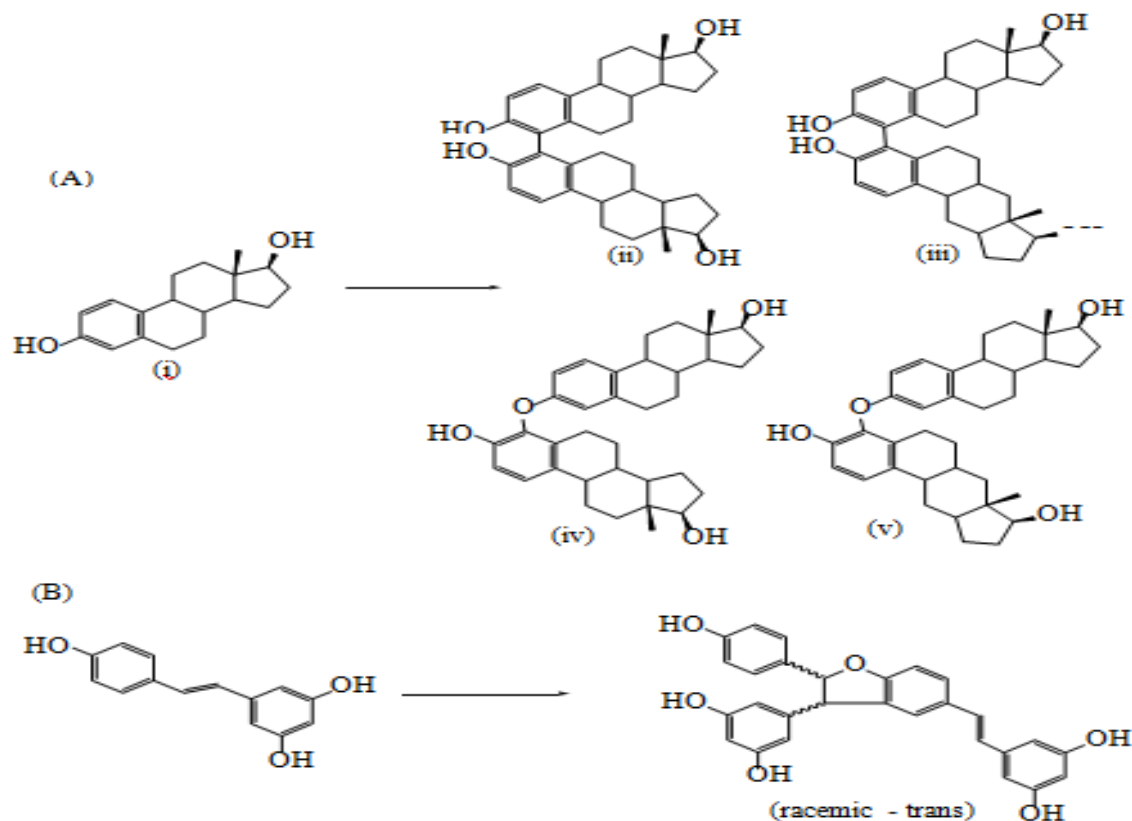
Fig.6: (A, ii-v) Dimeric products obtained by the oxidationof β-estradiol, (B) Dimeric product obtained by the oxidation of the phytoalexin resveratrol.

The compound is however only produced in small quantity in the plant, whereas the precursors-namely katarantine and vindoline are at much higher concentrations, and thus are relatively inexpensive to obtain and purify. A method of synthesis has been developed through the use of laccase with preliminary results reaching 40% conversion of the precursors to vinblastine [2] figure 6. Laccase coupling has also resulted in the production of several other novel compounds that exhibit beneficial properties, e.g. antibiotic properties.

VIII. CONCLUSION

This manuscript demonstrates the usefulness of the laccase in recent synthetic applications. Laccase or laccase mediator systems it provide alternative, environmentally friendly, oxidation methods that can be used to replace a host of traditional chemical oxidants for a wide range of substrates. This increased application of laccase in organic synthesis will future as our understanding of the enzyme structure and mechanism and new laccases are discovered. It is anticipated that the reaction conditions under which laccase performs will be broadened and this will open further research opportunities. In addition, it is also used in fast moving consumer goods (FMCG) as tooth paste, mouthwash, detergent, soap, and diapers in cosmetics as deodorants; in beverage and food industry for wine and juice stabilization.

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Feasibility of agricultural transition in family agriculture

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Abstract—*The agroecological transition is a slow, non-uniform agricultural, political, economic and socio-cultural process. In Brazil, the diversities are proportional to the size of the continent, a fact that makes it important to report the most diverse successful experiences in order to contribute to the construction of this transition process. Considering the need for a transition with biological efficiency and respect for sustainability, several properties have opted for a change in their "conservative status". From the articles found, the study of Silva; Gemim; Silva (2020) entitled "The complexity of four practical experiences", published in the GeoPantanal Journal in 2020 was selected to demonstrate characterization of all stages, dimensions and levels of agroecological transition. Thus, this article aims to identify the agroecological transition processes in family farming. The picked study brings production units in different transition stages that made it possible to achieve a proposal to identify the transition processes. Of the four producing units, we chose to analyze the exemplary case of unit 3, as it characterized all stages, dimensions and levels of agroecological transition. There was a comparison of the data found with the bibliographic review pertinent to the theme, showing that a successful agroecological transition is possible and providing information to farmers who choose the agroecological transition.*

I. INTRODUCTION

The agroecological transition supports a sustainable approach to food cultivation as a result of negative social and environmental effects already experienced by conventional agriculture, and shows that profits can be obtained in a new way with the promotion of environmental sustainability (SILVA; GEMIM; SILVA, 2020).

For Santos et al. (2014), after the negative environmental and social impacts of the end of the twentieth century, due to the Green Revolution, agroecology emerges placing sustainability as a key point in agriculture and rural territorial development.

The social sciences and earth sciences come together in search of a sustainable goal for both points of view. It is a civilizing change in search of preserving the planet. In this model, peasant communities with their ancestral practices

of land and animal management, as well as cultural diversity and popular knowledge, strengthen agroecology and fit as an agroecological model that can be used as a guide in the transition period, respecting the particularities of each reality (LEFF, 2011; SILVA; GEMIM; SILVA, 2020).

According to Caporal and Costabeber (2004), the agroecological transition is a non-uniform process. In Brazil, the dimensions are territorial: each region's particularities are innumerable and the successful experiences have inestimable value to assist other farmers who still are on this transition journey. Therefore, as an object of analysis, the unit described is located in the city of Barra do Turvo, São Paulo, with an area of 43 bushels, obtained in the early 1990s. It happens in the period of 1986, when the Report appeared Bruntland, putting sustainability as a key point in agriculture, and rural territorial development. At that time, the family invested in cattle breeding, but due to factors such as: relief, soil type and environmental degradation, they started to look for production alternatives more suited to the local reality.

Therefore, a family member participated in a course on agroforestry and decided to work with the theme. Together with other farmers and technicians, in 2003 they created the Agroforestry Farmers Association of Barra do Turvo and Adrianópolis (COOPERAFLORESTA) and the Agroforestry Center of the Ecovida Agroecology Network.

As of 2009, the property becomes a training center in agroforestry, organizing courses, experiences and exchanges.

II.   METHOD

This is a case study, addressing the technical and socio-ecological processes that characterize the levels of agroecological transition, comparing this information with the bibliographic review relevant to the theme in Scielo, CAPES and Google Escolar databases in the months of January and February 2021.

According to Gil (2002), the case study is a modality of research that consists in the deep and exhaustive study of one or a few objects so that allows its broad and detailed knowledge.

A general characterization of the experience was carried out, covering several aspects such as: context, history, subjects involved, organizations, sources of resources, time, results achieved, as well as the technical and socio-ecological processes that characterize stages, dimensions and levels of transition were identified and discussed. In addition, the limits and possibilities of the

experience and their contributions to the debate on the Agroecological Transition were analyzed.

III.   DISCUSSION AND RESULTS

3.1 Identification of Technical and Socio-Ecological Processes that characterize the Transition Levels

Food systems are in a critical situation and thus the populations of the countryside and the city are directly affected by this situation (SIMÃO; NUNES, 2020). In contrast to the conventional model employed, the use of a production system based on organic agriculture and agroecological practices are proving to be viable solutions to be adopted at local cultures (GERMINO et al. 2015). The use of agroecological techniques by farmers in their production systems and the consumption of these foods by the population can also be seen as a strategy that, adopted by the population, can assist in health and sustainability promotion. (SIMÃO; NUNES, 2020).

Agroecology is a technique used by the population, especially in small towns and communities, where spaces are formed for the exchange of knowledge that provide a new interaction between producers and consumers (SIMÃO, 2020). Agroecology proposes a set of participatory principles and methodologies that support the process of transition from conventional agriculture models to a style of agriculture and sustainable rural development (AGUIAR et al. 2017).

In this sense, Schmitt (2013) states that the transition to sustainable agriculture based on agroecological approaches, encompasses a complex reflection of the correlation between the modes of production and social organization characteristic of family farming, and the management of agroecosystems based on ecological principles.

Unlike conventional agriculture, ecologically-based production does not follow ready-made packages: the way forward depends on each property and producer, on their specific characteristics on the use of modern inputs, on investment conditions, on the local market, on knowledge and available technical assistance (FEIDEN; BORSATO, 2011). In this scenario, agroecology has increasingly become a necessity in order to achieve more sustainable agricultural systems, not only nationally but worldwide, in view of the reality of the depletion of natural resources that is occurring all over the planet. Reading the agroecological transition in different realities is the key to understand the complexity of the factors that influence this process (SILVA; GEMIM; SILVA, 2020).

In this context, in order to understand the processes involved in the agroecological transition, an

agroecological transition experience was identified on an unit focused on agroforestry systems and experiences on the topic located in the city of Barra do Turvo, SP, in the region of Vale do Ribeira (UF3). This experience is being reported in Silva's Gemim; Silva's study (2020) together with 3 more experiences in other units of farming families which were selected for having characterized the phases of the agroecological transition.

The discussion about the technical and socio-ecological processes that characterize stages, dimensions and levels of transition was based on the description of Gliessman (2000; 2010), which didactically describes the agroecological transition on four levels: (i) Level 1: Advanced, increasing the efficiency of conventional practices in order to reduce the use and consumption of scarce, expensive or environmentally harmful inputs, that is, for situations where each stage is identified in its entirety; (ii) Level 2: Partial - Substitution of conventional inputs and practices with alternative practices, that is, partial, for cases in which activities are in progress, but less intensely; (iii) Level 3: Initial - Redesign of the agroecosystem so that it works based on a new set of ecological processes, that is, where actions happen sporadically or moderately; and (iv) Level 4: Without starting - Reestablishing a more direct connection between those who grow the food and those who consume, that is, without starting, relative to the scenarios in which no procedures were identified.

According to what was described in the experience report at UF3, the agroecological transition of the property was entirely without the use of any input or management technique that was not agroecological. This decision was also taken by all members of COOPERAFLORESTA. These families opted for the full transition and showed that it is possible to initiate a total change and obtain achievements.

3.2 Transition process levels of the studied family unit

The first efforts related to Level 1 of conversion were focused on enhancing forest succession as the main source of energy for the transition of the system. This first phase in the transition process refers to increasing efficiency in the use of inputs, and for that, the cultivation system was redesigned resulting in a set of landscapes formed by agroforestry of different ages, areas of regenerating forests, an "agrosilvopastoral" system and a space for pig breeding.

This local transformation into an agroforestry mosaic provided a greater input of inputs from the pruned material from the trees. In addition, they used in a small amount the natural phosphate, poultry litter and limestone, together with a compost made in the unit based on swine manure and straw.

At Level 2 of conversion aims to replace products and practices that use a lot of resources and degrade the environment with those which are more benign from the environmental point of view. At this level, partial or total tree pruning techniques were used, where they opened gaps in agroforestry or in regenerating forests.

The pruned material was neatly placed on the ground with the help of a machete and chainsaw. Depending on the availability of input and the fertility of the place, natural phosphate and limestone were also spread. Then species of short, medium and long cycles were planted, seasonally selective weeding and pruning were performed for maintenance and availability of inputs.

At Level 3, the property is redesigned, integrating Levels 1 and 2 which, according to Gliessman (2015), works based on a new set of ecological processes. At this level, the fundamental changes in the general design of the system made it possible to eliminate the root causes of many of the problems that still exist at Levels 1 and 2. In the UF3 experience, the redesign of the property was established for all families that were part of COOPERAFLORESTA: the crop systems have been redesigned and transformed into agroforestry of different ages, regenerating forest areas, an "agrosilvopastoral" system and a space for pig breeding.

Regarding level 4, even if the central element of the transition at that level is to imitate the natural ecosystem, that is, a forest, there were simultaneous actions related to the regional reorganization, such as the construction of a marketing channel, landscape redesign and integration between them.

In addition, another level of transition was identified, Level 5, described by Titonell (2019) as socio-ecological processes that are generated by external stimuli such as market opportunities, regulation or legislation, or intrinsic, associated with aspirations, objectives and values rural families, communities or individual producers. At Level 5, the families involved in the conversion process are involved in issues related to sustainability, as well as more complex social issues. Through the actions carried out by COOPERAFLORESTA, the farming families established a strong relationship with the articulated society through visits, exchanges and experiences, local representatives constantly participate in awareness-raising activities, courses and in other contexts: one of the most important COOPERAFLORESTA contribution.

As a new field of study, the transition model as a whole can contribute to the design of sustainable rural development strategies, reinforcing the need to build and

reconstruct the knowledge of the local population, as a basic strategy for agroecological transition processes (GUZMÁN, 2001).

In general, agroecology brings the idea and the expectation of being a new agriculture, capable of doing good to society and the environment as a whole, and capable of moving away from the orientation of dominant agriculture, which is intensive in capital, energy and non-renewable natural resources, in addition to being aggressive to the environment, exclusion from the social point of view and causing economic dependence (CAPORAL; COSTABEBER, 2002).

It is important mentioning that the experiences mentioned by the family unit are a situation where the agroecological transition was carried out in the most efficient way possible. When there are real efforts to promote agroecological transition at the community, territorial or regional level, whether through development projects or public policies, it is important to characterize the community's agroecological starting point. In such cases, at least three types of producers usually appear: (i) those who are in agroecological transition as a result of a conscious and planned choice; (ii) those who are not in transition and (iii) those who are in advanced stages of agroecological transition, or who directly employ an agroecological management approach, but without knowing, or having never heard of the term agroecology (TITTONELL, 2019).

The experience of the agroecological transition presented here aimed at reducing and replacing synthetic inputs and use agroecological alternatives for fertilizing the soil and plants in family agricultural production systems. In view of the correct knowledge of what agroecology is essential to rectify some conceptual misconceptions that can often hinder the advancement of the agroecological transition (CAPORAL, 2009), it is increasingly necessary to propose appropriate public policies for development. family farming, adaptation and coexistence with different biomes in addition to promoting Agroecology, as a sustainable local/regional development strategy through the agroecological transition (FREITAS et. al, 2015).

1.3 Limits and possibilities for agricultural transition

The Agroecological Transition, due to its complexity, can't be understood in a single and linear model. The environmental conditions of the property, local climatic conditions, norms and regulations are some of the aspects that can configure a multiplicity of forms or models that make this transition possible in a productive unit. It is in this perspective of complexity that it is possible to consider some limits to the implementation of the

agroecological transition to the farmer and family's farmer, without losing sight of the possibilities that contribute to the optimization of the process and to the improvement of productivity, both in the quality of the product as in preservation and conservation of available natural resources.

The challenges of an agroecological transition can start from what can be called the "cultural tradition" passed on to each generation, which constitute traditional or conventional models, which are judged as more comfortable options, which require less effort when compared to the transition that takes place in a gradual process of changes and restoration of the natural environment, restoring its structural functions in its biodiversity, as well as in the physical-chemical properties of the soil and water.

The efforts that promote the agroecological transition also present themselves as limits, given that the farmer, according to Tittonnell (2019), should invest more time and labor.

Starting from the levels of agroecological transition, addressed by Gliessman (2002), Level 3, which deals with the redesign of the agroecosystem to function based on a new set of ecological processes, is considered by Tittonnell (2019) as the starting point of the transition, followed due to the change in management practices; however, it is another point that imposes limitation since many producers consider it more difficult to redesign the system than to adopt new practices gradually. Perhaps this point can be analyzed from the perspective that changes can cause insecurities in the process and the adoption of a more gradual work helps familiarize and more concretely visualize the benefits that a sustainable agro-ecosystem can offer.

The redesign of the agro-ecosystem adopted as the beginning of the transition could allow the resolution of situations that would eliminate possible problems that still exist at Levels 1 and 2, avoiding the appearance of other problems, in a preventive way. In this sense, Hill (1985) points out that in a redesigned agro-ecosystem it is necessary to invest time so that the environment can act naturally, maintaining the integration of the elements present, respecting the cycles and limits; crop rotation, and consortia as sustainable practices.

In addition to the efforts mentioned above, another aspect that deserves attention in the transition process, when in the interest of family farmers, is the low availability of accessory technologies, especially in the period when replacing chemical inputs with natural ones, considering that the replacement of some of these chemical inputs doesn't necessarily means changes in the production

system; this is still a very delicate moment, as they can cause a certain economic and productive vulnerability if there is no adequate planning for such a situation.

Silva et. al (2020), in their study to understand the complexity of the factors that influence the agroecological transition process, bring the example of some small producers who presented themselves in different stages of the transition: Family Unit 3 (UF3) is the one that has made the most progress making integrally the transition to agroecological production.

However, it is important to note that the process presented as one of the limits to the replacement of cattle raising by an agroforestry system. This was due to the initial need for survival of UF3 given the difficulties with the relief of the region, the type of soil and environmental degradation.

Starting from this initial need, there was an insight to create, in 2003, the Association of Agroforestry Farmers of Barra do Turvo and Adrianópolis (COOPERAFLORESTA) and the Agroforestry Center of the Ecovida Network of Agroecology, opening opportunities for the creation, in 2009, of a center of training in agroforestry. Another important point that deserves to be highlighted at UF3 was the need for inputs to be generated by family units and for agroecological techniques to be worked on throughout the process (full transition): this was defined as a limit that could not serve two gentlemen, that is, to practice the technological package of the green revolution and make use of agroecology in different spaces within the same family context.

IV.　FINAL CONSIDERATIONS

4.1 Contribution to the debate on the Agroecological Transition

UF3 includes all the attributes of the agroecological transition at an advanced level, showing that it is possible to initiate a total change and obtain excellent results. The agroecological transition of UF3 suggests that the unit contemplated the stages for such a process, namely: substitution of inputs, diversification and integration of activities, redesign of the landscape, complex production systems and regional reorganization.

There is a strong relationship between UF3 and articulated society through visits, exchanges and experiences. Local representatives frequently participate in awareness-raising activities in other discussion spaces, also contributing to the formation of COOPERAFLORESTA. The relationship with other producers also occurs with the development and

socialization of technologies for planting and transporting production.

From the ecosystem's point of view, the complexity of the agroecological transition, in itself, is challenging and is also necessary because it is the most sensible moment of the relationship between mankind and the environment.

Although several models are adopted to better suit local and territorial realities, the fact is that the transition requires a joint effort where not only changes the production system, but also an organizational effort of development policies, given that the many that occur in the local landscape go beyond the physical limits of the family unit and should add other units in the surroundings, which consequently will be reflected in the issues of marketing and adding value to products originating from sustainable agro-ecosystems.

According to Tittonnell (2019), the political-institutional transition takes place on a territorial scale, but also on a regional or national scale and is strongly linked to the generation of favorable situations for all levels of transition to occur. This transition occurs through incentives, opportunities, regulations which in general can promote the implementation of public policies, the rules that emerge in distribution and commerce's sectors of or the collective action of various organizations that represent and channel social demands.

The author also considers that the political-institutional transition may foster a transformation, not only of the productive systems but also of the agro-food system, going through socio-environmental, economic, political-cultural issues, being an agenda for debates in the agroecological transition processes.

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Evaluation of the Sexual and Urinary Functions of Transsexual Women

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Abstract— The number of transsexual people who choose transsexualizing procedures has grown in recent years. These processes are associated with several changes in their anatomy, as well as sexual and urinary function. This study proposed to identify the sexual and urinary functions of transsexual women. Two transsexual women who underwent sexual reassignment surgery participated in the study. We used the questionnaires: Female Genital Self Image Scale (FGSIS), Female Sexual Distress Scale (FSDS-R), Female Sexual Function Index (FSFI), Three Questions Incontinence Test (3IQ), Protection, Amount, Frequency, Adjustment, Bodyimage (PRAFAB). Excel software was used for data entry, preparation of tables and descriptive statistical analysis. One of the participants is neither satisfied nor comfortable with the appearance of her genitals and even feels ashamed. Satisfaction with sexual intercourse is impaired in both participants, who had a high score on the FSDS-R.Asin the FSDS-R, the total score on the FSFI characterizes the participants as havinga sexual dysfunction. The most compromised domain for both was satisfaction. Pain and arousal were scored more by one of the participants. None of the participants, according to the 3IQ test, reported urine leakage, so it is not possible to apply PRAFAB. The sexual function of the transsexual women in this study was altered. There was no change in urinary function.

Resumo— O número de pessoas transexuais que optam pelos procedimentos transexualizadores cresceu nos últimos anos. Esses processos estão associados a diversas mudanças em sua anatomia, função sexual e miccional. Este estudo propôs identificar as funções sexuais e miccionais de mulheres transexuais. Participaram do estudo duas mulheres transexuais que se submeteram a cirurgia de redesignação sexual. Foram utilizados os questionários: Female Genital Self ImageScale(FGSIS), Escala de Desconforto Sexual Feminino (FSDS-R), Índice de função sexual feminina (FSFI), Teste de Três Perguntas sobre Incontinência (3IQ), Protection, Amount, Frequency, Adjustment, Bodyimage (PRAFAB). Foi utilizado o software Excel para entrada dos dados, confecção das tabelas e análise estatística descritiva. Uma das participantes não

está satisfeita com a aparência de sua genitália, bem como não se sente confortável com a mesma, chegando a sentir vergonha. A satisfação com a relação sexual está prejudicada em ambas as participantes, que tiveram um escore alto no FSDS-R.Da mesma forma que no FSDS-R, o escore total no FSFI caracteriza as participantes com disfunção sexual. O domínio mais comprometido para ambas foi satisfação. A dor e a excitação foram mais pontuadas por uma das participantes. Nenhuma das duas participantes, de acordo com o teste de 3IQ, relatou perda urinária, por isso não possível aplicar o PRAFAB. A função sexual das mulheres transexuais deste estudo mostrou-se alterada. Não houve mudança na função urinária.

Descritores— Transexuais, Saúde Sexual, Genitália, Incontinência Urinária.

I.   INTRODUCTION

Defined by Harry Benjamin in 1953 as an association between biological normality and the conviction of belonging to another gender, transsexuality is born from the resulting conflict between gender identity and attributed sex. Thus, transsexualizing procedures are ways to adequate the body image to the proposed gender, with the sex reassignment (SR) surgery being the final step of these procedures[1].

Within this population, one can have a condition called gender dysphoria (GD), which is distress or discomfort that can occur when biological sex and gender are not in the same spectrum. Individuals who identify as transgenders tend to be more vulnerable and have higher indices of discrimination, depression and suicide when compared to the population in general[2].

There is a consensus among health professionals that transsexual surgery and hormonal procedures have a positive impact on this dysphoria, although some people do not intend to undergo the surgical procedure to express their gender and identity role[3]. The number of people seeking SR surgery is gradually increasing[4]. There is a worldwide estimation that 1:30,000 adult trans women and 1:10,000 adult trans men seek the procedures annually. However, disorders related to sex reassignment, especially in trans women, are becoming more common[5].

Considering the anatomical perspective, as the surgical procedure is extremely invasive on the structures that make up the pelvic floor region, a variety of dysfunctions are expected and one of the first to study the effects of the SR surgery on the urinary tract observed that the loss of urine occurred during the following period of up to three years after the surgery[6].

Since the number of transsexual people choosing to undergo transsexualizing procedures has been increasing in recent years, studies assessing the integrity of the sexual and urinary functions across the transition become necessary. Thus, this study proposes to evaluate the sexual and urinary functions of transsexual women in Belém, Pará, Brazil.

II.   METHODOLOGY

This is a cross-sectional observational study approved by Research Ethics Committee, Center of Biological and Health Sciences of the University of the State of Pará, with the report No. 3.366.922, conducted between June and July 2019.

Two transsexual women participated in the study:

P1: 48 years old, underwent the sex reassignment surgery 4 months before the study, single, making use of hormone therapy.

P2: 45 years old, underwent the sex reassignment surgery 10 years before the study, single, making use of hormone therapy.

The study was conducted in the Laboratory of Physiotherapy on Women's Health (LABFISM), University of the State of Pará. We used the following questionnaires for data collection: *Female Genital Self Image Scale* (FGSIS); Female Sexual Distress Scale (FSDS-R); Female Sexual Function Index (FSFI); Three Questions Incontinence Test (3IQ) and *Protection, Amount, Frequency, Adjustment, Bodyimage* (PRAFAB).

FGSIS was used to evaluate the perception of women about their genital organs. The questionnaire consists of seven questions and the answers follow the Likert Scale format (strongly agree, agree, disagree, strongly agree). The total score varies from 7 to 28 points, with higher values indicating a more positive genital self-image. FGSIS has been translated and validated for some western and eastern countries, is considered a reliable measurement and is being validated for Portuguese[7].

FSDS-R evaluates sexual distress. It consists of 12 questions. The participants evaluated the frequency in which they had uncomfortable and distressing sexual feelings in the past 30 days on a five-point scale which, when summed up, resulted in a final score in which higher values indicate more sexual distress (cutoff point=15.36)[7].

FSFI consists of 19 questions distributed into sex domains of sexual response: desire, arousal, lubrication, orgasm, satisfaction and pain/discomfort, and was used to evaluate sexual function. The score of each question varied

from 0 to 5. To obtain the domain's score, it is necessary to sum the corresponding questions of each and multiply by the correction factor (Table 1). By summing up the scores of the domains, we obtain the total score, which has the minimum value of 3 and the maximum value of 36, with

the highest values associated with a better sexual function. Thus, the cutoff point is defined to those that did not reach the total score of 26, with scores below or equal to this indicating sexual dysfunction[8].

Table 1 - FSFI Domain scores.

Domain	Question	Score variation	Factor	Minimum score	Maximum score
Desire	1,2	1 – 5	0,6	1,2	6,0
Arousal	3, 4, 5, 6	0 – 5	0,3	0	6,0
Lubrication	7, 8, 9, 10	0 – 5	0,3	0	6,0
Orgasm	11, 12, 13	1 – 5	0,4	0	6,0
Satisfaction	14, 15, 16	0(or 1) - 5*	0,4	0,8	6,0
Pain	17, 18, 19	0 – 5	0,4	0	6,0
Total Score				2,0	36

3IQ is a simple, fast and non-invasive test with acceptable precision in the classification of urgency and effort incontinence and was used to distinguish the type of urinary incontinence (UI) present in the patient. It includes three questions and can be answered in up to 30 seconds[9].

The data were analyzed by descriptive statistics. We used the software Excel for data input and table preparation.

III.   RESULTS

Both participants underwent the reassignment procedure, one in 2000 and the other in 2018. One was 45 years old and the other 48. Both made use of hormone therapy.

Table 2 describes the results of FGSIS. We considered the answers strongly agree and agree as comfortable/satisfied and the answers strongly disagree and disagree as uncomfortable/dissatisfied. One of the participants is neither satisfied nor comfortable with the appearance of her genitalia, feeling even ashamed.

Table 2. Female Sexual Discomfort Scale - FSDS-R (n=14).

How often did you feel:	Never	Rarely	At the same time	Very	Always	total
			n(%)			
Bothered by your sex life?	3 (18,8)	4 (31,3)	6 (43,8)	1 (6,3)	0	**14 (100)**
Unhappy about the sexual part of your relationship?	4 (25)	4 (25)	7 (43,8)	1 (6,3)	0	**14 (100)**
Frustrated by your sexual problems?	3 (25)	8 (56,3)	1 (6,3)	1 (6,3)	1 (6,3)	**14 (100)**
Stressed out about sex?	7 (43,8)	5 (31,3)	3 (18,8)	1 (6,3)	0	**14 (100)**
Inferiorized because of your sexual problems?	5 (31,3)	4 (31,3)	4 (31,3)	0	1 (6,3)	**14 (100)**
Worried about sex?	3 (18,8)	4 (31,3)	4 (31,3)	1 (6,3)	2 (12,5)	**14 (100)**

Sexually inappropriate?	8 (50)	1 (6,3)	4 (25)	1 (6,3)	2 (12,5)	**14 (100)**
Sorry about your sexuality?	12 (87,5)	1 (6,3)	0	0	1 (6,3)	**14 (100)**
Embarrassed because of your sexual problems?	7 (43,8)	7 (43,8)	1 (6,3)	1 (6,3)	0	**14 (100)**
Dissatisfied with your sex life?	6 (43,8)	2 (12,5)	4 (31,3)	2 (12,5)	0	**14 (100)**
Anger at your sex life?	9 (56,3)	4 (25)	1 (6,3)	2 (12,5)	0	**14 (100)**
Low sexual desire?	4 (31,3)	5 (37,5)	3 (18,8)	1 (6,3)	1 (6,3)	**14 (100)**

The satisfaction with sexual intercourse is impaired in both participants, who had high scores in FSDS-R. Details of the answers given in this scale are described in Table 3.

Table 3. Female Sexual Function Index of participants (n=14).

Scores by domain	Domains						Total score
	Desire	**Arousal**	**lubrication**	**orgasm**	**satisfaction**	**pain**	
Maxim	6	5,7	6	6	6	6	**35,7**
Minim	1,2	0	0	0	0	0	**1,2**
Average	3,78	3,05	3,21	2,42	0,5	1,85	**14,81**

As with FSDS-R, the total score of FSFI characterizes the participants with sexual dysfunction. The most compromised domain for both was satisfaction. Pain and arousal had higher scores for one of the participants (Table 4).

Table 4: Test of 3 questions on urinary incontinence - 3IQ.

Questions	Answers	n ()
During the last 3 months have you lost urine (even in small amount)?	yes	4 (25)
	No	10 (75)
During the last 3 months, you have lost urine when:	When I was doing some physical effort	1(25)
	When there was an emergency	3 (75)
	Neither making effort nor with a sense of urgency	0 (0)
During the last 3 months you have lost urine mainly when:	When I was doing some physical effort	2 (50)
	When there was an emergency	2 (50)
	Neither making physical effort nor having a sense	0 (0)

of urgency	
Almost equally, both in making effort and in the urgent	0 (0)

None of the participants, according to the 3IQ test, reported urine leakage, so that it was possible to apply PRAFAB.

IV. DISCUSSION

The search for the harmonization of body and mind and, consequently, one's welfare, makes some transsexual people choose the SR surgery, which results in functional complications in the new genital organ, such as the absence of vaginal lubrication and presence of hair in the vaginal canal, but also severe injuries, which may include prolapse or organ perforation[10].

Changes in the anatomy and functioning of the external genitalia may interfere with the behavior of people, including sexual activities. This fact justifies studies to better understand the physical appearance of this region and self-perception, as well as investigations related to sexual attitudes and the genital area[11].

In this study, one of the participants was not completely satisfied with her genitalia. Krege et al.[12] studied 66 transsexual women and the results confirmed that the patients were satisfied with the surgical results, the external appearance of the genitalia and function of the vagina and clitoris.

Regarding sexual function, both participants were uncomfortable with their sexual life. It is supposed that the presence of sexual dysfunctions leads to this discomfort, as both had low scores in FSDS-R and presented sexual dysfunction according to FSFI.

Supporting these results, a study[13] conducted with 518 transsexual people, of which 211 were trans men, showed that 54% of the men had sexual dysfunctions such as difficulty in achieving orgasm, pain during intercourse and decreased interest in sex. in the same study, 69% of the trans women had sexual problems such as pain during sex and decrease in sex drive[13].

The two women in our study were categorized as having sexual dysfunction. We reinforce the hypothesis that the decrease in sex drive, pain during sexual intercourse, as well as the decrease in lubrication observed in this study may have an important connection with sexual discomfort, which leads to dissatisfaction and stress regarding one's sexuality.

The transgenitalization surgeries and hormone therapy lead to phenotypical changes in the gender of transgender men and women. These procedures have considerable effects on sex drive and sexual function[14]. In general, a positive body image is associated with better sexual function and satisfaction[15]. This fact may be related to the sequels associated with the physical restrictions of the new genital organs or post-surgery pain[16].

Despite not being observed in this study, urinary dysfunctions can be common in women who underwent SR. Up to 20% of transsexual women report urinary problems after the surgery. Among them, urgency and effort UI and mixed UI are the most reported[17]. Among the ones with urinary complaints, it is estimated that 32% evolve into urinary infections due to incontinence problems.

Reinforcing the results of this study, a similar work conducted between 2013 and 2015 with 4 reassigned transsexual women observed that, after answering a questionnaire about quality of life, 100% of the sample did not present urinary incontinence[18].

The underlying cause of urinary symptoms after SR in transsexual women is not clear. A study[19] postulated that these symptoms may be the result of several factors. Many of these patients have smaller prostates in comparison with the homologous in men because the prostate becomes atrophic after the prolonged use of exogenous estrogen. An atrophied prostate could theoretically increase the risk of symptoms of effort urinary incontinence as it allows the passage of a smaller amount of urine through the urethra during the increase of pressures of Valsalva.

Direct sphincter lesion and denervation can also contribute to incontinence symptoms. Although most techniques avoid this type of lesion, it is plausible that they could happen. There is also likely a component of the pelvic floor for these symptoms. During the procedure, the bulbospongiosus muscle is partially transsectioned and spread laterally to allow the creation of a large enough space to make a neovagina of normal size and depth. The rupture of the muscles can lead to a dysfunction of the pelvic floor, which causes difficulty in emptying the bladder, sensation of incomplete emptying and other urinary symptoms. Physiotherapy for the pelvic floor can be useful in these clinical scenarios[20].

Thus, the factors involved in the integrated experience of the treatment of gender affirmation and how

sexuality is perceived are complex, and the support of sexuality and improvement of sexual function in trans patients is, therefore, multifaceted[20]. The sexual and urinary functions of transsexual people must be more studied to better understand their specific needs and, therefore, provide adequate treatment.

As limitations of this study, we mention the reduced number of participants due to the low availability in the studied region and the difficulties to access this population, as well as the use of questionnaires translated/validated only for cisgender women, which makes us question whether they are adequate tools to evaluate the same functions in the transgender population.

The development and validation of questionnaires to determine the outcome measures reported by the patient to the trans community are the next important step to evaluate the transsexualizing process amply and satisfactorily. It is still necessary to conduct studies that evaluate the quality of life, the function of the pelvic floor muscles and the relationship of the transsexualizing process with genital and urinary dysfunctions.

V.   CONCLUSION

The sexual function of the transsexual women of this study showed to be impaired. There was no change in urinary function.

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Sizing of a Water Heating System in a Single-Family Residence through Solar Energy Capture: Case Study

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Abstract— One of the major problems faced in the contemporary world is related to adopted energy matrices, since they result in a series of environmental impacts harmful to man. Therefore, it is necessary to develop new technologies for energy generation that can contribute to the preservation of natural resources and, consequently, reduce adverse impacts on the environment. the respective study presents itself as a tool of fundamental social, economic, ecological and environmental importance, since it is directed to the development of a project that aims to use a form of renewable energy to heat water in a single-family residence. The present study aimed to design a water heating system for a single family home, through the capture of solar energy. The methodological process used was the case study addressing the cost benefit of using photovoltaic energy technology to heat water in a single family home. For the dimensioning of the system, a survey of the number of people residing in the building was carried out, as well as the respective water consumption per capita. Based on the above, it is concluded that the project is economically viable since the results demonstrated a significant reduction in the cost of energy consumed at the residence. It presents itself as a tool of fundamental social, economic, ecological and environmental importance as it uses a renewable energy source.

I. INTRODUCTION

The first stage of the entire process for energy to reach our homes and industries is the generation by which it can be produced through different energy sources, such as: solar, nuclear, wind, natural gas, coal, oil, hydraulic and thermoelectric, that is, by burning biomass (wood, sugarcane residues and rice husks).

The energy matrix existing on the planet is made up of a set of accessible sources for the generation of electricity, whether for the world, a country, state or municipality. In Brazil, a large part of the electricity generated comes from renewable sources such as hydroelectric plants, which makes the Brazilian electricity matrix mostly renewable.

One of the major problems faced in the contemporary world is related to adopted energy matrices, as they result in a series of harmful environmental impacts to man. Therefore, it is necessary to develop new technologies for energy generation that can contribute to the preservation of natural resources and consequently reduce adverse impacts on the environment.

To face these challenges, it is necessary to adopt energy sources that generate less negative environmental impacts, among the energy matrices, solar energy can be

highlighted, as it is considered to be clean and renewable energy since it is produced by from natural resources that are always replenished by nature.

The renewable energy source is of fundamental importance for the environment, since there is a great global concern for the replacement of energy from non-renewable sources, such as oil, nuclear and coal. These types of power generation, once resources are exhausted, cannot be maintained.

Therefore, the Universities and Technological Research Institutions present themselves as the main sponsors of studies aimed at obtaining new technological alternatives with a view to generating energy for use in the civil construction industry, among which the use of solar energy can be highlighted, since it is a renewable energy source, obtained from the sun's rays.

In this sense, the respective study presents itself as a tool of fundamental social, economic, ecological and environmental importance, since it is aimed at the development of a project that aims to use a form of renewable energy for heating water in a single family home.

In this context, the research had as a general objective to dimension a water heating system of a single-family house, through the capture of solar energy and specific objectives to address concepts and standards related to the use of solar energy in civil construction works, dimension the system of capture of solar energy for the water heating of a single-family residence in the city of Manaus and analyze the cost-benefit of implementing the project object of this case study, in the residence in question.

II.   LITERATURE REVIEW

One of the main factors contributing to world economic development and industrialization is energy. And among the various sources that energy can be obtained, solar can be highlighted, which has been presenting itself as of great importance to ensure the sustainability of production processes. The energy generated by the sun is an infinite and non-polluting resource (Bisht et al., 2018).

Brazil has a diversified energy matrix, having in its territory significant reserves of non-renewable sources (oil, natural gas, coal, uranium, etc.) and diversified sources of renewable energy, highlighting the vast hydroelectric, wind, and solar potential and biomass available in the country for electricity generation (Bandeira 2012 apud Kemerich et al., 2016).

For Cabral (2012), the energy crisis, an issue of not very recent origin, but still a much debated topic in

society, constitutes one of the great challenges of today. Some factors related to it can be highlighted, such as: the reduction of world oil reserves, especially after the oil crisis in the 70s, environmental impacts caused by the use of polluting energy sources, the potential scarcity of natural resources and the increased demand for energy supply, due to the continuous growth of the population, which generates uncertainties about the world energy future and significant discussions at the global core.

Faced with this problem, an environmental concern has spread over the years that has consolidated and gained space in society, from which a process of searching for alternative sources of energy that promote the rational use of energy resources is observed, reduction of environmental impacts and expansion of energy in isolated areas (Cabral, 2012).

Cabral (2012) highlights that photovoltaic energy is an excellent alternative energy to non-renewable sources to meet the growing energy demand and expand access to energy in places where the implementation of the conventional electricity grid is technically and economically unfeasible, especially in rural areas.

It is important to highlight that Brazil is a country with a high potential for producing solar energy, as it benefits from the abundant solar radiation prevalent in almost every month of the year, despite the different climatic characteristics observed in our territory, it can be observed that the annual average of global irradiation shows good uniformity, with relatively high annual averages across the country (Kemerich et al., 2016).

According to Santana (2020), the term "photovoltaic" has etymological origins in the words phos, which means "light" in Greek and voltaic, in reference to the Italian physicist Alessandro Volta, a great scholar of electricity and inventor of the voltaic cell. Thus, solar photovoltaic energy is obtained through the direct conversion of light into electricity through the photovoltaic effect.

For Jannuzzi et al., (2009), the physical principle of operation of photovoltaic modules is called photovoltaic effect (photo = light; volt = electricity), which is the phenomenon presented by certain materials that, exposed to light, produce electricity.

For Bezerra (1982) highlights that the use of solar energy coming from the Sun is made through the capture of light and/or heat energy, which is transformed into something better usable by human beings, such as mechanical or electrical energy. Cometta (1985), on the other hand, says that solar energy is energy radiated by the sun, energy that is non-polluting and inexhaustible.

Water heating using solar collectors has been growing every decade. Domestic solar heaters are currently widely used to produce solar thermal energy at low temperatures and aim to reduce costs, use less natural resources and reduce pollution. For this reason, they have been the subject of several researches and studies since the 1950s (Marques et al., 2014).

The anthropic contribution to global warming through the burning of fossil fuels has become a consensus, putting on the agenda the need for mitigation measures, with emphasis on the use of a cleaner energy matrix. In this context, Brazil has a favorable structure. In 2014, renewable resources represented 50.8% of the country's energy matrix. In terms of the electrical matrix, in that same year, 74.6% of the domestic supply came from renewable sources, mostly hydraulic energy (Mme, 2015; Carvalho, 2017).

Jannuzzi et al., (2009) highlight that Brazil has a great challenge in the coming decades to seek solutions that will meet the growing requirements of energy services and, at the same time, meet criteria of economy, security of supply, public health, guarantee of universal access and environmental sustainability. The growing environmental pressures on the exploitation of the hydraulic potential located in the Amazon region and the energy resources that are increasingly distant from the load centers are some elements that are used to seek new solutions. In order to satisfy these criteria, significant public policy efforts for the insertion of new technologies must be started immediately with the objective of meeting the expected energy demand in 2030-2050.

1.1 Classification of Photovoltaic Systems

For Ribsol (2021), a photovoltaic solar energy system, also called a solar energy system, or even a photovoltaic system, is a system capable of generating electrical energy through solar radiation. There are two basic types of photovoltaic systems: Isolated Systems (Off-grid) and Grid Connected Systems (Grid-tie).

As they are electricity generators, photovoltaic systems are classified according to their topology in relation to the most common means of supplying electricity, the public electricity distribution network. They are classified as: isolated photovoltaic systems and photovoltaic systems connected to the grid (Santana, 2020), as described below:

1.1.1 Isolated photovoltaic systems

For Santana (2020), Isolated Systems are those that do not have any type of interconnection with the energy distribution network. They are used in remote locations or where the cost of connecting to the power grid is high. They are used in country houses, refuges, lighting,

telecommunications, water pumping, etc. It is divided into: stand-alone without storage and Stand-alone with storage.

1.1.1.1 Standalone solar systems without storage

They are isolated photovoltaic systems formed by the set of photovoltaic modules, charge controller and inverter, Figure 1.
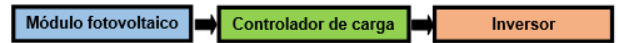
Fig.1: Standalone solar systems without storage

Source: Adapted from Santana (2020).

As an example of the use of autonomous systems without storage, we can mention the water pumps for dams and artesian wells, as illustrated in Figure 2.

Fig.2: Anauger solar pumping kit

Source: Adapted from Santana (2020).

1.1.1.2 Autonomous Solar Systems with Storage

According to Santana (2020), the autonomous photovoltaic system with storage, like the previous one, follows the same studied topology, consisting of a photovoltaic module, charge controller and inverter. However, the novelty comes through the connection of batteries to carry out the accumulation of energy, as illustrated in Figure 3.
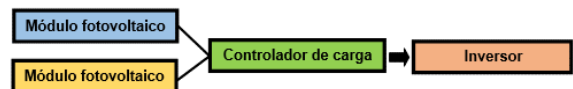
Fig.3: Autonomous solar system with storage

Source: Adapted from Santana (2020).

1.1.2 Grid connected photovoltaic systems

They are those that depend on the interconnection with the grid to carry out the transformation of solar radiation into electrical energy. For Ribsol (2021), the Solar System Connected to the grid, replaces or complements the conventional electric energy available in the electric grid.

Unlike isolated systems that serve a specific and local purpose, these systems are also capable of supplying the electricity grid with energy that can be used by any consumer on the grid. Connected systems have a great advantage over isolated systems in that they do not use batteries and charge controllers. This makes them about 30% more efficient and also ensures that all energy is used, either locally or elsewhere on the network. Grid connection systems can be used either to supply a home, or simply to produce and inject energy into the electricity grid, just like a hydroelectric or thermal plant.

One of the bets being made in several countries is the use of photovoltaic systems connected to the grid (SFCR). Although it is still an expensive solution today compared to other solutions, it is the technology that presents the highest growth rate and lower costs. In addition to the gains in scale and learning effects, technological advances and new discoveries are very promising to further lower costs. It is anticipated that energy generated through these systems will become competitive with electricity tariffs paid by European consumers between 2010 and 2020 and with average generation costs after 2030 (Jannuzzi et al., 2009).

Souza et al., (2018) mention that demand for energy has become increasingly higher, thus, research and searches for renewable energy sources are essential to ensure the sustainability of the energy sector. Among so many options, solar energy has stood out as an energy source with great availability.

Marques et al., (2014) highlight that domestic solar heaters, currently widely used for the production of solar thermal energy at low temperatures, have been the object of several researches and studies since the 1950s.

Siqueira (2009) mentions that the solar collector is the main component of a solar heating system. It promotes the conversion of solar radiation, transferring the energy flow from the incident radiation to the fluid that circulates inside it.

Flat collectors are used for temperatures below 93° C. It receives and uses solar radiation on the same surface. It consists of a black heat-absorbing plate, piping through which the fluid to be heated flows, thermal insulation, and generally with a transparent cover (Hudson et al., 1985 apud Sales, 2017).

In the solar water heating system there are two systems: active and passive. The active system needs a pump to support the circulation of water, requiring sensors and a system to control its operation. In the passive system or natural circulation, it does not need the use of a pump, the collector being installed at a level below the thermal reservoir (figure 1). The water naturally circulates inside

the collector and goes up to the reservoir. This effect is called thermosyphon (Islam et al., 2013 apud Sales, 2017).

1.2 Legislation Applied to the Solar Energy Sector

According to Sales (2017), in Brazil there are technical standards that specify the products and equipment used in systems for the thermal use of solar energy, where they deal with specifications, materials, technical requirements, thermal performance and other associated topics, as described below:

✓ ABNT NBR 15747 - 1 (2009): Solar thermal systems and their components - Solar collectors - Part 1: General requirements.

The purpose of this part of the standard is to specify the requirements for durability (including mechanical strength), reliability, safety and thermal performance of liquid heating solar collectors. It also includes provisions for assessing compliance with those requirements.

✓ ABNT NBR 15747 - 2 (2009): Solar thermal systems and their components - Solar collectors - Part 1: Test methods.

This part of the standard aims to specify the test methods for validating the requirements of durability, reliability and safety and thermal performance of liquid heating solar collectors, which are specified in NBR15747-1. It includes three test methods for characterizing the thermal performance of collectors.

✓ ABNT NBR 15569 (2008): Direct circuit solar water heating system - Design and Installation.

This standard aims to establish the requirements for the solar heating system (SAS), considering the aspects of design, dimensioning, hydraulic arrangement, installation and maintenance, where the transport fluid is water, as it is applied to the SAS composed of flat solar collectors, with or without thermal reservoir, and an eventual auxiliary water heating system. It is also applicable to systems where the circulation of water in the solar collectors is done by thermosyphon or forced circulation. The same does not apply to the heating of water in a swimming pool or in the indirect circuit solar heating system.

✓ ABNT 10185 (2018): Thermosolar reservoirs for liquids for solar energy systems - Test method for thermal performance.

Its objective is to specify the test methods that allow the evaluation of the global heat flux coefficient for the environment, the loading and unloading capacities of thermosolar reservoirs used in systems of thermal utilization of solar energy.

1.3   Concepts

1.3.1   Photovoltaic system

In a basic definition, a photovoltaic system is an integrated set of photovoltaic modules and other components, designed to convert solar energy into electricity (Treble, 1991 apud Sales, 2017). For Santana (2020), it is a set of equipment that together form an energy generator through which it becomes possible to transform solar photovoltaic energy into electrical energy as we know it, as shown in Figure 4. The respective figure shows that there is an increase temperature and consequently the heating of the water as the solar rays affect the photovoltaic panels.
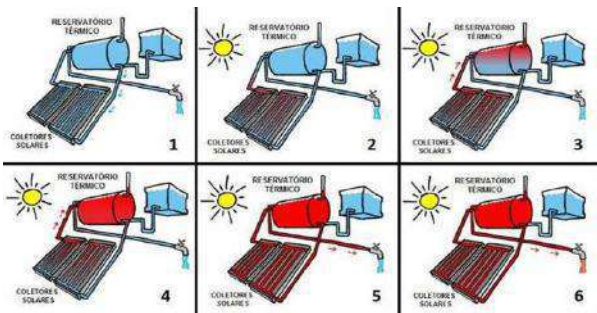
Fig.4: Photovoltaic System

Source: Cycle, 2020.

1.3.2   Photovoltaic Cell or Collector

According to Santana (2020), it is a device manufactured with semiconductor material, it is the main unit of this process of converting solar radiation into energy. As for ABNT NBR 15569 (2008), the solar collector is a device that absorbs incident solar radiation, transferring it to a working fluid, in the form of thermal energy, as shown in Figure 5.

Fig.5: Photovoltaic Cell

Source: Cycle, 2020.

1.3.2.1   Solar Thermal Energy

It is a form of alternative energy, and a technology, used to generate thermal energy or electrical energy, for use in homes or industries. These technologies allow us to convert solar energy into thermal with different developments depending on the range of temperatures required. As an example, there is the heating of swimming pools, water for bathing, space heating and heating for industrial processes (Agência Nacional de Energia Elétrica, 2008).

III.   MATERIALS AND METHODS

The project on screen aims to analyze the cost-benefit of implementing the project of a solar energy capture system for the water heating of a single-family residence, located in the city of Manaus. The research was classified according to objectives and approach. As for the objectives, the research is presented as exploratory and descriptive.

It is classified as exploratory because it compiles information that will expand knowledge and familiarity with the subject outlined for the project, which will support the understanding of the concepts and applications of the studied object and is descriptive, as it aimed to describe, interpret and explain about the research topic. Regarding the approach, it is quantitative, as the results were quantified.

In order to enrich the research, a systematic survey of the literature related to the topic was carried out in electronic databases, including: Academic Google and Scielo, searching for studies published in the last 10 years.

The keywords used to survey the publications will be: solar energy, photovoltaic system, water heating. The project is a case study that addresses the cost-benefit of using photovoltaic energy technology to heat water in a single-family home. To design the system, a survey was carried out on the number of people residing in the building, as well as their per capita water consumption.

For the project, a single-family building consisting of 2 rooms, 5 bedrooms, kitchen, 5 bathrooms, pantry, service area and garage was used as the object of study, located in the Alphaville 2 condominium on H - 1 street, block K2, lot 42, neighborhood Tarumã in the city of Manaus, Figure 6.

Fig.6: Location of the building

Source: Google Maps.

1.4 SOLAR HEATING SYSTEM

According to ABNT NBR 15569 (2008), the solar heating system basically consists of three main elements: solar collector(s), thermal reservoir and auxiliary heating system. For its assembly, the materials and components described in Chart 1 are used.

Chart 1: Materials and components of the solar heating system - SAS

ITEM	COMPONENT	FUNCTION
1	Solar collector	Convert radiant energy to thermal energy
2	Thermal reservoir	Accumulate thermal energy in the form of heated water
3	Differential temperature controller	Control the operation of the solar heating system hydraulic motor pump and possibly have safety functions
4	Temperature sensor	Measure the water temperature at specific points on the solar heating system
5	Expansion reservoir	Protect the system against pressure variations and volumetric expansion during the operation of the SAS
6	Pressure relief valve	Automatically relieve SAS pressure if maximum pressure is reached
7	Retention valve	Do not allow reverse water movement
8	Air eliminator valve	Allow SAS air out
9	Vacuum break valve	Relieve negative pressures formed during the operation of the SAS, allowing the entry of air
10	Drain	Enable the drainage or drainage of water from the SAS
11	Motor pump	Promote the forced circulation of water through the SAS
12	Tubes and fittings	Interconnect components and transport heated water
13	Thermal insulation	Minimize thermal losses of SAS components and accessories
14	Auxiliary heating equipment	Supply the complementary thermal demand of SAS
15	Breather	Equalize SAS positive and negative pressures and allow air and steam to escape

Source: Google Maps.

1.4.1 Dimensioning of the solar heating system

ABNT NBR 15569 (2008) highlights that the purpose of the dimensioning is to determine the collecting area and the volume of the storage system necessary to meet the useful energy demand of a given consumption profile, which is carried out as determined by it and following the recommendations contained in manufacturers manuals. The respective dimensioning was carried out according to the steps of the items described below.

1.4.1.1 Calculation of the volume of hot water consumption in the home

The calculation was performed using the information and equation below, contained in ABNT NBR 15569 (2008) as follows.

Number of people residing in the building: 6 people;

Shower flow (shower): 6.6 l/min;

Average bath time: 10 min;

Bathing frequency: 2 baths per person

The calculation was performed using the equation (1).

$$Vconsumo = (Qch \times Tu \times Fu \times Np) \quad (1)$$

$$Vconsumo = (6.6 \ l/mim \times 10mim \times 2 \times 6)$$

$$Vconsumo = 792 \ liters$$

In which:

- ✓ Vconsumo: total volume of hot water consumed daily (l);
- ✓ Qch: shower flow (l/mim);
- ✓ Fu: total number of shower usage per user per day;
- ✓ Np: number of people residing in the building.

1.4.1.2 Calculation of storage system volume

For this calculation, the parameters and equation contained in ABNT NBR 15569 (2008) were used, as follows:

Consumption temperature: 40ºC;

Annual average room temperature: 26ºC;

Water storage temperature: 50ºC.

For the calculation of this step, the equation (2)

$$Varmaz = \frac{Vconsumo \times (Tconsumo - Tambiente)}{(Tarmaz - Tambiente)}$$

$$Varmaz = \frac{792 \times (40 - 26)}{(50 - 26)}$$

$$Varmaz = 462 \ liters$$

In which:

- ✓ Varmaz: reservoir storage volume (l);
- ✓ Vconsumo: total volume of hot water consumption in the building (l);
- ✓ Tambiente: average ambient temperature in the locality (ºC);
- ✓ Tconsumo: hot water consumption temperature (ºC);
- ✓ Tarmaz: storage temperature (ºC).

For better security of the hot water supply in the storage system, a Boiler 500 liter hot water tank or 0.50 m³ horizontal Rinnai high pressure (5 m.c.a) hot water tank was adopted, stainless steel 444R, double plate, Figure 7.

Fig.7: Rinnai high pressure 500 liters horizontal bolher
Source: Reservatório Solar (2021).

1.4.1.3   Calculation of useful energy demand and loss

For the respective calculations it was necessary to use the parameters and equations that are part of ABNT NBR 15569 (2008). The data used in this calculation step were:

- ✓ Specific mass of water (p): 1000, expressed in kilograms per cubic meter (kg/m3);
- ✓ Specific heat of water (Cp): 4.18, expressed in kilojoules per kilogram kelvin (kj/kg).

1.4.1.3.1   Calculation of useful energy demand and loss

For the calculation, on screen, the equation was used (3);

$$E_{útil} = \frac{V_{armaz} \times p \times C_p \times (T_{armaz} - T_{ambiente})}{3600}$$

$$E_{útil} = \frac{0,50 \times 1000 \times 4,18 \times (50 - 26)}{3600}$$

$E_{útil}$ = 8,13 Kwh/day or 243,60 Kwh/month

In which:

- ✓ Eútil: Useful energy, expressed in kilowatt hours per day (Kwh/day);
- ✓ Varmaz: reservoir storage volume (m^3);
- ✓ p: Specific mass of water (kg/m^3);
- ✓ Cp: Specific heat of water, expressed in kilojoules per kilogram kelvin (kj/kg).
- ✓ Tarmaz: storage temperature (ºC).
- ✓ Tambiente: average ambient temperature in the locality (ºC).

1.4.1.3.2   Loss calculation

The energy from the losses was obtained using the percentage of 15% of the useful energy needed to heat the water, as recommended by NBR 15569 (2008).

For the respective calculation, the following equation was used (4);

Eperda = 0,15 x Eútil (4)

Eperda = 0,15 x 8,13

Eperda = 1,22 Kwh/day

In which:

- ✓ Eperda: Thermal losses of the primary and secondary circuits, expressed in kilowatt hours per day (Kwh/day);
- ✓ Eútil: Useful energy, expressed in kilowatt hours per day (Kwh/day).

1.4.1.4   Calculation of the solar energy collecting area

The sizing of the solar energy collecting area had as a starting point the value obtained in the calculation of useful energy demand. With the result achieved, it was possible to find the collecting area by consulting the table of Energy Consumption and Energy Efficiency of solar collectors from the National Institute of Metrology, Quality and Technology (2018).

In the aforementioned table you can find all manufacturers of collectors for solar water heating accredited in the Brazilian Labeling Program, showing the average monthly energy production of the equipment per square meter and per type of collector.

Therefore, to meet the demand for useful energy, equipment was chosen supplied by the company Rinnai Brasil, Tecnologia de heating LTDA, Rinnai brand, model RSC 1002V, bath application, operating pressure 40 mca, external collector area 1.01 m2, production monthly average of energy per collector 70.60 kWh/month.

With the information from the equipment, to meet the useful energy demand, which is 243.60 kWh/month, it is necessary to have a solar energy collecting area of 4.04 m^2, which could be supplied by 4 plates of 1.01 m^2 each . However, for safety reasons, 5 boards of 1.01m^2 each were adopted, totaling 5.05m^2.

1.4.2   Installation of solar heating system

According to the Rinnai installation and use manual, the solar heating system requires an installation to be carried out by a specialized company, as good as the equipment is, if it is poorly positioned and does not obey the correct distances, the yield will be much lower than expected. The respective system and its components are represented in the operating diagram as shown in figure 8.
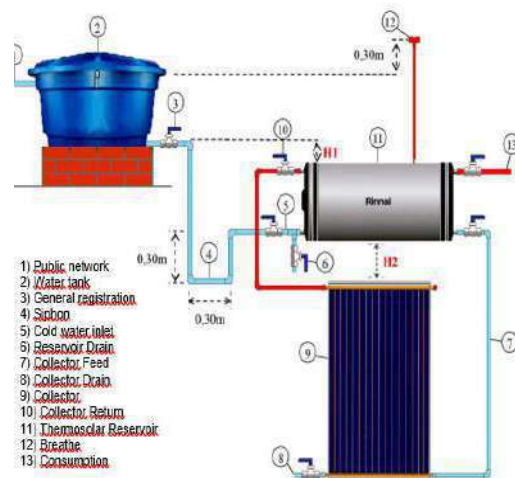
Fig.8: Operating diagram of SAS and its components

Source: Manual de instalação e utilização Rinnai.

Due to the architectural characteristic of the building, the circulation system adopted was a natural thermosyphon. As stated in the Rinnai installation and use manual, the movement of water inside the pipe occurs due to the thermal difference between the reservoir and the collectors, so only one power point will be needed next to the thermosolar reservoir, to use the electrical support when used. The exchange of hot water in the collectors and the reservoir takes place naturally without the need for any auxiliary equipment. To obtain the maximum pressure, consider the water sheet of the box at the top of the reservoir, figure 9.
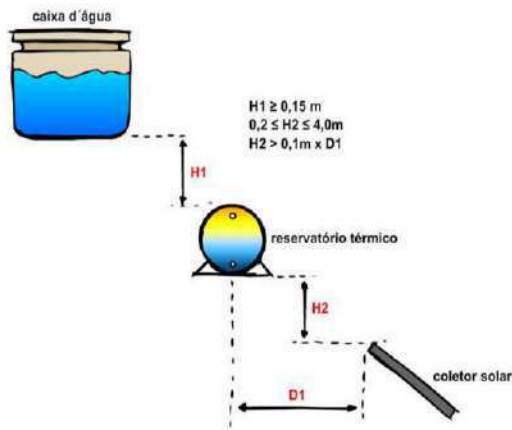
Fig.9: Thermosyphon natural circulation

Source: Manual de instalação e utilização Rinnai (2020).

1.4.2.1   Installation of solar collectors

1.4.2.1.1   Angle of inclination

According to ABNT NBR 15569 (2008), solar collectors must be installed with inclination angles equal to the local latitude plus 10º and never less than 15º as shown in figure 10. The Rinnai installation and use manual indicates which inclination angle should be the city's latitude increased by 10°, in cases where this sum does not reach 20°, adopt the 20° inclination so as not to harm the proper water flow, this inclination favors the best performance for the winter periods, as in the summer the incidence of solar radiation is higher.
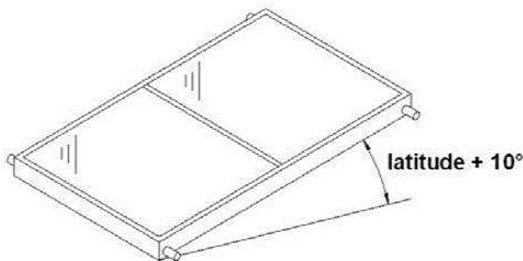
Fig.10: Angle of inclination of collectors

Source: ABNT NBR 15569 (2008).

1.4.2.1.2   Geographical orientation

In the Installation and Use Manual Rinnai highlights that in Brazil the collectors must be directed to the GEOGRAPHICAL north, figure 11. If the collectors are 30º out of phase with the geographic north, they must be added in the dimensioning at least 20% of the collector area. Installation with an offset above 30° is not recommended due to the drastic drop in performance.
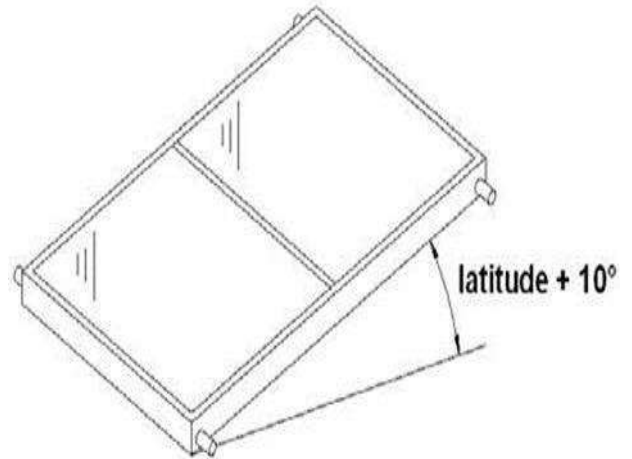
Fig.11: Geographic orientation of collectors

Source: ABNT NBR 15569 (2008).

The installation of the solar heating system of the project on screen was carried out in compliance with the recommendations of ABNT NBR 15569 (2008) and the Rinnai Installation and Use Manual.

Estimated cost for implementing the solar heating systemThe cost of implementing the solar heating system for the respective project is described in Table 2.

Table 2: Cost of implementing the solar heating system

UNIT	DESCRIPTION	UNIT VALUE	PARCIAL VALUE
1	Reservoir Termossolar Rinnai de 500 (l)	R$ 8.900,00	R$ 8.900,00
5	Solar Collector 1x1 Rinnai	R$ 1.682,00	R$ 8.410,00
1	Pressurizer Jacuzzi 1/2 CV	R$ 3.180,00	R$ 3.180,00
1	Expansion Tank Dancor	R$ 2.860,00	R$ 2.860,00
1	Safety Valve	R$ 380,00	R$ 380,00
1	Vacuum Break Valve	R$ 420,00	R$ 420,00
1	Retention valve	R$ 412,00	R$ 412,00
10	Aquatherm 22 tube	R$ 79,00	R$ 790,00
8	Copper Tube 22	R$ 458,00	R$ 3.664,00
10	Copper Union 22	R$ 78,00	R$ 780,00
5	Aquatherm Mixer	R$ 128,00	R$ 640,00
1	Connections Kit	R$ 3.250,00	R$ 3.250,00
-	TOTAL VALUE	-	R$ 33.686,00

1.4.3   Estimate of energy saved with SAS deployment

To calculate the estimated energy saved with the implementation of the solar water heating system, it was necessary to collect the following data:

- ✓ Solar fraction of energy consumed for heating water supplied by the solar system used: 73.50% obtained from the Solarimetric Atlas (2016 apud SALES, 2017).
- ✓ Average number of baths surveyed: 2 baths per day per person according to ABNT NBR 15569 (2008).
- ✓ Bathing time: 10 min, according to table C.1 which indicates the consumption of hot water points of use of ABNT NBR 15569 (2008).
- ✓ Electric shower used: Acqua Duo shower 220V 7800W, Lorenzetti.
- ✓ Number of days per year: 365 days.

To determine the amount of energy saved for years, the total number of daily baths must be obtained using equation 5.

$$NTB = Fu \times NTPRE \quad (5)$$

$$NTB = 2 \times 6$$

$$NTB = 12 \text{ baths per day.}$$

In which:

- ✓ NTB: Total number of baths per day;
- ✓ Fu: Frequency of bathing per person day;
- ✓ NPTRE: Total number of people residing in the building.

With the data obtained, it is possible to calculate the amount of energy saved per day in Kwh with the installation of the solar water heating system using equation 6.

$$EE = FS \times PC \times NTB \times (T/60) \times 10^{-5} \quad (6)$$

$$EE = 73,50 \times 7800 \times 12 \times (10/60) \times 10^{-5}$$

$$EE = 11,70 \text{ Kwh/day}$$

In which:

- ✓ EED: Energy saved in kWh/day;
- ✓ FS: solar fraction of energy consumed for heating water supplied by the solar system (%);
- ✓ PC: Electric shower power watts;
- ✓ NTB: Total number of baths per day;
- ✓ T: Average time per bath.

1.4.3.1   Installation of solar collectors

For the respective calculation, a survey was carried out at the Amazonas Energia utility to verify the cost of the Kwh of energy consumed.

In this sense, it can be seen that for each Kwh of energy consumed, the amount of R$ 0.94559 is paid,

Figure 13. Therefore, we obtained the pecuniary value saved for one year using equation 7.

Fig.13: Kwh value of energy consumed

Source: The author.

The calculation was performed using the equation (7).

$$VPEDA = EED \times Tax \times 365 \quad (7)$$

$$VPE = 11,70 \times 0,942559 \times 365$$

$$VPE = 4.025,20/\text{year}$$

In which:

- ✓ VPEDA: Cash value saved for one year;
- ✓ EED: Energy saved in kWh/day;
- ✓ Tax: Fee charged by Manaus energy per kWh of energy consumed.

1.4.4   Calculation of payback time

In order to better verify the economic feasibility of the project, we sought to determine the investment payback time, using the investment economic feasibility indicator called return (TR). For this procedure, the data described below was used:

- ✓ Value obtained for the investment: R$ 33.686,00;
- ✓ Cash savings with the implementation of the project (benefit): R$ 4.025,20;
- ✓ Interest rate (i): 1.18% p.m the equivalent of 15.16% a,a (using the rates charged by Banco Santander).

To calculate the internal rate of return, the equation used was (8)

$$TR = -\frac{\ln(1 - C \times i/P)}{\ln(1+i)} \quad (8)$$

$$TR = -\frac{\ln(1 - 33.686 \times 0,1516/4.025,20)}{\ln(1+0,1516)}$$

$$TR = 9 \text{ years and } 3 \text{ months}$$

In which:

- ✓ TR: Return time in year;
- ✓ C: Investment;
- ✓ i: Interest rate a,a;
- ✓ P: Billing of the year.

IV. RESULTS AND DISCUSSIONS

The object of the research was a development of a single-family residence located in the Flores neighborhood in the city of Manaus, in the state of Amazonas, having as a proposal the design and implementation of a system for heating water through the capture of solar energy.

The dimensioning of the hot water consumption, foreseen for the project indicated that a 500 liters reservoir meets the required demand for the residence.

The calculation to obtain the collectors area indicated that to compensate the useful energy demand, which is 243.60 kWh/month, a solar energy collecting area of 5.05m2 was necessary, which was supplied by 5 solar energy collectors with a generation capacity of 70.60 kWh of energy per month.

The cost of energy saved with the implementation of the solar water heating system indicates a positive economic result, buying that the project is economically viable with a payback time of approximately 9 years and 3 months.

V. CONCLUSION

As seen earlier, it is concluded that the project is economically viable since the results showed a significant reduction in the cost of energy consumed in the residence, thus contributing to a payback time of 9 years and 3 months for the investment after project implementation.

Other relevant factors with the implementation of the solar heating system is that it presents itself as a tool of fundamental social, economic, ecological and environmental importance, as it is aimed at the development of a project aimed at the use of a form of renewable energy which can contribute to an immediate valuation in the market.

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3D Printing of Concrete in India

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Abstract— In this study, we have examine the importance of 3D printing of concrete in this era. It is a handy replacement of self compacting concrete and sprayed concrete which does't need formwork, Moreover,it will save time ,labour and cost efficient.To achieve this technique we need both hardware and software.In India L&T Construction Ltd. Were first to accomplish this technique which was two Storey building. and thus has a unique advantage over conventional construction methods.

I. INTRODUCTION

There were a lot of problems faced in traditional construction like the cost of formwork increases the project economy, cost of man-power & time and thus effects the quality of construction. 3D Concrete printing aims at enhancing construction on several levels: it minimizes the duration of the construction process by eliminating some time-consuming processes in the traditional method, it reduces costs of the project by minimizing waste and overproduction. In addition to minimizing the use of labor, it also provides flexibility in building structural shapes which are not possible to build by traditional methods which results an improvement in the overall safety and economy of structures.In principle, 3D printing of concrete has the advantages of both self-compacting concrete (i.e. self- compacting without any assistance of vibration) and sprayed concrete (i.e. fresh concrete is expelled from a nozzle to fabricate complex forms) to meet the critical requirements of a freeform construction process. We can clearly observe in Fig 1 that to construct a building we have to face many complications like orientation of formwork carried out by heavy machineries thus a minor mistake can causes a loss of money, time and the property.Hence to eradicate this

problem a new and better construction technique is presented called 3D PRINTING OF CONCRETE

Fig. 1: Complications in Convection Construction Technique

II. OBJECTIVES

The main objective of the project is the implementation of a contour crafting system to a 3D concrete printer. The goal is to assemble a 3D printer that gives the user a greater degree of freedom in designing different forms and

improves the aesthetic of the finished product. To print few objects by using the 3D printer developed. The long term objective of the project is to patent the 3D printing technology for concrete and there by introduce the same in the construction industry.

III. METHODOLOGY

3D Concrete printing is a construction method that has the potential of fabricating a predesigned building in 2D layers on top of each other, the repetition of which completes a 3D model. The concrete, which is erected out from a printing nozzle, does not need any vibration or formwork.Contour Crafting (CC) is one method of concrete printing that shows great potential in improving construction techniques and methodologies.CC constructs objects layer by layer using robotic arm or such mechanical tools; it is used for small-scale industrial parts and also was identified as a method which is capable of delivering components large enough for building structures. Moreover, components are designed as volumetric instruments using 3D modeling software's like SolidWorks & Inventor.Afterwards, they are sliced and represented as a series of 2-D layers. The information is then exported to a printing machine which obeys layer-by-layer Pattern in order to print structural components by the controlled extrusion of a cementitious material.

The evolution of a printing concrete is utilize the likely of this advanced method of construction.The correct needs to have an acceptable degree of extrudability to be extruded through a printing head which consists nozzles to form small concrete filaments.The filaments must adjoin together to form each layer, as the fresh concrete is continuously extracted to form consecutive filaments layered on the previous ones to build complete 3D components.Furthermore, the material must have sufficient build-ability characteristics to enable it to lay down correctly, remain in position, be stiff enough to support further layers without collapsing and yet still be suitable to provide a good bond between layers. A high strength (of the order of 80 MPa in compression) is proffered because the layered structure of components fabricated by this method is likely to be inherently weaker than conventional in-situ and precast concrete.

A typical 3D concrete printer is designed for the nozzle head movement of maximum of 475 mm in the X-direction 650 mm in the Y-direction and the printing base of 750 mm in the Z-direction. This can be done by 300 W servomotors which actuates linear screws. A 660 watt servo motor can be used for driving a screw-type extruder. The concrete printer will be controlled by Software's which could be better used by mechanical engineers.

Software's like Solidwork or Inventor plays a major role to produce printed concrete. Some are not open source software but software used in CNC milling machines are beneficial to design structure. An open source slicer-software converts stereo-lithography files to the G-code instructions used by these software's.

Hardware: The purpose of contour crafting is to ease the surface of the concrete flowing out of the outer of nozzle. To implement this to the concrete printer, a new nozzle with trowels that follow the outer edge is needed. The trowels should also also be capable that it can create an angle according to the shape of the printed object to allow angled walls to be printed. Additionally the trowels should not be in contact of the concrete paste during The fill cycle. An idea of Printing Concrete the help of robotic hand was purposed by Lund university, Sweden as shown in Fig 2. This robotic hand is operated by a software and thus improves the accuracy of 3-D printed structure.
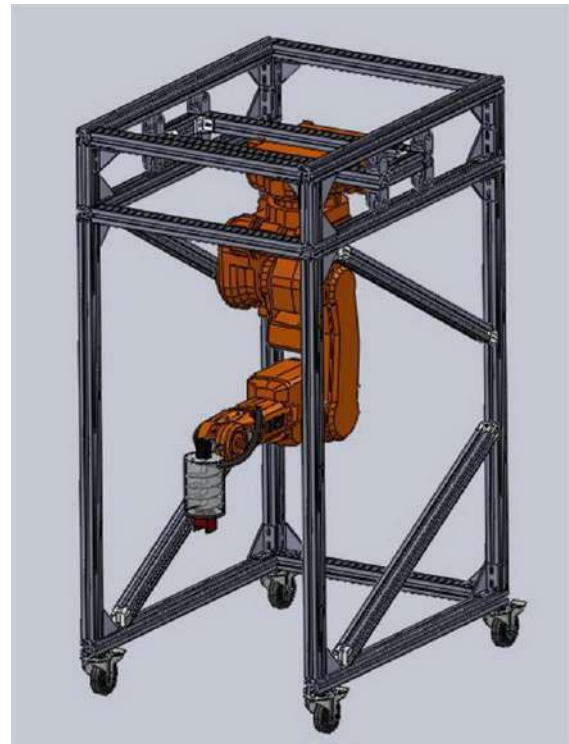
Fig. 2: Prototype of robotic hand presented by lund Univesity, Sweden

Software: To implement contour crafting,An additional axis is needed which is known as G-Code.In the original setup of the printer, G-code is generated from a CAD model by the open source software like slic3r or some paid softwares like solidworks.These software's break the CAD model in stereolithography format down to points in the X-Y plane.CAD software moves the nozzle according to the path given by the G-code. In order to control the additional axis, a program will be written in programming language.

The program should be able to read the coordinates, written in the G-code file as well as calculates the angle for the nozzle.

Concrete mixture

Contour crafting method needs some additional requirements on the concrete property which is being used like ,The printability of a concrete mix are defined as extrudability (the ability of the mass to easily flow through the extruder), Buildability (the resistance against deformations by the subsequent layers) and Formability of concrete.The existing recipe has to be reconsider to accommodate the implementation of the contour crafting system.While water and Admixture content of the mix has to be adjusted until the criteria listed above are deemed fulfilled. Fig 3 show an idea Concrete mixture used for this Technique

Fig. 3: An experiment of 3D printing of Concrete.

IV. RESULT

The advantages of this process includes: (1) Influence of mechanical and electrical services within voids formed in the structure could optimize materials usage and can easily work on site; (2) Enhancement of build material can produce internal and external finishes (3) Designing integrated units will reduce interface detailing and hence the can be cost efficient and (4) By Contour crafting method which obeys layer-by-layer concreting with solid modeling techniques will give greater design freedom.

V. CONCLUSION

Over time, building components and engineering practices have an exponential growth, with the approach of

building superstructures to building a most economical building 3-D printing of concrete is able to complete a construction project more accurately, economically and early as compared to traditional Construction techniques. As in some countries due to topographic factors the amount of admixture should be used accordingly. Whereas this technique needs experts from multi-disciplinary departments from Civil, Mechanical, Robotical and Computer which could result in some complications However it can be solved with less efforts.

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Operational feasibility of Implementation and Analysis of return on investment: A Comparative study between Peach and Grape Crop, applied in a family rural Property in Campestre da Serra - Rio Grande do Sul.

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Abstract— *This study aims to analyze the operational viability and return on investment of two permanent crops, grape variety rosated niágara and peach variety fascination, and compare them to see the return to the rural producer in a period of 10 years. The methodology used was a case study, a quantitative research was used for analysis. Data collection was performed at the property through interviews, based on the amounts obtained from companies in the region for the allocation of initial investments and operating costs. Thus, financial viability indicators were used, such as Net Present Value, Simple Payback (time needed to recover the cost of investment) and the Internal Rate of Return to analyze which of the two investments would be more viable to the producer. After checking the indicators, the peach orchard emerged, obtaining better results. Given these indicators, it is concluded that the investment that will bring more return to the producer will be the implementation of the peach orchard, because it is the investment that will pay faster and will enable greater return.*

I. INTRODUCTION

In recent years, agriculture has had an expressive growth in the technological area. This has greatly helped the small producer, reducing the damage and losses caused by aspects that the farmer can not contain, such as the climate (a lot of rain, drought, windstorms, hail),marketprice fluctuations, prices of the insum, among others. These risks can be reduced thanks to the aid of technology, such as more accurate and fast equipment, orchard cover, irrigation, agricultural insums, among riogrande do Suldive otherinnovations.

According to Matos, Machado and Lopes (2020, p. 6) "Fruit growing is to be seen as a promising business, so all phases that relate economic, ecological and technical issues, become fundamental before the implementation of the orchard, because usually the costs are high and the markets are demanding in quality and very competitive".

The Region of Serra Gaúcha, Rio Grande do Sul, is well known for grape cultivation. According to IBGE data (2017) in the city of Campestre da Serra 341 properties have vines, among the 341 properties, 8 properties produce table grapes and 333 properties produce grape intended for wine or juice production, these produce approximately a total of 15,133 tons per year.

In addition to the cultivation of vines, Campestre da Serra is also well known for the production of peaches, which according to IBGE (2017) 88 properties

grow peach trees, and the total sum of these properties total an area of 152 hectares, producing a total of 1,986 tons per year.

With the proposed study, we seek to analyze, the investments, costs, expenses and revenues that a rural producer has with the implementation of 1 hectare of orchard of peach trees fascination variety comparing with the implnesting 1 hectare of vine variety niágara rosada and what the result generated financial ly of the same crops.

The study will becarried out in a small rural property, located in Campestre da Serra - Rio Grande do Sul, focusing ondemonstrating which crop will be more profitable in the period of 10 years, after planting. To carry out the study, cost accounting techniques will be applied in the rural property, in order to assist the smallproducer.

The analysis of the performance of the study will be done through the use of cost accounting in the fruit sector, seeking to identify all the costs incurred in the implementation and production and analyze the profitofthe crops. Net present value (LPV), internal rateof return(IRR),simple payback and cashflow willbe calculated.

The research will be carried out in order to demonstrate information to the rural producer, information regarding costs, expenses, revenues and net income that it has obtained over the years, assisting in the decision of future investments.

The theme proposed in the study brings the comparison of two different cultures, in order to assist small farmers in decision making. Based on this arises the following problem: What is the economic result generated by the sale of grape and peach on a rural property of Campestre da Serra - Rio Grande do Sul during the harvests of the period 2020 to 2030?

Thus, the general objective of this study is to analyze the return on investment based on the economic result generated by the sale of grape and peach in a rural property of Campestre da Serra - Rio Grande do Sul during the 2020 to 2030 harvests.

The proposed objective is based on its family cultivating peach and grape, emerging the curiosity to know which variety will bring a greater economic return. The study will help the family, which depends entirely on financial resources, from the cultivation of orchards. The lack of effective data harms the producer who invests in a given orchard and ends up obtaining little remuneration, compared to another crop.

The main beneficiary of the study will be the manager of the property, through the identification of revenue, its costs and expenses, being possible to make an estimate of the result obtained in the period.

In view of the difficulty of measuring the costs and expenses in rural property, the study will not only contribute to your family, but your community and producers from other locations, and can serve as a modeland be plicated in other properties.

II. THEORETICAL FRAMEWORK

In this chapter will be presented several theoretical concepts related to the proposed theme, such as accounting, cost accounting, rural accounting, agribusiness, cost management, theories that are related to the theme, providing sustainability to work.

For Lakatos and Marconi (GUTH and PINTO 2007, p. 142) " with a view to answering the question "how? ", the theoretical basis, contains the literary basis on the subject, as well as the definition of the concepts employed. "

2.1 AGRIBUSINESS

The concept of agribusiness derives from the expression "agribusiness", attributed to Davis and Goldberg (1957), and refers to all operations of production and distribution of agricultural supplies; production operations on the farm; storage, processing, industrialisation and distribution of agricultural products. (Feix, Junior, Agranonik, 2017, p.5).

Data demonstrated by IBGE 2017, from the 2017 Agricultural Census, indicate that in all national territory, there are more than 5,073,324 agricultural establishments, 7.2% of which are in Rio Grande do Sul, and that it ranks 4th in the IBGE ranking. The total area of these establishments reaches a total of 351,289,816 hectares, in Rio Grande do Sul, the mark is 21,684,558. In Rio Grande do Sul, there are more than 992,000 people who work in the field, and who depend on agribusiness for their livelihood.

The agribusiness business, encompasses the entire production chain, which are classified in segments, before the gate, which is the supply of machinery, supplies and specialized service, within the gate, which is what is involved with the preparation and management of the harvest, and after the port, which is related to transport, storage and industrialization and marketing. (FEIX, JUNIOR AND AGRANONIK, 2017.)

The CNA (Confederation of Agriculture and Livestock of Brazil) announced on its website that in the

first two months of 2020 there was a growth in GDP (Gross Domestic Product) of agribusiness of 2.42% compared to the first two months of 2019.

According to Feix and Júnior (2019, p. 22)"Temporary and permanent agriculture occupies approximately nine million hectares in Rio Grande do Sul. About 95% of this area is focused on grain (cereals and oilseeds) production, which is the main agricultural activity of the State. "

Agribusiness ranges from production to the sale of the product, and it is possible to perceive the importance it has in Brazil and in the world. Present in most states, agriculture is something that is very proud of our country, assisting in the economy, bringing income and food to all.

2.2 - ACCOUNTING

Accounting is a very important science that assists the entire community, it studies, records and interprets phenomena that affect the heritage of any entity. One of its purposes is to provide necessary information, to assist in decision making and also to have good planning.

Since antiquity, man has directed efforts in order to organize and manage his profits, aiming at increasing his wealth. And it is through accounting that this process has become possible. More than exclusively managing and constituting riches, accounting has become an indispensable tool for modern man. (ALMEIDA, ANGELS, 2018, p. 2).

Generally speaking, when it comes to accounting, the first impression that comes to mind, is that only companies need this tool, but in fact it is quite the opposite. Of course, for companies, regardless of billing, accounting is indispensable, but accounting goes beyond that, it is necessary for both good control and personal financial planning as also necessary for rural producers.

The accounting context is unique, but accounting covers vast information for different branches. It is important to emphasize that for each type of activity it is necessary to apply techniques of different types. For the rural environment, rural accounting techniques are applied, necessary for control and administration of rural property, is a fundamental tool for rural producers, because through it it is possible to measure information to control their property and finances and assists in the decision-making of the producer.

2.2.1 - Rural accounting

Agriculture represents all the activity of exploitation of the land, be it the cultivation of crops and forests or the creation of animals, with a view to obtaining products that will meet human needs. (CREPALDI, 2019, p. 1).

Rural accounting is very important for the agriculture industry, regardless of whether it is large, medium or small producer, it is the accounting that assists the rural producer in the administration of his crop or orchard, controlling economically and financially the property, a tool that assists in decision making.

The contability inBrazil is littleused,due to the lack of knowledge of the importance of the information that rural accounting provides to the entrepreneur and the importance of it for decisionmaking. This ignorance is part of both entrepreneurs, who manage their crops, and accountants. (CREPALDI, 2019)

In rural areas, it is more difficult to apply accounting due to the great difficulty of separating what are production costs and what are expenses, especially when the producer owns more than one type of crop on his property and when the orchards are of permanent crops. An example that can be used is the difficulty of measuring the hours worked with the same machinery used in different orchards.

2.2.2 - Permanent crops

Permanent crops of long duration, which after their harvest do not require a new planting, but have been fixed to the soil for several consecutive years. Some examples of permanent crops are peach, grape, orange, coffee, bergamot, plum, permaqui crops, etc.

The accounting of permanent crop orchards requires little more attention, but ensures accurate information that helps the producer to define what is cost or expense of the respective orchard.

According to ibge 2017 data from the city of Campestre da Serra - Rio Grande do Sul,there are approximately 450 properties that use their land with some permanent culture, they are: plum, blackberry, banana, permaqui, fig, kiwi, orange, apple, walnut, pear, peach, bergamot and grape.

2.2.3 Vine culture

The area cultivated with vines in Brazil, in 2018, was 75,951 ha, the cultivation of this crop produced in the same year 1,592,242 tons of grape. The Southern region of Brazil is home to the largest viticulture area in the country, where it had a 73.35% share of all production. Rio Grande do Sul, is the state that stands out in grape production, and is responsible for 62.39% of the national wine area, in 2018 was responsible for the production of 822,689 toneladas. (MELLO, 2019, p.3).

The vine is a permanent crop that had a strong influence of Italian colonization, most of its cultivation is located in the northeast of the State of Rio Grande do Sul, especially the Serra region. All municipalities that produce on average more than 10,000 tons/year in the period 2016-2018 are located in the Serra region, with the exception of Monte Alegre dos Campos and Campestre da Serra, which are located in the Campos de Cima da Serra region. (SOCIO-ECONOMIC ATLAS RIO GRANDE DO SUL, 2019).

Only a small part of its cultivation is intended for table consumption, the grape is more used for making juice and wines. There are several varieties of grape, burgundy, isabel, merlot, cabernet, pink niágara, white niagara, among other varieties.

The production of the variety of the rosada niágara grape focuses on meeting the consumption in natura. Generally the producers of this variety, invest in new technology, such as the use of plastic cover and irrigation, to optimize their production both in yield and quality.

2.2.4 Peach culture

The peach tree is a species native to China, which would have been taken from China to Persia and then spreading throughout Europe, studies indicate that the species remoteto 20 centuries to C.. In Brazil, according to reports, the peach tree was introduced in 1532 by Martim Afonso de Souza, through seedlings brought from Madeira Island and planted in São Vicente, now the state of São Paulo. (EMBRAPA, 2003).

In Brazil, the states located in the southern region have the best natural conditions for commercial peach production. It is also possible to produce it in other states with less demanding cold cultivars or in microclimatic seasons appropriate to the minimum viable requirements, technically and economically. Rio Grande do Sul is the largest national producer of peach, being possible to find its cultivation in all regions of the state. (EMBRAPA, 2003).

The variety of peach fascination was launched in 2012, production in adult plants reaches an average of 90 kg/plant and adapts in regions with 200 to 300 hours of hibernation cold. (EMBRAPA, 2020).

Data from IBGE 2018 report that in Brazil, the amount produced tons of peach reached 219,598 nationwide, the states of Rio grande do Sul, Santa Catarina and Paraná produced a total of 176,799 tons. The state of Rio Grande do Sul was responsible for most of it, totaling 146,431 tons produced.

2.3. COST ACCOUNTING

Cost management aims to analyze the possibility of minimizing costs and maximizing profit, through facts and reports that enable the separation of costs and expenses. Cost accounting helps companies of different branches, among many there are industrial, commercial and agricultural companies as well, being responsible for generating information that serves for decision making, planning and also in increasing the profitability of the company.

Cost accounting arose due to the need to measure the costs of products to facilitate the calculation of the result, over the years, cost accounting has become a very important tool in the management area of companies, being also used in planning, cost control, decision making and meeting fiscal and legal requirements. (ATKINSON, BANKER, KAPLAN AND YOUNG,2000 apud CREPALDI And CREPALDI, 2018)

Over time, cost accounting has been evolving and is no longer just an instrument that assists in the valuation of inventories and profits. With modernization it is becoming an important instrument of control and support for decision making. As a management tool, it ceased to be an instrument only that industrial companies used, and began to be used in several other fields. (CREPALDI and CREPALDI, 2018)

For Ribeiro (2013, p.13) cost accounting is a branch applied only in industrial companies. The author refers to cost accounting, such as industrial accounting, being applied only to assets of industrial companies. For the author industrial companies are those whose main activity is focused on the transformation of raw material into products.

Cost accounting is characterized by being a set of specific records, such as bookkeeping-based records supported by tools such as spreadsheets, apportionments, calculations, and many others, to identify, measure, and report sales costs for products, goods, and services. (CREPALDI and CREPALDI, 2018)

Crepaldi and Crepaldi bring a more revolutionary view of cost accounting, and can be applied in all branches of companies, for Ribeiro, cost accounting can only be applied in industrial companies. But everyone is aware that cost accounting is an essential tool that assists managers in decision making.

III.   METHODOLOGY

The research methodology aims to help the researcher understand theprocess of research

It is characterized by the proposal to discuss and evaluate the characteristics of science and other forms of knowledge, such as methodological approach, focusing on planning, presentation, execution and reporting. (GUTH and PINTO, 2007)

The methodology is a way to be followed to reach a certain end, and that aims to evaluate, criticize and limit the study.

3.1 RESEARCH DESIGN

To Guth and Pinto (2007, p. 41). " When to the objectives the research can be exploratory, descriptive or explanatory. What determines the choice of one or the other type are the established objectives. "

For the proper study, an exploratory research will be applied, which for Gil (apud PEREIRA, 2019, p. 90) exploratory research "provides greater familiarity with the problem in order to make it explicit or to construct hypotheses. It involves bibliographic survey, interviews with people who had practical experiences with the problem researched. "

It can be affirmed that exploratory research takes a form of case study, bibliographic research will be used to give basis and foundation to the study and also property data to solve the problem researched.

The case study explores real-life situations in order to find solutions to situations that have not yet been defined, preserving the character of the object studied, formulations of hypotheses, explanations of phenomena. (GUTH and PINTO, 2007)

As for the procedure, for Guth and Pinto (2007, p. 47), "the design refers to the planning of the research in which its deepest dimension involving both the diagramming and the prediction of analysis and interpretation of data collection."

In this case study, it is intended to collect data from the property for analysis and interpretation of the same. In addition to the collection of data on the property, budgets will be made with companies in the region to obtain data on the amount that will be invested for coverage and irrigation. Through the data will be applied all methods and rationale to analyze the investment proposal of the research.

The research design will be carried out through bibliographic research, in which books, scientific articles and other means of publications and the collection of property data will be used.

The main objective of the research is to assist rural producers in making decisions on their property and in the administration of the site.

3.2 STUDY PARTICIPANTS (QUALITATIVE STUDY) AND/OR POPULATION AND SAMPLE (QUANTITATIVE STUDY)

A quantitative research will be applied, as a data analysis will be performed to obtain a concrete result. According to the authors Guth and Pinto (2007, p. 75) skin is characterized as a statistical instrument both for the data collection phase and for the treatment of the collected data, [...], because it is concerned only with the general behavior of the facts.

The participants of the sample will be the rural producers who have the same cultures of the study, will be used information from the producer block of the same to make an average of the production volume and sales price.

3.3 DATA COLLECTION AND ANALYSIS PROCESS

Data collection will be through budgets and information through interviews with the producer himself, since he has both varieties on his property, however, exposed to the effects of time, affecting the quality of the product and also endangering its harvest. The implementation of the orchards will be funded through the BNDS (National Bank for Economic and Social Development), and the payment will take place year by year, until the end of the period of 10 years.

The analysis of the study will be done through the use of cost accounting in the fruit sector, seeking to identify all the costs incurred in the implementation and production and analyze their profitability. An analysis of the contribution margin, net present value, internal rate of return, payback and cash flow will be made.

IV.   RESEARCH RESULTS

In this part will be presented the analysis of data and information on the feasibility of implantation of a peach orchard and other orchard of vines, of which an investment analysis will be made and find out which is the most profitable for the producer in a period of 10 years, crop 2020/2021 to 2030/2031.

For the implementation of permanent crop orchards, will be taken into account all technology that today is necessary for a production of good quality and productivity. In the project, the orchards will be covered and irrigated, the vines having plastic cover and the peach screens anti hail.

As a projection of years will be made, it was considered an annual inflation of 5.85%, in the value of costs and expenses, and also in the value of the sales price.

To reach this index, an average was made using the values of the Accumulated National Index of Broad Consumer Prices (IPCA) of each year, from 2010 to 2019.

4.1 PRESENTATION OF THE INVESTMENT OF ORCHARDS

The initial cost for the implementation of orchards of 1 hectare each was calculated through a research with companies close to the region, which provided the structure of these orchards and budget for

their implementation. In Tables 1 and 2, we can analyze the composition of materials needed for the implantation of orchards.

Chart 1 is the materials used for the implantation of parreiral, it is worth mentioning that it was considered an orchard of rosadania vines, which has cover and irrigation, which help in a production of quality and also of quantity.

Table 1 - Parreiral investment base.

BASE DE INVESTIMENTO PARREIRAL					
MATERIAL	**UNIDADE**	**QUANT**	**VALOR UNIT.**	**VALOR TOTAL**	**PERCETUAL**
MUDAS	UN.	2680	R$ 10,00	R$ 26.800,00	15,99%
RABICHO	UN.	148	R$ 14,00	R$ 2.072,00	1,24%
RABICHO DE CANTO	UN.	4	R$ 120,00	R$ 480,00	0,29%
PALANQUE DE CANTO	UN.	4	R$ 120,00	R$ 480,00	0,29%
PALANQUES DE ESCORA	UN.	1280	R$ 8,00	R$ 10.240,00	6,11%
PALANQUES LATERAIS	UN	148	R$ 25,00	R$ 3.700,00	2,21%
CORDOALHA 7 FIOS	METROS	220	R$ 7,00	R$ 1.540,00	0,92%
CORDOALHA 3 FIOS	METROS	3500	R$ 1,25	R$ 4.375,00	2,61%
ARAME LISO DE 1.000 MTS.	ROLOS	28	R$ 320,00	R$ 8.960,00	5,35%
ARAME LISO NÚMERO 20	KG	6	R$ 20,00	R$ 120,00	0,07%
MÃO DE OBRA		1	R$ 25.000,00	R$ 25.000,00	14,92%
HORA MÁQUINA	HORAS	10	R$ 250,00	R$ 2.500,00	1,49%
PALANQUE 3 MTS TRATADO	UN	80	R$ 30,00	R$ 2.400,00	1,43%
COBERTURA	UN	1	R$ 64.086,80	R$ 64.086,80	38,25%
IRRIGAÇÃO	UN	1	R$ 14.807,62	R$ 14.807,62	8,84%
TOTAL DO INVESTIMENTO				**R$ 167.561,42**	**100%**

Source: Producer data, prepared by the author (2020).

Table 1 details the base of materials used for the implantation of the vine orchard, the total value of the initial investment is R$ 167,561.42. A loan will be made through the bank, of the total amount, with a payment term of 10 years.

Chart 2 is the materials needed to implement the orchard of peach trees of the fascination type.

Table 2 - Peach orchard investment base.

BASE DE INVESTIMENTO PÊSSEGOS							
MATERIAL	UNIDADE	QUANT	VALOR UNIT.		VALOR TOTAL		PERCENTUAL
MUDAS	UN.	1000	R$	10,00	R$	10.000,00	12,60%
MÃO DE OBRA	HORAS	10	R$	120,00	R$	1.200,00	1,51%
HORA MÁQUINA	HORAS	10	R$	250,00	R$	2.500,00	3,15%
COBERTURA	UN.	1	R$	54.404,00	R$	54.404,00	68,57%
IRRIGAÇÃO	UN.	1	R$	11.232,62	R$	11.232,62	14,16%
TOTAL DO INVESTIMENTO					R$	79.336,62	100,00%

Source: Producer data, prepared by the author (2020).

Table 2 details the base of materials used for the implementation of the peach orchard, the total value of the initial investment is R$ 79,336.62. A loan will be made through the bank, of the total amount, with a payment term of 10 years.

Analyzing Tables 1 and 2, it is possible to notice that indifferent to the type of plantation that the producer chooses, its largest expenditure will be on the orchard cover, in the investment of the parreiral, the coverage is responsible for 38.25% of the total investment, while in the investment of the peach orchard this percentage increases even more, totaling 68.57% of the total investment.

Even so, for the rural producer, it becomes advantageous to cover their orchards, assisting in the higher productivity and quality of the fruit, and also assisting in the protection of orchards against hail storms.

Comparing one investment with the other, it is possible to perceive the difference in value for the implantation of the orchards. The peach orchard has a much lower expenditure compared to parreiral, this happens due to the demand for structure to keep the parreiral standing, and also the differentiated labor for each orchard.

The labor force used is the largest differential between investments, R$ 25,000.00 for parreiral implantation, and only R$ 1,200.00 for the planting of peach trees. This difference is due to the being different segments, each culture has its own structure.

For the implementation of parreiral is necessary all labor for installation of podiums, wire, rabichos and planting, already in the orchard of peach trees, the labor is only for planting the plant.

But in addition to all the expenses that the producer will have on the implementation, will also have expenses with the conduct of the orchard, agricultural insums, insurance and taxes on land.

4.2 COSTS IN THE CONDUCT OF ORCHARDS

All information on the costs of conducting the orchards was provided by the producers in the region who grow this same type of fruit. After the interview with the producers, it was necessary to contact companies close to the region to budget the products used by the producers.

Tables 3, 4, 5 and 6 deal with the driving costs of each orchard, starting from the 2020/2021 harvest until the 2029/2030 harvest.

Table 3 - Cost of grape production.

CUSTO DE PRODUÇÃO DA UVA										
CUSTO DE PRODUÇÃO DE 1 HECTARE	2020/2021		2021/2022		2022/2023		2023/2024		2024/2025	
INSUMOS AGRÍCOLAS	R$	3.152,00	R$	3.336,39	R$	3.732,13	R$	3.950,46	R$	4.181,56
MÃO DE OBRA CONTRATADA	R$	1.950,00	R$	2.064,08	R$	10.644,01	R$	11.266,69	R$	11.925,79
FRETE					R$	605,03	R$	640,42	R$	677,89
HORAS MÁQUINAS	R$	900,00	R$	952,65	R$	1.344,51	R$	1.423,16	R$	1.506,42
ITR	R$	63,76	R$	67,49	R$	71,44	R$	75,62	R$	80,04
TOTAL	R$	6.065,76	R$	6.420,61	R$	16.397,11	R$	17.356,34	R$	18.371,69

Source: Producer data, prepared by the author (2020).

For the survey of costs, was taking into account all agricultural insums, labor, used for pruning, mooring, harvesting, freight, hour machines and land tax. The ITR (Rural Territorial Tax), in the municipality of Campestre da Serra,

is calculated on the value of bare land, R$ 3,188.00 per hectare, the rate is based on the Selic rate, which at the moment is 2%.

Table 4 Shows the continuation of the calculation of grape production costs.

CUSTO DE PRODUÇÃO DA UVA										
CUSTO DE PRODUÇÃO DE 1 HECTARE	2025/2026		2026/2027		2027/2028		2028/2029		2029/2030	
INSUMOS AGRÍCOLAS	R$	4.426,18	R$	4.685,11	R$	4.959,19	R$	5.249,30	R$	5.556,39
MÃO DE OBRA CONTRATADA	R$	12.623,45	R$	13.361,92	R$	14.143,59	R$	14.970,99	R$	15.846,79
FRETE	R$	717,54	R$	759,52	R$	803,95	R$	850,98	R$	900,77
HORAS MÁQUINAS	R$	1.594,54	R$	1.687,82	R$	1.786,56	R$	1.891,07	R$	2.001,70
ITR	R$	84,72	R$	89,68	R$	94,93	R$	100,48	R$	106,36
TOTAL	R$ 19.446,43		R$ 20.584,05		R$ 21.788,21		R$ 23.062,82		R$ 24.412,00	

Source: Producer data, prepared by the author (2020).

For the calculation of freight, it was estimated a value of R $ 3.00 the kilometer wheeled, and a total of 180 kilometers traveled for delivery of the grape, the distance between the orchard of the producer to the city for delivery is 15 kilometers, considering round trip totals 30 kilometers each trip. This value was used in 2020, with an adjustment each year of 5.85%. To choose the index, an average inflation was made for the years 2010 to 2019. The same index used to correct revenues.

Production starts from the 2022/2023 crop, and so the costs increase in value, from the 2022/2023 to 2029/2030 crop to 2029/2030 the amount of insum, labor, freight, machinery hours and land tax are the same, the difference in value is due to the annual adjustment of the values, that is, 5.85% per year.

To estimate the costs of peach orchard, was also taken into account the same annual adjustment and also the same basis on the land tax, the difference is that, from the harvest 2021/2022 begins the production of fruits, and with this the cost is higher, tripling its value, after this harvest the costs remain equal only, only suffer the annual adjustment.

The freight value was also considered the same value, R $ 3.00 the kilometer wheeled, the difference is only in mileage, which happens to be 150 kilometers, the same 30 kilometers were considered for the calculation of freight, the difference is in the amount of trips for the freight of the grape was considered 6 trips and for peaches 5 trips. The table better shows us how the costs look during the period analyzed.

Table 5 - Cost of peach production.

CUSTO DE PRODUÇÃO DO PÊSSEGO										
CUSTO DE PRODUÇÃO DE 1 HECTARE	2020/2021		2021/2022		2022/2023		2023/2024		2024/2025	
INSUMOS AGRÍCOLAS	R$	3.620,50	R$	3.832,30	R$	6.030,11	R$	6.382,87	R$	6.756,27
MÃO DE OBRA CONTRATADA	R$	1.050,00	R$	9.103,10	R$	9.635,63	R$	10.199,32	R$	10.795,98
FRETE			R$	476,33	R$	504,19	R$	533,69	R$	564,91
HORAS MÁQUINAS	R$	1.300,00	R$	1.058,50	R$	1.120,42	R$	1.185,97	R$	1.255,35
SEGURO			R$	4.763,25	R$	5.041,90	R$	5.336,85	R$	5.649,06
ITR	R$	63,76	R$	67,49	R$	71,44	R$	75,62	R$	80,04
TOTAL	R$ 6.034,26		R$ 19.300,96		R$ 22.403,69		R$ 23.714,31		R$ 25.101,60	

Fonte: Producer data, prepared by the author (2020).

The first year, 2020/2021 crop, has a reduced cost compared to subsequent harvests. This reduction is due to the no harvest in 2021/2021, and therefore its costs are reduced, it is observed that there is a large increase in the labor of 2021/2022 compared to the 2020/2021 crop, an increase caused by the labor used in harvesting, pruning and thleging.

Table 6 shows the continuation of the calculation of peach costs.

Table 6 - Cost of peach production.

CUSTO DE PRODUÇÃO DO PÊSSEGO										
CUSTO DE PRODUÇÃO DE 1 HECTARE	**2025/2026**		**2026/2027**		**2027/2028**		**2028/2029**		**2029/2030**	
INSUMOS AGRÍCOLAS	R$	7.151,51	R$	7.569,88	R$	8.384,92	R$	8.481,46	R$	8.977,62
MÃO DE OBRA CONTRATADA	R$	11.427,54	R$	12.096,05	R$	12.431,47	R$	13.552,69	R$	14.345,52
FRETE	R$	597,95	R$	632,93	R$	669,96	R$	709,15	R$	750,64
HORAS MÁQUINAS	R$	1.328,78	R$	1.406,52	R$	1.488,80	R$	1.575,89	R$	1.668,08
SEGURO	R$	5.979,53	R$	6.329,33	R$	6.699,60	R$	7.091,52	R$	7.506,38
ITR	R$	84,72	R$	89,68	R$	94,93	R$	100,48	R$	106,36
TOTAL	**R$ 26.570,04**		**R$ 28.124,39**		**R$ 29.769,67**		**R$ 31.511,19**		**R$ 33.354,60**	

Source: Producer data, prepared by the author (2020).

It was considered safe only for the peach orchard, because the cover only protects from hail rains, if there is some frost during the period of fruit formation the cover will not protect it. In the case of vines, it was not considered safe, because the producers claim that with the cover the vine and its production are protected from hail rains.

The values were presented only their totalities, due to the large accumulation of information, because it is a projection for 10 years, plus all costs were included according to the production and the need of each crop.

As mentioned above, the projection of costs was made according to information of producers who have this type of crops, and after data collection the product budget, labor and insurance for their projection.

4.3 RECIPES

Revenue swerves from the sale of goods and the provision of services. There are other activities that can generate revenue and that are not linked to the sale or provision of service, such as rents or income from a financial application.

For the study, the average used amount of grape harvested was 30,000 kilos per hectare, and peach 25,000 kilos per hectare. The selling price was extracted from the notes issued from 2015 to 2019 from the blocks of rural producers that have these crops on their properties and from these made an average of the value.

The Tables below better detail this information, showing us the gross and net revenue of each crop over a 10-year period. Funrural, rural worker assistance fund, is a fund focused on social contribution, its collection is mandatory, and essential for rural producers to retire.

The value in Funrural, focuses on gross revenue, and its rate of 1.5 % (1.2% INSS + 0.1% RAT + 0.2% SENAR) is considered only for rural producers individuals.

Table 7 - Recipes obtained vine.

RECEITAS SAFRAS 2020/2021 A 2029/2030 - VIDEIRA									
SAFRAS	**QUANT COLHIDA**	**VALOR UNIT**		**REC. BRUTA**		**FUNRURAL 1,5%**		**RECEITA LÍQUIDA**	
2020/2021	-	-		-		-		-	
2021/2022	-	-		-		-		-	
2022/2023	30.000	R$	2,40	R$	72.000,00	R$	1.080,00	R$	70.920,00
2023/2024	30.000	R$	2,54	R$	76.200,00	R$	1.143,00	R$	75.057,00
2024/2025	30.000	R$	2,69	R$	80.700,00	R$	1.210,50	R$	79.489,50
2025/2026	30.000	R$	2,85	R$	85.500,00	R$	1.282,50	R$	84.217,50
2026/2027	30.000	R$	3,01	R$	90.300,00	R$	1.354,50	R$	88.945,50
2027/2028	30.000	R$	3,19	R$	95.700,00	R$	1.435,50	R$	94.264,50
2028/2029	30.000	R$	3,38	R$	101.400,00	R$	1.521,00	R$	99.879,00
2029/2030	30.000	R$	3,57	R$	107.100,00	R$	1.606,50	R$	105.493,50
TOTAL				**R$ 708.900,00**		**R$ 10.633,50**		**R$ 698.266,50**	

Source: Producer data, prepared by the author (2020).

The amount of production will always be considered the same, in the case of the vine, from the 2022/2023 crop to the 2029/2030 harvest, was considered the same amount harvested, 30,000 kilos per year, as is being made a projection of the harvests, we chose to follow an average harvest of the past harvests. These quantities were also extracted from the notepads of producers who grow this type of crop.

Table 8 - Recipes obtained peach.

RECEITAS SAFRAS 2020/2021 A 2029/2030 - PÊSSEGO					
SAFRAS	**QUANT COLHIDA**	**VALOR UNIT**	**REC. BRUTA**	**FUNRURAL 1,5%**	**RECEITA LÍQUIDA**
2020/2021	-	-	-	-	-
2021/2022	25.000	R$ 2,00	R$ 50.000,00	R$ 750,00	R$ 49.250,00
2022/2023	25.000	R$ 2,12	R$ 53.000,00	R$ 795,00	R$ 52.205,00
2023/2024	25.000	R$ 2,24	R$ 56.000,00	R$ 840,00	R$ 55.160,00
2024/2025	25.000	R$ 2,37	R$ 59.250,00	R$ 888,75	R$ 58.361,25
2025/2026	25.000	R$ 2,51	R$ 62.750,00	R$ 941,25	R$ 61.808,75
2026/2027	25.000	R$ 2,66	R$ 66.500,00	R$ 997,50	R$ 65.502,50
2027/2028	25.000	R$ 2,81	R$ 70.250,00	R$ 1.053,75	R$ 69.196,25
2028/2029	25.000	R$ 2,98	R$ 74.500,00	R$ 1.117,50	R$ 73.382,50
2029/2030	25.000	R$ 3,15	R$ 78.750,00	R$ 1.181,25	R$ 77.568,75
TOTAL			**R$ 571.000,00**	**R$ 8.565,00**	**R$ 562.435,00**

Source: Producer data, prepared by the author (2020).

In the case of peach production, the same amount harvested in all harvests was also considered, 25,000 kilos, because it is a projection, the notepads of the past harvests were used to reach an average production.

As previously mentioned, the harvest period of the grape considered from the 2022/2023 crop, because in the first two years, the orchard is still in formation, and therefore has no active production yet. For the peach orchard, peach harvest was considered from the 2021/2022 crop, because in its second year it already has production.

4.5 DEPRECIATION OF ASSETS

Depreciation, which is also known as devaluation of a good or product, begins when the asset is in place and conditions for operation. For the study, the linear method of depreciation was used, that is, that the values will be constant in all periods. For the calculation of depreciation, the value of the good was used and divided by the useful life of the same.

Table 9 - Parreiral depreciation

TABELA DE IMOBILIZADO						
DESCRIÇÃO DO BEM	**ANO DO BEM**	**ANO DA AQUISIÇÃO**	**VIDA ÚTIL (ANO)**	**TAXA DE PREPRECIAÇÃO POR ANO**	**VALOR DO BEM**	**DEPRECIAÇÃO ANUAL**
TRATOR LS R50	2017	2017	20	5,00%	R$ 70.900,00	R$ 3.545,00
PULVERIZADOR REBOQUE 600 LT	2019	2019	20	5,00%	R$ 28.500,00	R$ 1.425,00
ROÇADEIRA 1,50 METROS	2019	2019	20	5,00%	R$ 5.500,00	R$ 275,00
TESOURA DE PODA ELETRICA	2019	2019	10	10,00%	R$ 7.000,00	R$ 700,00
ESPALHADOR DE ADUBO	2018	2018	20	5,00%	R$ 2.200,00	R$ 110,00
CARRETÃO	2008	2008	20	5,00%	R$ 1.500,00	R$ 75,00
PULVERIZADOR 200 LT	2007	2007	20	5,00%	R$ 5.000,00	R$ 250,00
PLATAFORMA BASCULANTE	2015	2015	20	5,00%	R$ 1.800,00	R$ 90,00
PLAINA TRATORIZADA	2017	2017	20	5,00%	R$ 2.200,00	R$ 110,00
PAVILHÃO	2017	2017	25	4,00%	R$ 70.000,00	R$ 2.800,00
PARREIRAL			30	3,33%	R$ 167.561,42	R$ 5.579,80
TOTAL						**R$ 14.959,80**

Source: Producer data, prepared by the author (2020).

For depreciation of parreiral, it was considered a useful life of the orchard of 30 years, 3.33% of depreciation per year, totaling a value of R$ 5,579.80 only depreciation of the parreiral.

Table 10 - Depreciation peach orchard

TABELA DE IMOBILIZADO						
DESCRIÇÃO DO BEM	**ANO DO BEM**	**ANO DA AQUISIÇÃO**	**VIDA ÚTIL (ANO)**	**TAXA DE PREPRECIAÇÃO POR ANO**	**VALOR DO BEM**	**DEPRECIAÇÃO ANUAL**
TRATOR LS R50	2017	2017	20	5,00%	R$ 70.900,00	R$ 3.545,00
PULVERIZADOR REBOQUE 600 LT	2019	2019	20	5,00%	R$ 28.500,00	R$ 1.425,00
ROÇADEIRA 1,50 METROS	2019	2019	20	5,00%	R$ 5.500,00	R$ 275,00
TESOURA DE PODA ELETRICA	2019	2019	10	10,00%	R$ 7.000,00	R$ 700,00
ESPALHADOR DE ADUBO	2018	2018	20	5,00%	R$ 2.200,00	R$ 110,00
CARRETÃO	2008	2008	20	5,00%	R$ 1.500,00	R$ 75,00
PULVERIZADOR 200 LT	2007	2007	20	5,00%	R$ 5.000,00	R$ 250,00
PLATAFORMA BASCULANTE	2015	2015	20	5,00%	R$ 1.800,00	R$ 90,00
PLAINA TRATORIZADA	2017	2017	20	5,00%	R$ 2.200,00	R$ 110,00
PAVILHÃO	2017	2017	25	4,00%	R$ 70.000,00	R$ 2.800,00
POMAR PÊSSEGO			15	6,67%	R$ 79.336,62	R$ 5.291,75
TOTAL						R$ 14.671,75

Source: Producer data, prepared by the author (2020).

Tables 9 and 10 show a small difference in the total depreciated value, this small difference occurs due to the difference in useful life between the parreiral and the orchard, the parreiral has a useful life of 30 years and the peach orchard has a useful life of 15 years, because of this there was not much difference in depreciated values. The other goods will remain the same because they all meet the needs of the crops.

4.5 INCOME STATEMENT FOR THE YEAR

To elaborate the demonstration of the results, we considered all the data mentioned above, its main objective is to detail the formation of the net result of each crop crop and crop, in order to analyze the result obtained, and compare one crop with the other.

Tables 11 and 12 show the results obtained from the vine orchard, and Tables 13 and 14 show us the result obtained by the peach orchard.

Table -11 DRE vine.

DEMONSTRAÇÃO DO RESULTADO DO EXERCÍCIO - VIDEIRA					
	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025
PRODUÇÃO DE 1 HECTARE (KG)	-	-	30.000	30.000	30.000
PREÇO DE VENDA	-	-	R$ 2,40	R$ 2,54	R$ 2,69
RECEITA BRUTA	-	-	R$ 72.000,00	R$ 76.200,00	R$ 80.700,00
(-) IMPOSTOS - FUNRURAL 1,5%	-	-	R$ 1.080,00	R$ 1.143,00	R$ 1.210,50
(=) RECEITA LÍQUIDA	-	-	R$ 70.920,00	R$ 75.057,00	R$ 79.489,50
(-) CUSTOS VARIÁVEIS	R$ 5.102,00	R$ 5.400,47	R$ 14.376,14	R$ 15.217,14	R$ 16.107,34
INSUMOS AGRÍCOLAS	R$ 3.152,00	R$ 3.336,39	R$ 3.732,13	R$ 3.950,46	R$ 4.181,56
MÃO DE OBRA CONTRATADA	R$ 1.950,00	R$ 2.064,08	R$ 10.644,01	R$ 11.266,69	R$ 11.925,79
(-) DESPESAS VARIÁVEIS	R$ 900,00	R$ 952,65	R$ 1.949,53	R$ 2.063,58	R$ 2.184,30
FRETE	-	-	R$ 605,03	R$ 640,42	R$ 677,89
HORAS MÁQUINAS	R$ 900,00	R$ 952,65	R$ 1.344,51	R$ 1.423,16	R$ 1.506,42
(=) MARGEM DE CONTRIBUIÇÃO	-R$ 6.002,00	-R$ 6.353,12	R$ 54.594,33	R$ 57.776,28	R$ 61.197,85
(-) CUSTOS FIXOS	R$ 14.959,80	R$ 14.959,80	R$ 14.959,80	R$ 14.959,80	R$ 14.959,80
DEPRECIAÇÃO DO PARREIRAL	R$ 5.579,80	R$ 5.579,80	R$ 5.579,80	R$ 5.579,80	R$ 5.579,80
DEPRECIAÇÃO DOS BENS	R$ 9.380,00	R$ 9.380,00	R$ 9.380,00	R$ 9.380,00	R$ 9.380,00
(-) DESPESAS FIXAS	R$ 63,76	R$ 67,49	R$ 71,44	R$ 75,62	R$ 80,04
ITR	R$ 63,76	R$ 67,49	R$ 71,44	R$ 75,62	R$ 80,04
(-) DESPESAS FINANCEIRAS	R$ -	R$ -	R$ -	R$ 52.399,09	R$ 29.682,31
TAXAS/ JUROS DE EMPRÉSTIMOS				28.793,17	6.076,39
AMORTIZAÇÃO DO EMPRÉSTIMO				23.605,92	23.605,92
(=) RESULTADO FINANCEIRO	-R$ 21.025,56	-R$ 21.380,41	R$ 39.563,09	-R$ 9.658,23	R$ 16.475,70
(-) IR	-	-	-	-	-
(=) RESULTADO OPERACIONAL	-R$ 21.025,56	-R$ 21.380,41	R$ 39.563,09	-R$ 9.658,23	R$ 16.475,70

Source: Producer data, prepared by the author (

2020).

Table 12 shows the continuation of the calculation of vine recipes.

Table 12 - DRE vine.

DEMONSTRAÇÃO DO RESULTADO DO EXERCÍCIO - VIDEIRA					
	2025/2026	2026/2027	2027/2028	2028/2029	2029/2030
PRODUÇÃO DE 1 HECTARE (KG)	30.000	30.000	30.000	30.000	30.000
PREÇO DE VENDA	R$ 2,85	R$ 3,01	R$ 3,19	R$ 3,38	R$ 3,57
RECEITA BRUTA	R$ 85.500,00	R$ 90.300,00	R$ 95.700,00	R$ 101.400,00	R$ 107.100,00
(-) IMPOSTOS - FUNRURAL 1,5%	R$ 1.282,50	R$ 1.354,50	R$ 1.435,50	R$ 1.521,00	R$ 1.606,50
(=) RECEITA LÍQUIDA	R$ 84.217,50	R$ 88.945,50	R$ 94.264,50	R$ 99.879,00	R$ 105.493,50
(-) CUSTOS VARIÁVEIS	R$ 17.049,62	R$ 18.047,03	R$ 19.102,78	R$ 20.220,29	R$ 21.403,18
INSUMOS AGRÍCOLAS	R$ 4.426,18	R$ 4.685,11	R$ 4.959,19	R$ 5.249,30	R$ 5.556,39
MÃO DE OBRA CONTRATADA	R$ 12.623,45	R$ 13.361,92	R$ 14.143,59	R$ 14.970,99	R$ 15.846,79
(-) DESPESAS VARIÁVEIS	R$ 2.312,08	R$ 2.447,34	R$ 2.590,51	R$ 2.742,05	R$ 2.902,47
FRETE	R$ 717,54	R$ 759,52	R$ 803,95	R$ 850,98	R$ 900,77
HORAS MÁQUINAS	R$ 1.594,54	R$ 1.687,82	R$ 1.786,56	R$ 1.891,07	R$ 2.001,70
(=) MARGEM DE CONTRIBUIÇÃO	R$ 64.855,79	R$ 68.451,13	R$ 72.571,21	R$ 76.916,65	R$ 81.187,86
(-) CUSTOS FIXOS	R$ 14.959,80	R$ 14.959,80	R$ 14.959,80	R$ 14.959,80	R$ 14.959,80
DEPRECIAÇÃO DO PARREIRAL	R$ 5.579,80	R$ 5.579,80	R$ 5.579,80	R$ 5.579,80	R$ 5.579,80
DEPRECIAÇÃO DOS BENS	R$ 9.380,00	R$ 9.380,00	R$ 9.380,00	R$ 9.380,00	R$ 9.380,00
(-) DESPESAS FIXAS	R$ 84,72	R$ 89,68	R$ 94,93	R$ 100,48	R$ 106,36
ITR	R$ 84,72	R$ 89,68	R$ 94,93	R$ 100,48	R$ 106,36
(-) DESPESAS FINANCEIRAS	R$ 28.724,81	R$ 27.767,32	R$ 26.809,83	R$ 25.852,33	R$ 24.894,84
TAXAS/ JUROS DE EMPRÉSTIMOS	5.118,89	4.161,40	3.203,91	2.246,41	1.288,92
AMORTIZAÇÃO DO EMPRÉSTIMO	23.605,92	23.605,92	23.605,92	23.605,92	23.605,92
(=) RESULTADO FINANCEIRO	R$ 21.086,46	R$ 25.634,33	R$ 30.706,66	R$ 36.004,05	R$ 41.226,86
(-) IR	-	-	-	-	-
(=) RESULTADO OPERACIONAL	R$ 21.086,46	R$ 25.634,33	R$ 30.706,66	R$ 36.004,05	R$ 41.226,86

Fonte: Dados do produtor, elaborado pelo autor (2020).

In the first two years, the vine orchard showed negative results, but this is due to the fact that it does not have estimated production for this period, after which it is possible to perceive positives. In the period 2023/2024, operating results are negative again, due to the financial expenses of the period. The financial expenses come from the loan to cover investment expenses, a loan made in ten years to pay, with three years of grace and interest of 4% per year. The portion in the period 2023/2024 is higher, compared to the others due to the accumulation of the portions of the grace years.

Table 13 - Peach DRE.

DEMONSTRAÇÃO DO RESULTADO DO EXERCÍCIO - PÊSSEGO					
	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025
PRODUÇÃO DE 1 HECTARE (KG)	-	25000	25000	25000	25000
PREÇO DE VENDA	-	R$ 2,00	R$ 2,12	R$ 2,24	R$ 2,37
RECEITA BRUTA	-	R$ 50.000,00	R$ 53.000,00	R$ 56.000,00	R$ 59.250,00
(-) IMPOSTOS - FUNRURAL 1,5%	-	R$ 750,00	R$ 795,00	R$ 840,00	R$ 888,75
(=) RECEITA LÍQUIDA	-	R$ 49.250,00	R$ 52.205,00	R$ 55.160,00	R$ 58.361,25
(-) CUSTOS VARIÁVEIS	R$ 4.670,50	R$ 12.935,40	R$ 15.665,74	R$ 16.582,19	R$ 17.552,25
INSUMOS AGRÍCOLAS	R$ 3.620,50	R$ 3.832,30	R$ 6.030,11	R$ 6.382,87	R$ 6.756,27
MÃO DE OBRA CONTRATADA	R$ 1.050,00	R$ 9.103,10	R$ 9.635,63	R$ 10.199,32	R$ 10.795,98
(-) DESPESAS VARIÁVEIS	R$ 1.300,00	R$ 1.534,83	R$ 1.624,61	R$ 1.719,65	R$ 1.820,25
FRETE	-	R$ 476,33	R$ 504,19	R$ 533,69	R$ 564,91
HORAS MÁQUINAS	R$ 1.300,00	R$ 1.058,50	R$ 1.120,42	R$ 1.185,97	R$ 1.255,35
(=) MARGEM DE CONTRIBUIÇÃO	-R$ 5.970,50	R$ 34.779,78	R$ 34.914,64	R$ 36.858,16	R$ 38.988,75
(-) CUSTOS FIXOS	R$ 14.671,75	R$ 19.435,00	R$ 19.713,65	R$ 20.008,60	R$ 20.320,81
DEPRECIAÇÃO DO POMAR	R$ 5.291,75	R$ 5.291,75	R$ 5.291,75	R$ 5.291,75	R$ 5.291,75
DEPRECIAÇÃO DOS BENS	R$ 9.380,00	R$ 9.380,00	R$ 9.380,00	R$ 9.380,00	R$ 9.380,00
SEGURO	-	R$ 4.763,25	R$ 5.041,90	R$ 5.336,85	R$ 5.649,06
(-) DESPESAS FIXAS	R$ 63,76	R$ 67,49	R$ 71,44	R$ 75,62	R$ 80,04
ITR	R$ 63,76	R$ 67,49	R$ 71,44	R$ 75,62	R$ 80,04
(-) DESPESAS FINANCEIRAS	R$ -	R$ -	R$ -	R$ 24.809,81	R$ 14.053,92
TAXAS/ JUROS DE EMPRÉSTIMOS	R$ -	R$ -	R$ -	R$ 13.476,01	R$ 2.720,12
AMORTIZAÇÃO DO EMPRÉSTIMO	R$ -	R$ -	R$ -	R$ 11.333,80	R$ 11.333,80
(=) RESULTADO FINANCEIRO	-R$ 20.706,01	R$ 15.277,29	R$ 15.129,56	-R$ 8.035,87	R$ 4.533,98
(-) IR	-	-	-	-	-
(=) RESULTADO OPERACIONAL	-R$ 20.706,01	R$ 15.277,29	R$ 15.129,56	-R$ 8.035,87	R$ 4.533,98

DEMOSTRAÇÃO DO RESULTADO DO EXERCÍCIO - PÊSSEGO									
		2020/2021		2021/2022		2022/2023		2023/2024	2024/2025
PRODUÇÃO DE 1 HECTARE (KG)		-		25000		25000		25000	25000
PREÇO DE VENDA		-	R$	2,00	R$	2,12	R$	2,24	R$ 2,37
RECEITA BRUTA		-	R$	50.000,00	R$	53.000,00	R$	56.000,00	R$ 59.250,00
(-) IMPOSTOS - FUNRURAL 1,5%		-	R$	750,00	R$	795,00	R$	840,00	888,75
(=) RECEITA LÍQUIDA		-	R$	49.250,00	R$	52.205,00	R$	55.160,00	R$ 58.361,25
(-) CUSTOS VARIÁVEIS	R$	4.670,50	R$	12.935,40	R$	15.665,74	R$	16.582,19	R$ 17.552,25
INSUMOS AGRÍCOLAS	R$	3.620,50	R$	3.832,30	R$	6.030,11	R$	6.382,87	R$ 6.756,27
MÃO DE OBRA CONTRATADA	R$	1.050,00	R$	9.103,10	R$	9.635,63	R$	10.199,32	R$ 10.795,98
(-) DESPESAS VARIÁVEIS	R$	1.300,00	R$	1.534,83	R$	1.624,61	R$	1.719,65	R$ 1.820,25
FRETE		-	R$	476,33	R$	504,19	R$	533,69	564,91
HORAS MÁQUINAS	R$	1.300,00	R$	1.058,50	R$	1.120,42	R$	1.185,97	R$ 1.255,35
(=) MARGEM DE CONTRIBUIÇÃO	-R$	5.970,50	R$	34.779,78	R$	34.914,64	R$	36.858,16	R$ 38.988,75
(-) CUSTOS FIXOS	R$	14.671,75	R$	19.435,00	R$	19.713,65	R$	20.008,60	R$ 20.320,81
DEPRECIAÇÃO DO POMAR	R$	5.291,75	R$	5.291,75	R$	5.291,75	R$	5.291,75	R$ 5.291,75
DEPRECIAÇÃO DOS BENS	R$	9.380,00	R$	9.380,00	R$	9.380,00	R$	9.380,00	R$ 9.380,00
SEGURO		-	R$	4.763,25	R$	5.041,90	R$	5.336,85	R$ 5.649,06
(-) DESPESAS FIXAS	R$	63,76	R$	67,49	R$	71,44	R$	75,62	R$ 80,04
ITR	R$	63,76	R$	67,49	R$	71,44	R$	75,62	80,04
(-) DESPESAS FINANCEIRAS	R$	-	R$	-	R$	-	R$	24.809,81	R$ 14.053,92
TAXAS/ JUROS DE EMPRÉSTIMOS	R$	-	R$	-	R$	-		13.476,01	R$ 2.720,12
AMORTIZAÇÃO DO EMPRÉSTIMO	R$	-	R$	-	R$	-		11.333,80	R$ 11.333,80
(=) RESULTADO FINANCEIRO	-R$	20.706,01	R$	15.277,29	R$	15.129,56	-R$	8.035,87	R$ 4.533,98
(-) IR		-		-		-		-	-
(=) RESULTADO OPERACIONAL	-R$	20.706,01	R$	15.277,29	R$	15.129,56	-R$	8.035,87	R$ 4.533,98

Source: Producer data, prepared by the author (2020).

In the demonstration of peach results it is also possible to notice that in the first year, a negative result was obtained, from the second year on, it begins to present a positive and growing result. In the period 2023/2024, operating results are negative again, due to the financial expenses of the period.

Table 14 presents the continuation of the calculation of peach revenues.

Table 14 - DRE peach tree.

DEMOSTRAÇÃO DO RESULTADO DO EXERCÍCIO - PÊSSEGO									
		2025/2026		2026/2027		2027/2028		2028/2029	2029/2030
PRODUÇÃO DE 1 HECTARE (KG)		25000		25000		25000		25000	25000
PREÇO DE VENDA	R$	2,51	R$	2,66	R$	2,81	R$	2,98	R$ 3,15
RECEITA BRUTA	R$	62.750,00	R$	66.500,00	R$	70.250,00	R$	74.500,00	R$ 78.750,00
(-) IMPOSTOS - FUNRURAL 1,5%	R$	941,25	R$	997,50	R$	1.053,75	R$	1.117,50	R$ 1.181,25
(=) RECEITA LÍQUIDA	R$	61.808,75	R$	65.502,50	R$	69.196,25	R$	73.382,50	R$ 77.568,75
(-) CUSTOS VARIÁVEIS	R$	18.579,05	R$	19.665,93	R$	20.816,39	R$	22.034,14	R$ 23.323,14
INSUMOS AGRÍCOLAS	R$	7.151,51	R$	7.569,88	R$	8.384,92	R$	8.481,46	R$ 8.977,62
MÃO DE OBRA CONTRATADA	R$	11.427,54	R$	12.096,05	R$	12.431,47	R$	13.552,69	R$ 14.345,52
(-) DESPESAS VARIÁVEIS	R$	1.926,74	R$	2.039,45	R$	2.158,76	R$	2.285,05	R$ 2.418,72
FRETE	R$	597,95	R$	632,93	R$	669,96	R$	709,15	R$ 750,64
HORAS MÁQUINAS	R$	1.328,78	R$	1.406,52	R$	1.488,80	R$	1.575,89	R$ 1.668,08
(=) MARGEM DE CONTRIBUIÇÃO	R$	41.302,96	R$	43.797,12	R$	46.221,11	R$	49.063,31	R$ 51.826,89
(-) CUSTOS FIXOS	R$	20.651,28	R$	21.001,08	R$	21.371,35	R$	21.763,27	R$ 22.178,13
DEPRECIAÇÃO DO POMAR	R$	5.291,75	R$	5.291,75	R$	5.291,75	R$	5.291,75	R$ 5.291,75
DEPRECIAÇÃO DOS BENS	R$	9.380,00	R$	9.380,00	R$	9.380,00	R$	9.380,00	R$ 9.380,00
SEGURO	R$	5.979,53	R$	6.329,33	R$	6.699,60	R$	7.091,52	R$ 7.506,38
(-) DESPESAS FIXAS	R$	84,72	R$	89,68	R$	94,93	R$	100,48	R$ 106,36
ITR	R$	84,72	R$	89,68	R$	94,93	R$	100,48	106,36
(-) DESPESAS FINANCEIRAS	R$	13.600,56	R$	13.147,21	R$	12.693,86	R$	12.240,51	R$ 11.787,15
TAXAS/ JUROS DE EMPRÉSTIMOS	R$	2.266,76	R$	1.813,41	R$	1.360,06	R$	906,71	R$ 453,35
AMORTIZAÇÃO DO EMPRÉSTIMO	R$	11.333,80	R$	11.333,80	R$	11.333,80	R$	11.333,80	R$ 11.333,80
(=) RESULTADO FINANCEIRO	R$	6.966,40	R$	9.559,15	R$	12.060,97	R$	14.959,05	R$ 17.755,25
(-) IR		-		-		-		-	-
(=) RESULTADO OPERACIONAL	R$	6.966,40	R$	9.559,15	R$	12.060,97	R$	14.959,05	R$ 17.755,25

Fonte: Dados do produtor, elaborado pelo autor (2020).

The income tax was not considered, because from the year 2020 it is only mandatory to report if the producer has a gross income above R$ 142,782.50, and in the case of this study, no crop was reached this amount.

4.6 PROJECTED CASH FLOW

The projected cash flow is a projection of inputs and outputs for a given period, this projection is made according to actual input and output bases. For its elaboration, data were analyzed by rural producers, which were oscillated to get closer to an exact result.

Cash flow is fundamental for all types and companies and branches, as it helps to achieve proposed goals and objectives. The Tables below are representing the projected cash flow of each culture, transposing the flow of each period and the accumulated balance of each culture.

Table 15 - Projected Vines Cash Flow

FLUXO DE CAIXA VIDEIRAS					
DESCRIÇÃO	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025
ENTRADAS	R$ 173.627,18	6.420,61	R$ 72.000,00	R$ 76.200,00	R$ 80.700,00
RECEITA DE VENDAS			R$ 72.000,00	R$ 76.200,00	R$ 80.700,00
CAPITAL PRÓPRIO	R$ 6.065,76	R$ 6.420,61			
EMPRÉSTIMOS	R$ 167.561,42				
SAÍDAS	(173.627,18)	(6.420,61)	(17.477,11)	(70.898,43)	(49.264,50)
INVESTIMENTO FIXO	(167.561,42)				
IMPLANTAÇÃO - IVESTIMENTO INICIAL	(167.561,42)				
CUSTOS DIRETOS	(5.102,00)	(5.400,47)	(14.376,14)	(15.217,14)	(16.107,34)
INSUMOS AGRÍCOLAS	(3.152,00)	(3.336,39)	(3.732,13)	(3.950,46)	(4.181,56)
MÃO DE OBRA CONTRATADA	(1.950,00)	(2.064,08)	(10.644,01)	(11.266,69)	(11.925,79)
DESPESAS VARIÁVEIS	(900,00)	(952,65)	(1.949,53)	(2.063,58)	(2.184,30)
FRETE			(605,03)	(640,42)	(677,89)
HORAS MÁQUINAS	(900,00)	(952,65)	(1.344,51)	(1.423,16)	(1.506,42)
DESPESAS TRIBUTÁRIAS			(1.080,00)	(1.143,00)	(1.210,50)
IMPOSTOS A PAGAR			(1.080,00)	(1.143,00)	(1.210,50)
DESPESAS FIXAS	(63,76)	(67,49)	(71,44)	(75,62)	(80,04)
ITR	(63,76)	(67,49)	(71,44)	(75,62)	(80,04)
DESPESAS FINANCEIRAS				(52.399,09)	(29.682,31)
TAXAS/ JUROS DE EMPRÉSTIMOS				(28.793,17)	(6.076,39)
AMORTIZAÇÃO DO EMPRÉSTIMO				(23.605,92)	(23.605,92)
FLUXO DO PERÍODO			54.522,89	5.301,57	31.435,50
SALDO ACUMULADO			54.522,89	59.824,46	91.259,96

Source: Producer data, prepared by the author (2020).

Because there is no harvest in the first two years, it is noticed that the cash balance for the period 2020/2021 and 2021/2020 are zero. The loan was made only for payment of the orchard, and therefore it is necessary to use the producer's own capital to cover the expenses and costs of the period.

Table 16 shows the continued projection of the vines' cash flow.

Table 16 - Vine Designed Cash Flow.

FLUXO DE CAIXA VIDEIRAS					
DESCRIÇÃO	2026/2027	2027/2028	2028/2029	2029/2030	TOTAL
ENTRADAS	R$ 90.300,00	R$ 95.700,00	R$ 101.400,00	R$ 107.100,00	R$ 876.461,42
RECEITA DE VENDAS	R$ 90.300,00	R$ 95.700,00	R$ 101.400,00	R$ 107.100,00	R$ 708.900,00
CAPITAL PRÓPRIO					
EMPRÉSTIMOS					R$ 167.561,42
SAÍDAS	(49.705,87)	(50.033,54)	(50.436,15)	(50.913,34)	(568.230,48)
INVESTIMENTO FIXO					(167.561,42)
IMPLANTAÇÃO - IVESTIMENTO INICIAL					(167.561,42)
CUSTOS DIRETOS	(18.047,03)	(19.102,78)	(20.220,29)	(21.403,18)	(152.025,99)
INSUMOS AGRÍCOLAS	(4.685,11)	(4.959,19)	(5.249,30)	(5.556,39)	(43.228,70)
MÃO DE OBRA CONTRATADA	(13.361,92)	(14.143,59)	(14.970,99)	(15.846,79)	(108.797,29)
DESPESAS VARIÁVEIS	(2.447,34)	(2.590,51)	(2.742,05)	(2.902,47)	(21.044,52)
FRETE	(759,52)	(803,95)	(850,98)	(900,77)	(5.956,10)
HORAS MÁQUINAS	(1.687,82)	(1.786,56)	(1.891,07)	(2.001,70)	(15.088,43)
DESPESAS TRIBUTÁRIAS	(1.354,50)	(1.435,50)	(1.521,00)	(1.606,50)	(10.633,50)
IMPOSTOS A PAGAR	(1.354,50)	(1.435,50)	(1.521,00)	(1.606,50)	(10.633,50)
DESPESAS FIXAS	(89,68)	(94,93)	(100,48)	(106,36)	(834,51)
ITR	(89,68)	(94,93)	(100,48)	(106,36)	(834,51)
DESPESAS FINANCEIRAS	(27.767,32)	(26.809,83)	(25.852,33)	(24.894,84)	(216.130,53)
TAXAS/ JUROS DE EMPRÉSTIMOS	(4.161,40)	(3.203,91)	(2.246,41)	(1.288,92)	(50.889,09)
AMORTIZAÇÃO DO EMPRÉSTIMO	(23.605,92)	(23.605,92)	(23.605,92)	(23.605,92)	(165.241,44)
FLUXO DO PERÍODO	40.594,13	45.666,46	50.963,85	56.186,66	320.717,31
SALDO ACUMULADO	167.900,35	213.566,81	264.530,65	320.717,31	320.717,31

Source: Producer data, prepared by the author (2020).

Tables 15 and 16 are representing the cash flow of the vines, from the third year on, a result is obtained other than zero, and it is possible to notice that in the following year the cash flow decreases, from R$ 54,522.89 to R$ 5,301.57, this is due to the first amortization of the loan.

The loan, totals in 10 years to pay, having the first three years of grace, and an interest of 4% per year. Because of this, the fourth year is the one with the least value in cash flow, because the three grace plots plus the fourth year portion are added, plus the interest generated in that time.

Tables 17 and 18 show the cash flow of the peach orchard, in the same way used in the vine, the orchard consists of portions of the loan to be amortized from the fourth year.

Table 17 - FLuxury Box Designed Peach Trees.

DESCRIÇÃO	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025
FLUXO DE CAIXA PESSEGUEIROS					
ENTRADAS	R$ 85.370,88	R$ 50.000,00	R$ 53.000,00	R$ 56.000,00	R$ 59.250,00
RECEITA DE VENDAS		50.000,00	53.000,00	56.000,00	59.250,00
CAPITAL PRÓPRIO	R$ 6.034,26				
EMPRÉSTIMOS	R$ 79.336,62				
SAÍDAS	**(85.370,88)**	**(20.050,96)**	**(23.198,69)**	**(49.364,12)**	**(40.044,27)**
INVESTIMENTO FIXO	**(79.336,62)**				
IMPLANTAÇÃO - IVESTIMENTO INICIAL	(79.336,62)				
CUSTOS DIRETOS	**(4.670,50)**	**(12.935,40)**	**(15.665,74)**	**(16.582,19)**	**(17.552,25)**
INSUMOS AGRÍCOLAS	(3.620,50)	(3.832,30)	(6.030,11)	(6.382,87)	(6.756,27)
MÃO DE OBRA CONTRATADA	(1.050,00)	(9.103,10)	(9.635,63)	(10.199,32)	(10.795,98)
DESPESAS VARIÁVEIS	**(1.300,00)**	**(1.534,83)**	**(1.624,61)**	**(1.719,65)**	**(1.820,25)**
FRETE		(476,33)	(504,19)	(533,69)	(564,91)
HORAS MÁQUINAS	(1.300,00)	(1.058,50)	(1.120,42)	(1.185,97)	(1.255,35)
DESPESAS ADMINISTRATIVAS		**(4.763,25)**	**(5.041,90)**	**(5.336,85)**	**(5.649,06)**
SEGURO		(4.763,25)	(5.041,90)	(5.336,85)	(5.649,06)
DESPESAS TRIBUTÁRIAS		**(750,00)**	**(795,00)**	**(840,00)**	**(888,75)**
IMPOSTOS A PAGAR		(750,00)	(795,00)	(840,00)	(888,75)
DESPESAS FIXAS	**(63,76)**	**(67,49)**	**(71,44)**	**(75,62)**	**(80,04)**
ITR	(63,76)	(67,49)	(71,44)	(75,62)	(80,04)
DESPESAS FINANCEIRAS				**(24.809,81)**	**(14.053,92)**
TAXAS/ JUROS DE EMPRÉSTIMOS				(13.476,01)	(2.720,12)
AMORTIZAÇÃO DO EMPRÉSTIMO				(11.333,80)	(11.333,80)
FLUXO DO PERÍODO	**-**	**29.949,04**	**29.801,31**	**6.635,88**	**19.205,73**
SALDO ACUMULADO	**-**	**29.949,04**	**59.750,34**	**66.386,22**	**85.591,95**

Fonte: Dados do produtor, elaborado pelo autor (2020).

Because there is no harvest in the first year, it is perceived that the cash balance for the period 2020/2021 is zeroed. The loan was made only for payment of the orchard, and therefore it is necessary to use the producer's own capital to cover the expenses and costs of the period.

Table 18 shows the continued projection of the cash flow of peach trees.

Table 18 - FLuxury Box Designed Peach Trees.

DESCRIÇÃO	2026/2027	2027/2028	2028/2029	2029/2030	TOTAL
FLUXO DE CAIXA PESSEGUEIROS					
ENTRADAS	R$ 66.500,00	R$ 70.250,00	R$ 74.500,00	R$ 78.750,00	R$ 656.370,88
RECEITA DE VENDAS	66.500,00	70.250,00	74.500,00	78.750,00	R$ 571.000,00
CAPITAL PRÓPRIO					
EMPRÉSTIMOS					R$ 79.336,62
SAÍDAS	**(42.269,10)**	**(43.517,28)**	**(44.869,20)**	**(46.323,00)**	**(436.119,35)**
INVESTIMENTO FIXO					**(79.336,62)**
IMPLANTAÇÃO - IVESTIMENTO INICIAL					(79.336,62)
CUSTOS DIRETOS	**(19.665,93)**	**(20.816,39)**	**(22.034,14)**	**(23.323,14)**	**(171.824,74)**
INSUMOS AGRÍCOLAS	(7.569,88)	(8.384,92)	(8.481,46)	(8.977,62)	(67.187,45)
MÃO DE OBRA CONTRATADA	(12.096,05)	(12.431,47)	(13.552,69)	(14.345,52)	(104.637,29)
DESPESAS VARIÁVEIS	**(2.039,45)**	**(2.158,76)**	**(2.285,05)**	**(2.418,72)**	**(18.828,05)**
FRETE	(632,93)	(669,96)	(709,15)	(750,64)	(5.439,74)
HORAS MÁQUINAS	(1.406,52)	(1.488,80)	(1.575,89)	(1.668,08)	(13.388,31)
DESPESAS ADMINISTRATIVAS	**(6.329,33)**	**(6.699,60)**	**(7.091,52)**	**(7.506,38)**	**(54.397,41)**
SEGURO	(6.329,33)	(6.699,60)	(7.091,52)	(7.506,38)	(54.397,41)
DESPESAS TRIBUTÁRIAS	**(997,50)**	**(1.053,75)**	**(1.117,50)**	**(1.181,25)**	**(8.565,00)**
IMPOSTOS A PAGAR	(997,50)	(1.053,75)	(1.117,50)	(1.181,25)	(8.565,00)
DESPESAS FIXAS	**(89,68)**	**(94,93)**	**(100,48)**	**(106,36)**	**(834,51)**
ITR	(89,68)	(94,93)	(100,48)	(106,36)	(834,51)
DESPESAS FINANCEIRAS	**(13.147,21)**	**(12.693,86)**	**(12.240,51)**	**(11.787,15)**	**(102.333,02)**
TAXAS/ JUROS DE EMPRÉSTIMOS	(1.813,41)	(1.360,06)	(906,71)	(453,35)	(22.996,40)
AMORTIZAÇÃO DO EMPRÉSTIMO	(11.333,80)	(11.333,80)	(11.333,80)	(11.333,80)	(79.336,62)
FLUXO DO PERÍODO	**24.230,90**	**26.732,72**	**29.630,80**	**32.427,00**	**220.251,53**
SALDO ACUMULADO	**131.461,00**	**158.193,73**	**187.824,53**	**220.251,53**	**220.251,53**

FLUXO DE CAIXA PESSEGUEIROS					
DESCRIÇÃO	**2026/2027**	**2027/2028**	**2028/2029**	**2029/2030**	**TOTAL**
ENTRADAS	**R$ 66.500,00**	**R$ 70.250,00**	**R$ 74.500,00**	**R$ 78.750,00**	**R$ 656.370,88**
RECEITA DE VENDAS	66.500,00	70.250,00	74.500,00	78.750,00	R$ 571.000,00
CAPITAL PRÓPRIO					
EMPRÉSTIMOS					R$ 79.336,62
SAÍDAS	**(42.269,10)**	**(43.517,28)**	**(44.869,20)**	**(46.323,00)**	**(436.119,35)**
INVESTIMENTO FIXO					**(79.336,62)**
IMPLANTAÇÃO - IVESTIMENTO INICIAL					(79.336,62)
CUSTOS DIRETOS	**(19.665,93)**	**(20.816,39)**	**(22.034,14)**	**(23.323,14)**	**(171.824,74)**
INSUMOS AGRÍCOLAS	(7.569,88)	(8.384,92)	(8.481,46)	(8.977,62)	(67.187,45)
MÃO DE OBRA CONTRATADA	(12.096,05)	(12.431,47)	(13.552,69)	(14.345,52)	(104.637,29)
DESPESAS VARIÁVEIS	**(2.039,45)**	**(2.158,76)**	**(2.285,05)**	**(2.418,72)**	**(18.828,05)**
FRETE	(632,93)	(669,96)	(709,15)	(750,64)	(5.439,74)
HORAS MÁQUINAS	(1.406,52)	(1.488,80)	(1.575,89)	(1.668,08)	(13.388,31)
DESPESAS ADMINISTRATIVAS	**(6.329,33)**	**(6.699,60)**	**(7.091,52)**	**(7.506,38)**	**(54.397,41)**
SEGURO	(6.329,33)	(6.699,60)	(7.091,52)	(7.506,38)	(54.397,41)
DESPESAS TRIBUTÁRIAS	**(997,50)**	**(1.053,75)**	**(1.117,50)**	**(1.181,25)**	**(8.565,00)**
IMPOSTOS A PAGAR	(997,50)	(1.053,75)	(1.117,50)	(1.181,25)	(8.565,00)
DESPESAS FIXAS	**(89,68)**	**(94,93)**	**(100,48)**	**(106,36)**	**(834,51)**
ITR	(89,68)	(94,93)	(100,48)	(106,36)	(834,51)
DESPESAS FINANCEIRAS	**(13.147,21)**	**(12.693,86)**	**(12.240,51)**	**(11.787,15)**	**(102.333,02)**
TAXAS/ JUROS DE EMPRÉSTIMOS	(1.813,41)	(1.360,06)	(906,71)	(453,35)	(22.996,40)
AMORTIZAÇÃO DO EMPRÉSTIMO	(11.333,80)	(11.333,80)	(11.333,80)	(11.333,80)	(79.336,62)
FLUXO DO PERÍODO	**24.230,90**	**26.732,72**	**29.630,80**	**32.427,00**	**220.251,53**
SALDO ACUMULADO	**131.461,00**	**158.193,73**	**187.824,53**	**220.251,53**	**220.251,53**

Source: Producer data, prepared by the author (2020).

The cash flow of peach trees presented a flow of R$ 220,251.53. Being that in its first year, because it has not yet had a harvest, it did not present cash flow, and the producer will have to use its own savings to pay for the 2020/2021 harvest.

In the 2021/2022 and 2022/2023 harvest the cash balances are similar, but it is perceived that in the 2023/2024 harvest the cash balance is much less, as in the case of vines, the fourth year that is the 2023/2024 crop amortized the loan installments, and so the results are lower.

4.7 FINANCIAL VIABILITY INDICATORS

Investment analysis involves decisions of long-term resource applications, with the aim of providing adequate return to the owners of this capital. To make this decision, it involves a lot of dedication and commitment to make the investment.

There are several tools that help the investor make such an important decision for their business. The most common methods of evaluating investment projects are simple payback, net present value (LPV), and internal rate of return (IRR).

The net present value (LPV) ascertains in current values the financial gain, if it is greater than zero the project deserves to continue being analyzed, otherwise not. The net present value calculates the net monetary gain, already discounted all disbursements and all future entries, projecting for the current moment, using the expected rate of return. (BRUNI and FAMÁ, 2014).

Internal Rate of Return (IRR) can be deduced that irr is, the projected return on investment, that is, how much is estimated to gain (%) according to the defined cash budget. (Camloffski, 2014)

The simple Payback is defined by showing how long it will take for the disbursement corresponding to the investment to be recovered.

With the cash flow balances it is possible to analyze these indicators, and Table 19 presents the results obtained

Table 19 - Financial feasibility indicators.

INDICADORES	UVA		PÊSSEGO	
TMA		10%		10%
VPL	R$	9.644,66	R$	46.450,29
TIR		10%		20%
PAYBACK		6,93		4,67

Source: Eworked by the author (2020)

It is in Table 19 that the internal rate of return of the project is 10% p.a. for the vine orchard and 20% p.a. for the peach orchard, these values represent the

maximum profitability that the project supports to match its inputs to the value of the investment.

Comparing the minimum rate of attractiveness (TMA) with the internal rate of return (IRR), the vines totaled the same value, which indicates that the producer wants a more attractive rate should review his investment. The peach orchard, on the other, exceeded the producer's expectations. The TMA used was 10%, the same value for both cultures.

The vine orchard presented a LPV of R$ 9,644.66 and a payback of 6.93 years, this means that with this attractiveness rate, the investment is feasible, because it will be paid before the age of 7.

The peach orchard had a NPV of R$ 46,450.29 and a payback of 4.67 years. This means that with this attractiveness rate, the investment is viable, because it will be paid before the age of 5.

Given these indicators the investment that will bring more return to the producer will be the implementation of the peach orchard, because it is the investment that will pay faster and will bring more return on investment.

V.   FINAL CONSIDERATIONS

The study aims to compare two different cultures in order to assist small farmers in decision-making. Thus, an analysis was made of the data provided by the producers and based on this made the projection economic result generated by the sale of grape and peach in a rural property of Campestre da Serra - Rio Grande do Sul during the harvests of the period 2020 to 2030.

After the data were projected, it was concluded that the vine presented a Net Present Value (NPV) of R$ 9,644.66, and the peach orchard had a Net Present Value of R$ 46,450.29. These values represent the net monetary gain, already discounted all disbursements and all future entries, projecting to the current moment, being used the expected rate of return.

This study was dedicated to analyzing, the investments, costs, expenses and revenues that a rural producer has with the implantation of 1 hectare of fascine peach orchard compared with the implantation of 1 hectare of rose-hearted niagara vine and the financial generated result of the same crops.

To determine these data, an interview was made with producers in the region that grow peach fascine and niagara rose grape, which was obtained all the data necessary to determine the costs, expenses, revenues and also what is necessary for the investment.

With the data calculated, it was necessary to enter into contato com empresas da região para apuração dos valores de insumos agrícolas e base do investimento. Após levantamento pode-se apurar valores reais para o estudo.

The general objective of this study is to analyze the return on investment based on the economic result generated by the sale of grape and peach in a rural property of Campestre da Serra - Rio Grande do Sul during the 2020 to 2030 harvests.

For the initial investment of the vine orchard, the amount of R$ 167,561.42 will be required and the peach orchard will be r$ 79,336.62. The investment of the vine orchard doubles compared to the peach orchard, and due to this presented a lower result.

Based on the results presented by the cash flow, it was possible to check the rates of financial profitability, net present value (LPV), internal rate of return (IRR), simple payback and cash flow.

It was concluded that the crop that presented satisfactory results was the peach orchard, with an internal rate of return (IRR) of 20%, and a payback of 4.67 years, that is, that in less than 5 years the investment is paid.

Compared to the vine orchard, which presented a IrR of 10%, and a payback of 6.93 years, less than 7 years for the investment to pay.

Analyzing the cash flow, the vine has a cash balance much higher than the cash balance of peach trees, but this does not mean that it is more profitable, because its investment is very high compared to the peach orchard.

Through this study it was possible to make a survey of all expenses for the implantation of orchards, the costs incurred during the analyzed period and the results generated by the crops. The study shows the importance of accounting in a rural property, a fundamental tool for the manager and for decision making.

In view of the difficulty of measuring costs, expenses and results, this study can be used by rural producers who are seeking a better management of their orchards, being able to adapt with the reality of their property, thus assisting in decision making for new business. In addition, it is believed that it can serve as a basis for future academic studies and research in the area.

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Drone Application in Topography Services - Case Study

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Abstract— This article had the purpose of developing an alternative and innovative procedure for the field of civil engineering, with regard to topography services, the study was carried out in a stretch of the Leo Extension, in Manaus-Am.As a tool was used an Unmanned Aerial Vehicle (UAV), specialized software for the elaboration of the flight plan and image processing, orthophoto mosaic, point cloud, Digital Surface Model (MDS) and Digital Terrestrial Model (MDT) of the area under study. The stages of this case study were divided into three: preparation of the flight plan, its execution and the processing of the data of this survey. The objective is to demonstrate some of the main results that will be collected from the processing of these aerophotos and, in addition, propose a critical approach about the method elaborated and results collected. In view of the final results, it is certain to say that the use of drones in this area of operation is highly beneficial, more precisely in relation to time and cost.

I. INTRODUCTION

Topography has existed since the beginning of humanity, because there has always been a need to describe the environment in which we live. Even without the technology we have today, with rudimentary methods, data were collected that allowed the existence of the first charts and geographical plants for war and commercial purposes (DronEng, 2020).

Topography is the science that studies the exact and detailed description on the surface of a locality. It aims to graph through topographic surveys all the characteristics of a given area (JARDIM & GOMES, 2019), including geographic coordinates, relief, level curves, area calculation, quoted points and etc. Being fundamental support both in the project stage and in the execution of a work.

When referring to topography services, take into account three important steps, the first is data acquisition, the second step is processing or calculation and the third step is the preparation of technical parts.In conventional topography, data acquisition takes place through topographic surveys using technology such as Total Station, Theodolith, Topographic Levels and GNSS (Global Navigation Satellite System) Receivers.

The topographic surveys are constantly evolving and among several options of equipment and methods, it is up to the engineer responsible for the execution of the project to choose which will be the best method for each type of enterprise, considering its economy, quality and productivity.

According to Jardim & Gomes (2019), the topographic survey can be divided into two parts: the planimetric survey (determines the points in coordinates X and Y) and the altimetric survey (dimensions or altitudes of a Z point). Thus, one of the main methods for determining coordinates in topography is polygonation.

With this new digital age, many working methods and services have suited digital tools, in response to this high demand, most markets, industries, construction companies have sought intelligent solutions both for product development, as well as for service execution, and the main tool used is technology.

This technological advance is present in the civil engineering sector, currently we find several software that are able to perform services that previously required a high demand for time and team, today through technological advances, these same services are carried out remotely, enabling a greater advantage in optimizing time.

With the development of technology and computers in recent times, there was the need to improve the activities of topography, making room for the use of drones in topography services, which through software embedded in these aircraft has facilitated access to photogrammetric survey.

The topographic survey that was previously done with a team of approximately five or more people in the field, with large equipment and facing difficulty in accessing the information for data collection, today, through unmanned aircraft, can be done remotely, in the short term, with a maximum amount of at most two people in the field and an equipment that depending on the model can be transported in a backpack.

To make use of this method is necessary only one specialized drone and software, not necessarily the professional needs to be present in each area to be lifted and acquire the data.

In the construction market the drone has conquered its space, providing intelligent solutions from the preliminary phase, elaboration and development of project, until the later phase of engineering services.

The word Drone is of English origin which, translating to Portuguese, means "zangão", since this equipment produces a buzz similar to that of the insect (FALORCA & LANZINHA, 2018; VILAR, 2019). This term became worldwide popular to designate Remotely Piloted Aircraft (ARP). However, in addition to this, in Brazil it is technically known as UAV (Unmanned Aerial Vehicle), (SIGNIFICADOS, 2015).

Drones are usually used as a Hobby, but are currently employed in various activities and increasingly assist civil construction (FEITAL, 2017).

In planialtimetric topographic surveys, optical equipment such as the Total Station and the level are currently used, in addition to GNSS (Global Navigation Satellite System) receivers, however, these equipments require that data be collected on site, as well as the area of geoprocessing that currently still makes use of airplanes and helicopters to obtain images areas, the great difficulty of these types of services is pricing, which results in the lack of realization of them, compromising a range of information necessary for an optimal performance of the projects.

Because of these occurrences is that the application of drone in topography services has stood out, because the acquisition of the product is more accessible, has a greater ease in the execution of surveys and generates data rich in information.

With technological advances and new equipment, the conventional methodology has been replaced by methods that use the Drone, which does not necessarily require on-site data collection (FETAL; FERREIRA & ROSALEN), this can be done over long distances. However, there is a need to carry out studies that analyze the feasibility of this technology in carrying out these surveys (FERREIRA & ROSALEN, 2017)

Drones have been widely used by transport and traffic control agencies to monitor the surroundings of accident highways and paved structures (PURI, 2005; KARAN et al., 2014); in inspection of structures as a non-destructive method in the detection of pathological manifestations in construction through image capture (LISBOA et al,2018); for 3D mapping and modeling, and can be a low-cost tool, simple to manipulate, flexible and fast, and capture images from various angles (MELO,2016).

The use of a drone in mapping services enables an affordable and lower-cost alternative, especially when the area to be mapped is difficult to access.

It is important to highlight and consider the increased risk to people caused by remotely piloted aircraft in airspace, compared to the benefit that the new technology provides (LICCIARDI,2019).

For the application of this method it is important to comply with some laws. The flights performed to collect data from this article were carried out in compliance with ica 100-40 instructions on "Unmanned Aircraft and Access to Brazilian Space" following all the guidelines required by the Department of Airspace Control (DECEA).

This article aims to carry out an aerial mapping project with drone in Rama do Leão in the municipality of Manaus, Amazonas-Brazil.

To verify in practice the advantages and disadvantages of the use of drones as technological innovation in topography services, through a technical view, evaluating the differential and limited points of this new method as:

a) Demonstrate the processing time to generate the final products;

b) Describe the main complications of the extension.

c) Assess the differential and limited points of this new method.

In the following topics, a case study of drone application in topography services in an extension in the state of Amazonas for experimental purposes will be presented.

II. METHODOLOGY

In order to analyze the data obtained through the applicability of the use of UAEs in topographic mapping in a stretch of the Lion Extension, the present study is proposed, of exploratory-descriptive and qualitative methodological character.

In this case study we used drone technology for experimental research purposes, however, the research result will serve as the basis of preliminary studies for the development of extension recovery project.

1. CHARACTERIZATION OF THE STUDY AREA

The study area is located in the Extension of the Lion in the state of Amazonas, in the municipality of Manaus, according to the map below, (Figure 1).

To elaborate the flight plan, a technical visit is made in the field of the overflight area, where it is possible to detect all the difficulties that would be faced during the execution of the photogrammetry.

Fig. 1: Ramal do Leão. Source: Google Maps

2. FLIGHT PLANNING

The flight plan is an essential step, because it is through it that we define the resolution of the mapping, the

number of flights, the amount of days or hours required and the layout of the flight.

The data will be collected using the phantom 4 RTK model drone (Figure 2), this drone has an RTK GPS module integrated directly into its body, is an aircraft designed and developed for this purpose, providing global positioning data at centimetric level in real time, enabling better accuracy of captured images. This RTK module can offer positioning accuracy of up to 1 cm horizontally and 1.5 cm vertically, generating an absolute accuracy of 5 cm in the generated digital models. And for this case study, we are expecting the planimetric accuracy to be around 3 to 4 cm and the altimeter is between 8 and 9 cm providing a more efficient accuracy. A modem with internet access was also used.

The flight plan will be drawn up using specialized software. The program interface shows all the pertinent information to deliver results faster and with a better quality, generating data with a high level of detail, providing a faster pace in productivity for the preparation of final products.

Fig. 2: Drone modelo PHANTOM 4 RTK. Fonte: NW Shop (2021).

3. IMPLEMENTATION OF THE FLIGHT PLAN

For the execution of the flight plan, it is essential the authorization of the National Civil Aviation Agency (ANAC) and also the Department of Control of Brazilian Airspace (DECEA), where the day, time and duration of the flight, the description of the equipment used, the purpose of the same and the name of the user responsible for the areonave is scheduled.Through the sarpas system available on the DECEA website we enter the sisant record of the engineer responsible for the execution of the flight which was recognized as a pilot and released to fly over

the area of the experiment. Sent the flight request, about 20 minutes later, the authorization was obtained.

4. PREPARATION FOR DATA COLLECTION

Initially, with the help of Global Positioning System (GPS) resources, we located the terrain where the points and the base of the route and the location boundaries will be defined, all through the software.

The type of operation is performed through the DJI GO software, responsible for scheduling the flight execution of the aircraft path, through these settings is defined the duration of the flight, the memory capacity of the drone, the ambient temperature, wind speed, flight speed and overlaps.In this case study, the time in the field was 1h30 minutes and the duration of the overflight of 45 minutes, the amount of battery used was only one, 180 images captured.

In the execution of the flights is used a remote controller, where the pilot connects by the iPad 8 Apple device (Figure 3) a specialized application, where the elaborate flight plan is previously transmitted, you can view the images that the drone is doing, as well as the overflight in the defined graph, this whole process is done remotely on the tablet screen and in the palm of the hand and in case of any problem, you can change the flight plan by the app itself.

The maximum height range defined in the DECEA register is 120 m and during the execution of the flyover was reached up to 80 m (Figure 4), with Ground Sample Distance (GSD) of 3 cm, longitudinal overlap of 70% between the images and lateral of 70%, maximum speed of 15 m/s.

Fig. 3: Remote controller and iPad used. Source: prepared by the author (2021).

Fig. 4: Execution of the flight. Source: prepared by the author (2021).

To perform the flight, we opened the DJI GO and calibrated the aircraft, marked the home point, checked the available capacity of the memory card and then started the flyover. Professionals involved in a total of two people in the field to perform the photogrammetric survey.

III. RESULTS

1. CORRECTION OF IMAGES – ACCURACY

When we started the project, a GSD of 3 cm was used, that is, each pixel represented through the image is equivalent to 3 cm² and it is perceived that the higher the spatial resolution is, the greater the chance of dragging between the images causing blurs. In order for these drags not to impair the preparation of the final products, a report with all the execution data, called accuracy, is generated.

The program through calculation and statistics can calibrate the images, it is important that this correction with control point is made, because avoid errors according to (Table 1).

Table.1: Accuracy - Control Point Source: Prepared by the author (2021).

GCP name	X ERROR (m)	Y ERROR (m)	Z ERROR (m)	Projection Error [pixel]
A1	-0,036	0,043	0,028	0,673
A2	0,012	0,019	0,021	0,531
A4	-0,013	0,016	-0,038	0,618
A6	0,01	0,016	-0,013	0,996
A6	-0,027	-0,037	-0,044	0,878
A9	0,042	0,012	0,046	1,137
A10	0,006	0,062	0,029	0,9
MEAN (M)	-0,000916	0,001081	0,004137	
SIGMA (M)	0,024524	0,034092	0,0332	
RMSE (M)	0,024541	0,034109	0,033457	

After correction with the control point, it can be analyzed that the amount of errors reduced considerably according

to (Table 2) with excellent accuracy, we reached 1.7 cm in X and 5.1 cm in Y and finally 8.2 cm in Z. Taking into account that for a topographic survey that lasted about 45 minutes, the results were satisfactory enabling the field measurements.

Table.2: Accuracy- Check Points. Source: Elaborated By the author (2021).

CHECK POINT name	X ERROR (cm)	Y ERROR (cm)	Z ERROR (cm)	Projection Error [pixel]
A3	-0,0069	0,0499	-0,0852	0,7451
A6	-0,0233	0,0644	-0,0344	0,6408
A7	0,0182	-0,0344	-0,1098	0,5538
MEAN (M)	-0,004034	0,026634	-0,07647	
SIGMA (M)	0,017061	0,043592	0,03139	
RMSE (M)	0,017532	0,051084	0,082662	

2. IMAGE PROCESSING

Later the execution of the flight, through the images obtained, can be carried out the processing of the same through the Photocan software, where it is possible to produce the mapping from the captured aerial images, each photo collected is georeferenced, that is, a coordinate is assigned for each pixel of the image,allowing several measurements of this image, with data and dimensions generating the cartographic base of the terrain, which is composed of: Orthophoto Mosaic, Digital Surface Model (MDS), Digital Terrain Model (MDT), and Point Cloud.

According to Woff (1983) orthophotos are geometrically equivalent to conventional planialtimetric maps, which show the true orthographic positions of objects. The Orthophoto Mosaic or Orthomosaic is a product used to acquire various data and information from the study area flown through the various images acquired by the drone. Through orthomosaic we can perform direct measurements of distances, areas and angles of the terrain.

These data are indispensable for the elaboration of information directly related to topography, which is fundamental for architectural design and other engineering projects, as well as in the feasibility decision process through the preliminary study and in the generation of the pre-project recovery of the extension.

Based on these images it is possible to calculate the variation of terrain levels (level dimensions), their area, as well as the volume, between other solutions.

The mosaic of properly georeferenced orthophotos (Figure 5) was obtained after a series of steps that involved the removal of errors from the entrainments and distortions of the photos caused by the process in capturing the images.

Fig.5: Orthophoto mosaic. Source: prepared by the author (2021).

3. DIGITAL SURFACE MODEL

By running the correction program at the control point, two types of maps are generated which is the Digital Surface Model (MDS) where it is possible to make terrain-specific volume measurements, providing information such as actual size of objects, can be seen in (Figure 6)the elements arranged in the raised area, including buildings, road, vegetation. MDS is a unique product of photogrammetry, since it is not possible to obtain the same through conventional topography.
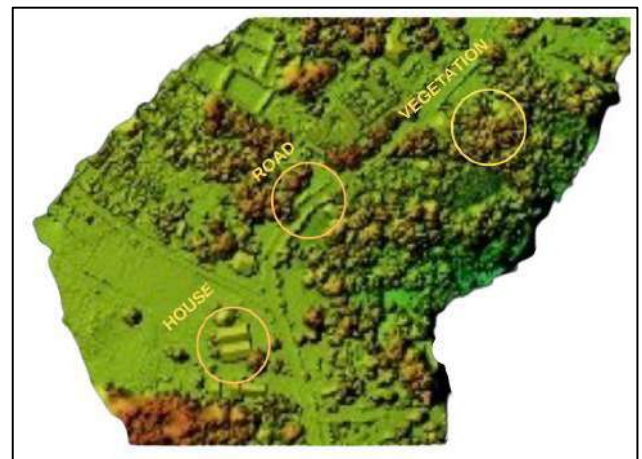
Fig. 6: Digital Surface Model (MDS). Source: prepared by the author (2021).

4. DIGITAL TERRAIN MODEL

Another map generated through the flyover, is the Digital Terrain Model (MDT) according to (Figure 7), which through the filtering made in the MDS obtained the

altimetry of the terrain, taking into account only the relief and slope, used in the topography.
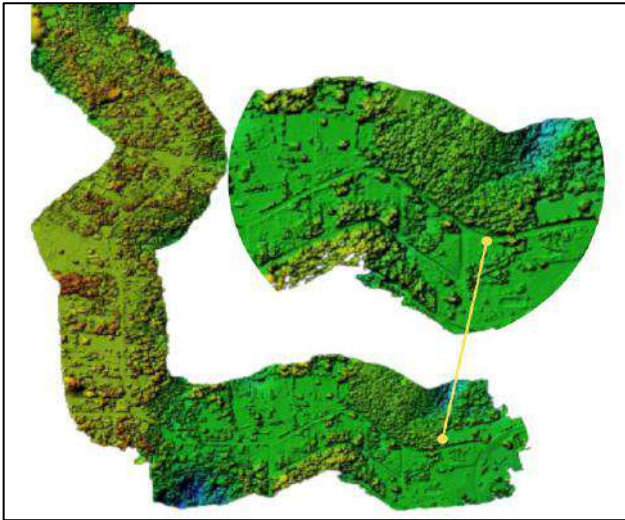
Fig. 7: Digital Terrain Model (MDT). Source: prepared by the author (2021).

5. POINT CLOUD AND LEVEL CURVE

The collection of the point cloud (Figure 8) is the basis that allows us to generate the 3D model of the current extension stage, which will serve as a realistic visualization of the area of interest, because each point is created through mathematical methods of triangulation.

The point cloud and level curve are key parts for a topography project. The level curve is the vectorized representation (Figure 9) of the altitudes of the mapping area, they are imaginary lines that characterize the flat surface and also the slope of the soil, serving as the basis for the leveling of the extension of this case study.
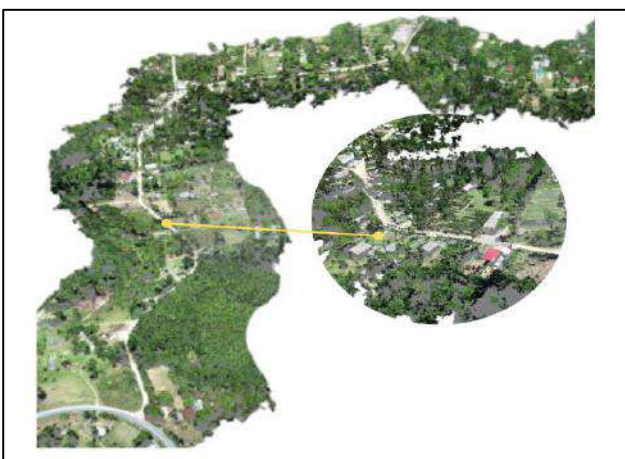
Fig. 8: Point Cloud. Source: prepared by the author (2021).

Fig. 9: Level Curve without lines. Source: prepared by the author

(2021).

The analysis of the main complications in the extension was performed through aerophotos, where we can notice that there is a small part of the asphalted extension (Figure 10) the results show that there is a great need for recovery, drainage and paving of the same.

Fig. 10: Start of paved extension. Source: prepared by the author

(2021).

Each project has its particular characteristics as is the case of the Lion Extension, with some areas where the forest is denser, making access to data collection more difficult and time-consuming, if we used traditional methodologies for the topographic survey of the area, in many places the data would be unattainable due to the lack of accessibility of the site.

IV. DISCUSSION

Topographic surveys aim to perform measurements of angles, distances and unevenness, which allow representing a portion of the earth's surface in an appropriate scale. From linear and angular measurements, areas, coordinates and volumes are calculated, among other elements, which can be graphically represented on maps or plans. The topographic survey aims to provide a planialtimetric representation of notable points, geographic accidents, earth moving volume and other relief details in areas where engineering works are being carried out.

Through the analysis of this study we can evaluate the differential and limited points of this new method.

Based on the results described above, it became feasible to conference the measurements in the field, obtaining the Orthophoto Mosaic, MDS, MDT, Level Curve, Point Cloud. Freeing up commuting everywhere, reducing spending and time on the field. Through specialized software it is possible to collect information such as distances, areas, volumes and sections of the extension.

One of the formidable advantages is undoubtedly the time savings and profit in productivity. The UARs can elaborate in minutes results that would take days to be collected in the field, with the high cost to maintain a team of six or more people and also with the rental of professionals and conventional equipment, especially in areas of difficult access.

The great accuracy of the collected data is through the high quality and resolution of the images obtained, enabling a detailed design with all the important and complete conformations of the terrain.

Drone topography offers a more detailed level of terrain, much higher information than conventional topography, but also offers a virtual reality of the terrain that cannot be generated only with topography.

The photogrammetry features that was somewhat restricted to large companies and public agencies, today through the drone, becomes accessible to small and medium enterprises.

However, the use of this new method also requires specific care and guidance to maintain safety during the use of this aircraft. Currently there are laws in force for the execution of unmanned aircraft flights.

In Brazil the agencies responsible for the registration, control and license of unmanned aircraft are: National Civil Aviation Agency (ANAC) is responsible for registering in the Unmanned Aircraft System (SISANT), with the National Telecommunications Agency (ANATEL) which is the mosaic system and also the Department of Airspace Control (DECEA), which is a sarpas system developed in order to enable the request for overflights in Brazilian airspace.

The guidelines found on the DECEA website describe where you can't and why you shouldn't lift the flyby. Most accidents with this type of aircraft occur due to misinformation of legislation and irregularity in use.

It is true to say that one of the relevant advantages regarding the use of drone in topography services is safety, this is because through the drone it is not necessary to travel several points of the terrain, you can perform the survey through a single starting point.

Despite all the positive results found in the application of drone use in the topography service of this case study, it is worth mentioning the limitations found in this method.

To meet the experiment of this case study we performed a flight with the phantom 4 drone, which lasted about 45 minutes, which was full of strong winds, the equipment was stable, but presented problems of distortions of the images obtained. In the execution of the flight at a faster speed, the propellers appeared in some images, causing the damage of the image and in relation to the propellers it is necessary to be removed every time the use of the drone ends and has to load compared to other aircraft that the propellers are foldable and more portable and easy to handle.

Also with regard to equipment in the field, only one battery was used, it is worth mentioning that the batteries of the phantom 4, have a high cost, so a greater investment is needed to obtain other batteries. It can be proven that the equipment is not so discreet, it is a drone that emits a high sound volume at the time of performing the flyover.

Moreover, the disadvantages of the phantom 4 line based on the experiment done in the field, it can be said that it would be the size of the equipment, because it is a large aircraft compared to other models on the market which hinders its mobility, which is not as easy and practical as other equipment that can be handled with greater ease and fits in a backpack for example.

In terms of camera quality, signal, rotation use the drone of the Phantom 4 Pro line is an impressive drone, with excellent features, and that meets the needs to perform a topographic mapping.

V. CONCLUSION

Topography is a technology where information is collected from the ground, being on the ground, that is, it is necessary to occupy the points that one wishes to obtain

the information, with the use for example of the Total Station.

The photogrammetry is promising, because it presents a fast result compared to conventional methods, because the use of drone for topographic work, reduces the operating time, as well as the cost of equipment and people in the field, but does not eliminate the need of the professional, since the professional is responsible for creating and executing the flight plan of the aircraft, i.e the drone is a tool for providing service and does not replace the professional.

Compared to equipment, manpower, it can be said that this method is partly very profitable, because it provides an optimization time, fast results, with excellent images that allows a faithful analysis of the survey and in high resolution.

The use of this innovative technology ensures reliable and judicious results, so the performance of surveying services with drone has its positive and negative points and especially its limitations. According to the project it is possible to choose the best science in question to be used and get more interesting data.

Based on this study, it is evident that the construction scenario is in line with the new digital model implemented in its services, thus, studies such as these become essential to maintain the training of an innovative and up-to-date professional.

This case study aimed to demonstrate the use of photogrammetry for topographic purposes, that is, the survey was done remotely, a way to map the terrain without having to occupy the same.

The system used in this research does not aim to propose the substitution of conventional topography methods, but rather to add a new approach to data collection maximizing information from the terrain through georeferenced images.The same envisions a positive impact on the application of drones in topography services, enabling a broad view of this new opportunity that is emerging and inform the providers of this type of service, the relevance of knowledge and acceptance of new technologies in the market, projecting a new and updated course for civil construction.

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Extension of the water distribution network in subnormal regions in the Manaus city

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Abstract— Due to the enormous socioeconomic inequality that marks the history of Brazil, the low-income population without government support uses irregular, disordered and precarious alternatives to structure their homes. Irregular land occupations are among the main types of construction in this regard and have raised numerous discussions on issues such as income concentration, land reform and land redistribution for decades. The so-called stilt houses also stand out in areas with rivers and lakes of great extension, with high rates of rainfall and flood.

In these places, minimum sewage system is irregular and improvised, with pipelines that are so short that they do not even touch the river, that is, the sewage falls in cascade mixing to the waters. In river flood time, the river level rises and such dirty water invades the stilt houses, when residents start to live daily with raw sewage directly on the floor of their homes, exposed to bad smell and disease-causing agents. This problem also ends up compromising the sanitation of the entire city because during intermittent periods, clandestine connections end up sucking the water from rivers due to pressure and again polluting treated water distributed by regular supply.

In these places clandestine connections must be changed for regular water distribution networks treated on the stilt houses.

Resumo—Em virtude da enorme desigualdade socioeconômica que marca a história do Brasil, a população de baixa renda e sem suporte governamental recorre a alternativas irregulares, desordenadas e precárias para estruturarem suas residências. As ocupações irregulares de terra estão entre os principais tipos para construção nesse sentido e levantam inúmeras discussões a respeito de temas como concentração de renda, reforma agrária e redistribuição de terras há décadas. As chamadas palafitas também se destacam em áreas com rios e lagos de grande extensão, com altos índices pluviométricos e alagadiça.

Nesses locais, a mínima rede de saneamento é irregular e improvisada, com tubos tão curtos que nem sequer chegam a tocar o rio, ou seja, os dejetos caem em cascata e se misturam às águas. Nas cheias, o nível sobe e toda essa água invade as palafitas, quando os moradores passam a conviver diariamente com esgoto in natura diretamente no chão de casa, expostos ao mau cheiro e a agentes causadores de doenças. Esse problema também acaba comprometendo o saneamento de todo o município, já que, nos períodos de intermitência, as ligações clandestinas acabam sugando as águas dos rios devido à pressão e poluem novamente a água tratada e distribuída pelo abastecimento regular.

Nesses locais devem ser trocados as ligações clandestinas por redes regulares de distribuição de água tratada nessas palafitas.

Palavras-chave—Abastecimento, Água, Desigualdade, Saneamento, Palafita.

I. INTRODUCTION

1.1 SANITATION IN BRAZIL The first well was drilled in 1561, to supply the city of Rio de Janeiro headed by Estácio de Sá. where the first happened, we can register as the introduction of Sanitation in Brazil [1].

Several factors over the years have hampered the progress of sanitation in the country. The lack of management of the sanitation companies, and projects with low technical quality, added to the difficulties in financing and obtaining concessions for the execution of works. Some of these until today is the impediment in the country hindering the development of the area lagging behind the countries of the world.

1.2 LAWS OF LEGISLATION Over the years, several problems have arisen and with an impact of minimizing their impacts, guidelines have been created in Brazil, implementing media and infrastructure.

The National Sanitation Plan was formed in the 1970s, PLANASA. At the beginning of 2007, after Federal Law 11,445 was enacted, municipalities became responsible for sanitation. In the same year, the National Basic Sanitation Law came into force, already establishing national guidelines.

Currently, there are bodies responsible for conducting and politically guiding public policies. The instrument that guides the conduct of public policies, goals and policies for the sanitation sector is the PLANSAB (National Basic Sanitation Plan). There are agencies that are responsible for monitoring these laws and guidelines, where we can mention the National Water Agency, which is responsible for the management of water resources, the National Sanitation Information System (SNIS), is the largest information system on sanitation in Brazil.

Currently, we have 83.7% of the Brazilian population served with treated water and 37% of the water treated by the concessionaires is not consumed according to information from the National Sanitation Information System.

Due to the enormous socioeconomic inequality that marks the history of Brazil, the low-income population without government support uses irregular, disorderly and precarious alternatives to structure their homes. Irregular occupations are among the main types of construction in this regard and have raised numerous discussions on topics such as concentration of income, land reform and land redistribution for decades. The solution for some families is the construction of their properties in swampy areas or on rivers, the so-called stilts ("Fig. 1").

Fig. 1: Imagem de moradias chamadas de Palafitas

To get an idea of the scale of the problem, the Brazilian Institute of Geography and Statistics (IBGE) estimated that, in 2010, 11.4 million people lived in such regions, named as subnormal agglomerations. The data is the most updated to date, since the operation for its survey is carried out only every ten years.

Under these conditions, the people who live there suffer from the lack of guaranteed rights and basic resources, such as access to quality food, health, electricity and, of course, sanitation. This indicator, in particular, compromises mainly the quality of life in the North and Northeast regions, which, respectively, remain with 43.5% and 26.1% of their homes without access to the water supply network, according to the National Survey by 2015 Household Sample, prepared by the same institute.

1.3 STILT HOUSE In the 50's there was an urban growth in the center of the city, where a population originating in the interior of the State that was forming clusters of small areas forming a kind of floating neighborhood. This place was located close to the Feira da Manaus Moderna, where restaurants, butchers, workshops and others operated, forming a floating city. This city was constantly in the news both nationally and internationally, being the subject of some national magazines of the time.

In 1966 the city was "undone", the neighborhood was made up of approximately 1,950 houses. At the time, there were about 1,950 houses that made up the neighborhood with an average of 11,500 residents.

Even though the floating city has been extinct for more than 5 decades, the culture of building wooden

houses bordering rivers and streams continues in the city of Manaus. Unlike other decades, houses are no longer floating [2].

1.4 THE FLOODS Year after year, the Rio Negro invades part of the city, with the population from Manaus facing floods, which until now the only solution found is to make wooden bridges so that pedestrians can move from their homes to the destination if you have to leave your homes. This abundant water is related to the La Niña phenomenon, which acts in the summer and in the autumn, with a greater than normal stimulus of rain over the Amazon basin. The flood occurs due to the excess of rain in summer and autumn in the Southern Hemisphere and also by the melting of the Andes [3].

Data from base year 2021, the National Information System, 98% of the population of Manaus has a supply of drinking water, rising 7 positions in the ranking of the 100 largest cities in the country compared to the previous year, as a result of investments in sanitation in a short time. operation in the city by the Sanitation Company of the AEGEA Group [4].

II. METHODOLOGY

The methodology of this article is divided into distinct and specific stages. The article was based on a bibliographic review of current legislation, technical standards and specific local solutions, linked to criteria for the elaboration of drinking water supply network projects.

The entire historical context found in books, articles and magazines was taken into account, emphasizing the importance of consuming treated water for disease prevention and as an essential good for human life.

Therefore, the research is classified as exploratory, investigating and taking notes of what would be necessary in order to implement the supply project in a stilt region, a vulnerable region found in the South Zone of the city of Manaus, the same is descriptive, where it will be evidenced clearly the conditions of the study site, it is also quantitative with regard to the number of inhabitants benefited with the supply of drinking water and water volume that the sanitation company has not measured for more than 10 years.

Finally, it is a case study that addresses the importance of supplying treated water to subnormal regions with photographic surveys.

In floods, the level rises and all this water invades these houses ("Fig.2"), when the residents start to live daily with fresh sewage directly on the floor of the house, exposed to bad smells and disease-causing agents.

In these places clandestine connections must be exchanged for regular water distribution networks treated on these stilts.

Fig. 2: Stilts being invaded by the Rio Negro flood

Considering the scenario and the urgency of the service, the option is for the installation of modern airways, which enable delivery of the same efficiency as the traditional ones and do not require drilling and excavation works, which are not feasible in the terrain in question ("Fig.3").

Fig. 3: Aerial water supply network on stilts

2.1 LOCATION In this context that Manaus is experiencing, in the light of sanitation, this study proposes a water supply solution in a region of stilts in the Cachoeirinha neighborhood (BecoNonato), South Zone of the city of Manaus ("Fig.4") and points out the benefits of implementing a water supply project as a solution for the distribution of this essential good, which is treated water.
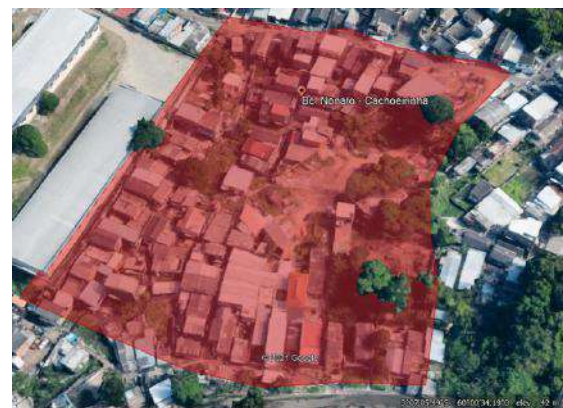
Fig. 4: source: Google - BecoNonato, Cachoeirinha, Manaus

2.2 SUPPLY CONDITIONS In these places, the minimum water supply network is irregular and improvised, with adapted pipes and connections, with a great possibility of contact with the wastes that mix in the water in which the houses are built because they do not also have the structure of sanitary sewage in addition to contact with venomous animals found in the region because of the garbage found nearby.

2.3 HYDRAULIC MODELING After collecting the data, they go to the project sector to perform hydraulic modeling using the QGIS Softwares, a professional GIS Free and Open Source application, which is built from Free and Open Source Software, (FOSS), WaterGems is a complete and easy-to-use tool that assists in making decisions about water distribution networks [5]. Through it, simulations of the behavior of the hydraulic system of the region are carried out, finalizing the project in the AutoCad software [6].

The material of the pipes used for the execution of the water supply network was made of high density polyethylene (HDPE, or in English, HDPE), it can be used in drinking water lines, waste water, sludge, chemicals, hazardous waste and compressed gas according to NBR 15561: 2017.This type of pipe can be cited several advantages in its use, which are: Great resistance to corrosive agents, low friction loss, thanks to its smooth walls, low encrustation effect and low weight, which facilitates its handling and installation, in addition to being able to use to carry out the aerial installation ("Fig.6"), reason for this study, because the polyethylene tubes are produced with the addition of 2 to 3% by mass of finely dispersed carbon black, presenting an excellent resistance to UV rays, with low loss of characteristics over its useful life, considerably over 50 years, according to the project specifications [7].

The support points, ideally, the pipe should be installed such that it does not suffer additional efforts to the internal pressure, allowing it to expand or contract freely, bending or flexing without causing efforts on its supports ("Fig.5") , nor suffer the consequent efforts, such as bending moments, buckling, traction, etc., which could compromise its useful life. For this, it was used the orientation chart ("Fig.4") provided in the Manual of Good Practices by ABPE, Brazilian Association of Polyolefinic Tubes and System, where, in the abscissa, the outer diameter of the tube (mm) and the ordinate, the maximum distance (cm) between the supports that will support the water pipe filled with water according to its temperature.

2.4 MEASUREMENT SYSTEM Measuring systems in the water supply are indispensable instruments for the effective operation of public systems [8].

The measurement of water consumption at each point of the water supply system, the so-called micro-measurement, where it allows recording the volume of water used by the consumer unit. The installation of these measuring devices (hydrometers), contributes to the care of the environment, as it leads to a reduction in the waste of water by the consumer.

After the installation of the network, we made the water connections, using in the building extensions the same material used in the supply networks, HDPE, installing a meter (water meter) for each residence, thus having an individual measurement.
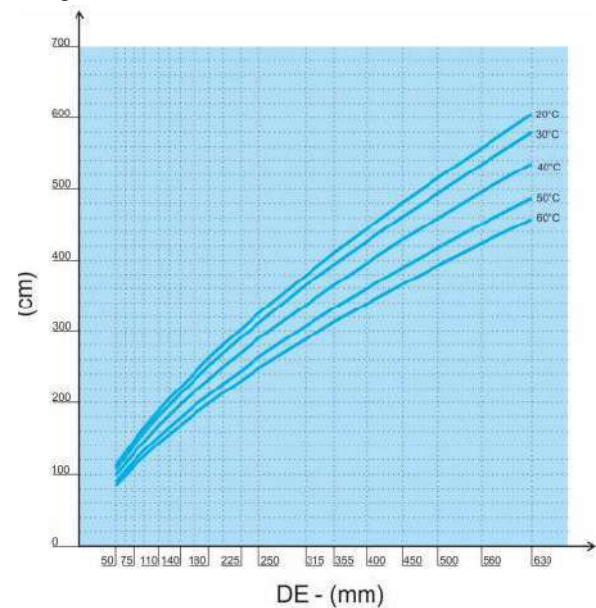
Fig. 4: Guidance chart, about distance between supports for tubes filled with water.

2.5 WATER LOSSES IN SUPPLY SYSTEM Characterized as lack of technical efficiency, the losses are inseparable from any water supply system. It is a subject of great value in the face of water shortages and high electricity costs, in addition to its direct relationship with the financial health of the Supply Companies of a city, since they can be considered as waste of natural resources and loss of revenue.

Actual losses are defined in all treated water offered for distribution that does not reach the consumer's meter. These losses result from leaks in pipelines, networks, branches, connections, reservoirs, in addition to frauds made with low quality material and connected in any way.

In these areas, as they still did not have a projected supply network, the residents as a means of survival, interconnected in a clandestine manner and in any case, often contaminating the water of their own consumption and the city's supply system.
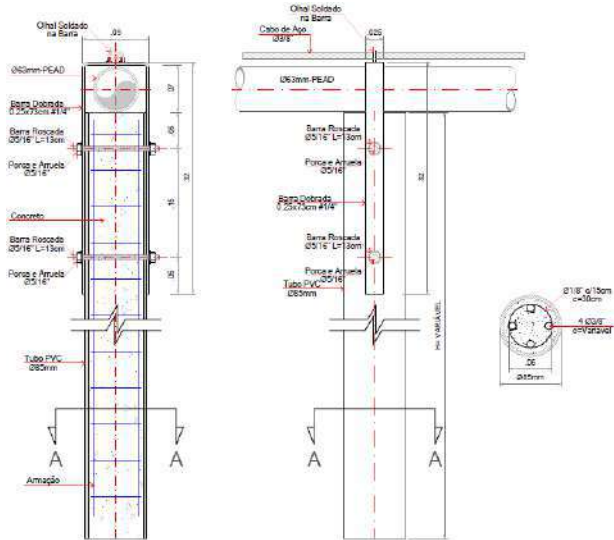
Fig. 5: Detailing of support supports.

Fig. 6: Aerial Supply Network made with HDPE tube.

2.6 COMMERCIAL SYSTEM REGISTRATION
With the cadastral survey and project completed, customers in the region are registered in the commercial system (GSS) of the Companhia de Saneamento responsible for the city's water supply.

III. STANDARDS

ABNT (Brazilian Association of Technical Standards) standards, which are based on international standards, are used to standardize the presentation of scientific papers across the country in order to facilitate the reading and understanding of the thousands of researches carried out every year [8]. The rules used for this project were:

3.1 NBR12266 –Design and Execution of Ditches for the Laying of Water, Sewer or Urban Drainage Pipelines - This Standard sets out the conditions required for the design and execution of ditches for the laying of water, sewage or urban drainage pipes. It also establishes criteria for positioning the ditch on the public road and dimensioning the shoring [9].

3.2 NBR 5626 NB 92Cold Water Building Installation - This Standard establishes requirements and recommendations regarding the design, execution and maintenance of the cold water building installation. The requirements and recommendations established here emanate fundamentally from respect for the principles of good performance [9].

3.3 NBR 15561:2017Polyethylene piping PE 80 and PE 100 for transporting water and sewage under pressure - This Standard specifies the requirements and test methods for manufacturing and receiving polyethylene tubes for transporting fluids at temperatures up to 40 ° C, with maximum pressure of operation of up to 2.5 MPa, designed for a useful life of 50 years, intended for use in: a) building water branches; b) water distribution networks and pipelines; c) pressure sanitary sewer lines [9].

IV. RESULTS OBTAINED

With the 507m laden drinking water distribution system, 105 properties were supplied with their individual meters (water meters) installed ("Fig.7"), with an estimated population of 635 beneficiaries. The measured volume of this area in the last 12 months of the system's activity, was more than 21,000m³ of water ("Fig.8"). A monthly average of 1,600m³ and 15.45m³ per property.

Fig. 7:Medidores (hidrômetros) instalados em palafitas

4.1 GROWTH OF COVERAGE With the installation of the water supply network in operation, the Concessionaire in the region is sure that it is bringing health to more people, with this there is an increase in coverage in the distribution of treated water to the population.

4.2 SOCIAL With customers registered with Supply Company, they now have proof of residence, meaning of dignity, where they can prove their residence when looking for a job, enrollment in schools, installment plans in local businesses, bank account, among others.

4.3 QUALITY OF LIFE AND HEALTH Once these residents of these regions are supplied with drinking water, they no longer need to boil their water before making food or even drinking.

4.4 LOSS REDUCTION As soon as it is able to measure the consumption of each residence, the supply company starts to reduce its losses, since at that moment it is able to measure what it has not been able to do for years due to clandestine connections and leaks in the adapted connections.

4.5 MAINTENANCE With overhead networks, if there is any type of leak, detection and maintenance is much faster than an underground leak.

4.6 SOCIAL TARIFF Residents in these regions have benefited from the Social Tariff, a benefit established by the Municipal Decree, which grants a discount on the water bill to low-income residents.
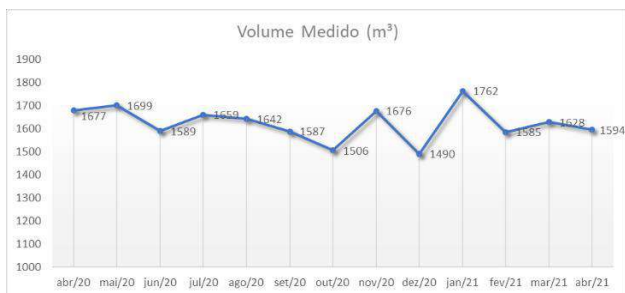
Fig. 8: Volume measured in the last 12 months (Source: Águas de Manaus)[13]

To prevent the meters from being submerged during the flood season, they were placed at a height above the region's historic flood height ("Fig 9"). Through an initiative of the Company, all these families had a different tariff charge and, in addition, managed to give dignity to those people who previously did not want to, a proof of housing and today they can be proud to say that they can prove where they live.

4.7 ECONOMIC - Before installing the supply system on site, residents compare gallons of mineral water to drink, sometimes even to cook with the cost of a gallon with 20l of water in the city of Manaus, ranging between 5 and 7 reais. Taking into account the average of 4.07 inhabitants in a domicile occupied in subnormal agglomerates [10], ingesting an average of 2l of water / day, as instructed by the Ministry of Health [11], the monthly consumption of gallons would revolve around 12.2 gallons, totaling a monthly cost of gallon water of around R $ 73, when the social tariff for each 1,000 l of water comes out at R $ 1,993 according to the city's Water and Sewage Concessionaire website [12], equivalent to 50 gallons of water of 20 liters.

V.   CONCLUSION

These actions make a larger amount of water available to the supply system, since there is a substantial reduction in distribution losses, promoting dignity, quality of life,

public health and the protection of the environment for any and all citizens.

With the new Basic Sanitation Framework signed in July 2020, Law No. 14,026 [14] will be the "North" for the advancement of water distribution in these regions, where the Federal Government's goal is the universalization of Sanitation by 2033, and with this will have major investors in basic sanitation in Brazil.

Fig. 9: Resident receiving treated water under his tap

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The training process for employees of the Federal Institute of Rio Grande do Sul - IFRS through Analysis of Social Networks – SNA

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Abstract— The qualification possibilities of public employees in Brazil are regulated by Law 8.112/90. The qualification and training of employees is directly related to the Federal Network, with no different at the Federal Institute of Rio Grande do Sul – IFRS. Social Network Analysis - SNA has been widely applied in building training networks. The objective of this work was to characterize the IFRS training indicators through the Analysis of Social Networks. In order to capture the data of qualifying employees and their respective courses, the institution's service bulletin was analyzed. With this, it was possible to build the graph network through the degree and pageRank algorithms. Altogether, sample data from 310 employees were analyzed, distributed in three groups: Total employees (310), administrative technicians (147) and teachers (163), of which were selected: employees capacity unit, qualification course and the total number of employees enrolled in the respective qualification. The degree analysis showed that the Rio Grande unit has the highest number of qualifying employees. The most sought after course is Education. In the teaching group, Porto Alegre has the highest number of all units, with the Education course highlighted. And finally, TAEs - Rectory, obtained the highest indicator, with Education as the greatest demand. It can be concluded that SNA allowed the visualization of employees in training under the IFRS, together with the search for postgraduate courses and the distribution per unit of employees in training.

I INTRODUCTION

The search for qualification or for its expansion is something recurrent both for people who are inserted in the labor market and looking for continuous improvement, as for people who are in contention for new opportunities. This search for the expansion of qualification is no different in public bodies, as in the case of Brazilian Federal Institutes.

Quantify the areas in which the most improvements are made by employees administrative or teachers, as well as knowing the postgraduate programs, in which they have sought to qualify, is of great interest to school management, since, based on these indicators, it is possible to draw the profile of each employee in the institution.

With the defined profile, it is possible to see the strengths that the institution has and in which it needs to improve. Thus, employees will be encouraged to qualify in

certain areas that can promote a greater degree of knowledge that will be considered as a point of improvement for the institution.

However, knowing the courses most sought after by public servants can also become an opportunity for the institution to institute qualification actions through the offer of *lato-sensu* and/or *stricto sensu* courses, in order to spread the knowledge acquired by its employees.

Another important factor, in the case of Federal Institutes, is the verticalization of education, which makes it possible to optimize the physical infrastructure, personnel and management resources, as well as integrate Basic to Higher Education, in addition to offering postgraduate courses -graduation in *lato-sensu* and *stricto sensu*. With this, it is possible to offer courses in the most diverse modalities, as needed and/or local demand. Thus, there is a need for constant improvements and qualifications of the staff, mainly by the teachers, who, after completing the proper qualification, will act in the respective courses whose ownership allows them to.

A. The Federal Network for Professional and Technological Education

The Federal Network of Professional and Technological Education started its activities in 1.909, when Nilo Peçanha, through Decree 7.566 [1], established the 19 Apprentice and Craftsman schools in the country.

The initial mark of public policies for the institution of the Federal Network of Professional Education began with Decree No. 7.566 of September 23, 1.909, instituting the Schools of Apprentices and Craftsmen. With 19 units distributed in the states of Alagoas, Bahia, Rio de Janeiro, Ceará, Espírito Santo, Goiás, Maranhão, Mato Grosso, Paraíba, Paraná, Piauí, Pernambuco, Rio Grande do Norte, São Paulo and Sergipe [2]; offering courses (works) in wood, mechanics and arts.

Initially, the courses offered by the schools were aimed at less favored people (ex: ex-slaves, who with abolition could not find ways to guarantee their livelihood).

According to Fonseca [3] , Professional Education was seen by society at the time as philanthropy or charity, acting as a mechanism for social regulation. With the national industrial development process, there was a constant need for qualified labor, which caused the Federal Education Network to be restructured.

Between 1.937 and 1.942 there was the first restructuring of the units with the creation of 21 Industrial Schools in the municipalities of Aracaju, Belém, Campos, Belo Horizonte, Cuiabá, Curitiba, Florianópolis, Fortaleza, Goiânia, João Pessoa, Maceió, Manaus, Natal, Niterói, Pelotas, Salvador, São Luiz, São Paulo, Recife, Teresina

and Vitória [2]. The curriculum offered already had an industrial profile with courses in mechanics, electrical, crafts and civil construction, and lasting four years. During this same period, the S system of professional qualification was founded, as a result of the public-private partnership.

In 1.942, SENAI – National Industry Service was created by Decree-Law 4.048 of January 22 [4], being a private institution of public interest, whose objective was to support the industry in the training of human resources, through the Professional education and the provision of services aimed at industrial workers, which is the objective even today [5].

According to Souza [5], on January 10, 1.946, SENAC - National Service for Commercial Learning was created, through Decree Law 8.621, a private institution of public interest, offering Professional Education aimed at training commercial workers [6].

In 1.964, with the beginning of the military dictatorship, the articulation between the interests of international capital and the national political elite was accentuated, and the increase in the education of workers became a determining factor for the country's industrial development.

Furthermore, with more people seeking access to secondary education, there was pressure for higher education places. With a more educated population, it could represent a risk to the political regime, so Vocational Education acted as an escape valve, alleviating the pressure for places in universities [7].

Over the years, the Federal Agricultural Schools were created - farm schools linked to the Ministry of Agriculture, and from Decree n. 60.731 of May 19, 1.967 are now supervised by the Ministry of Education and Culture [8].

Over time, a network of agricultural schools was created – Federal Agrotechnical Schools, based on the farm school model and linked to the Ministry of Agriculture. In 1.967, these farm schools were transferred to the then Ministry of Education and Culture, becoming agricultural schools. In 1.978, three federal schools, in Rio de Janeiro, Minas Gerais and Paraná were transformed into Federal Technological Education Centers (CEFET), being equal, in the scope of higher education, to university centers [9].

In the 1990s, several technical and agro-technical schools were transformed into CEFET – Federal Technological Education Centers, originating in 1994 the basis of the national system of technological education.

In 1.996, the Law of Guidelines and Bases of Education (Law 9.394/96) [10] and the Federal Decree

2.208/1997 [11] established the bases for the reform of vocational education in Brazil. According to Manfredi [12], formally, after the institution of the Law, every educational institution, whether private or public, adjusts to the new educational norms that the legislation in force determined. As a result, since the 1990s, Professional Education in Brazil has been acquiring a new institutionality.

On December 29, 2.008, Law 11.892 was enacted, which created the Federal Network for Professional, Scientific and Technological Education, at the same time as the Federal Institutes of Education, Science and Technology (IFs) were created. Despite maintaining, by virtue of this law, the provision of Vocational Technical Education, these new institutions now compete with federal universities in offering free public Higher Education [13].

Also in Law 11.892/2008, articles 7 and 8 defined the objectives of the Federal Institutes, divided as follows: a minimum of 50% (fifty percent) of their vacancies to provide high school technical professional education, primarily in the form of integrated courses, for those graduating from elementary school and for the public of youth and adult education; a minimum of 20% (twenty percent) of its vacancies to teach undergraduate courses at higher education level, as well as special pedagogical training programs, with a view to training teachers for basic education, especially in the areas of science and mathematics , and for professional education; and the remainder, 30% (thirty percent), is intended to provide higher education courses: a) higher technology courses aimed at training professionals for different sectors of the economy; b) bachelor's and engineering courses, aimed at training professionals for different sectors of the economy and areas of knowledge; c) *lato-sensu* postgraduate courses for improvement and specialization, aimed at training specialists in different areas of knowledge; and d) *strictu sensu* master's and doctoral postgraduate courses, which contribute to promoting the establishment of solid foundations in education, science and technology, with a view to the process of generation and technological innovation [13].

Pacheco [14] comments that the Institutes have characteristics of innovation and daring, characteristics that are necessary, and aim to meet:

"[...] a policy and a concept that seek to anticipate here and now the foundations of a contemporary school of the future and committed to a radically democratic and socially just society".

According to the Nilo Peçanha Platform (PNP 2.020), the Federal Network of Professional Education in 2.017

had 653 units, 41 Institutions, 22 Technical Schools linked to the Federal Institutes and the Federal Technological University of Paraná (UTFPR). With about 1.023.303 enrollments in courses, 46.688 professors throughout the network, 32.02% are doctors and 53.88% are masters, that is, 85.90% of the professors are masters or doctors.

B. The Federal Institute of Rio Grande Do Sul - IFRS

The Federal Institute of Education, Science and Technology of Rio Grande do Sul - IFRS is part of the Federal Education Network. The institution offers courses free of charge in approximately 16 municipalities in Rio Grande do Sul. The courses offered are initial and continuing education, high school courses in an integrated or concomitant form, and higher education courses (Bachelors and technologists), in addition to postgraduate courses . IFRS has about seventeen campuses and a rectory (in the municipality of Bento Gonçalves).

According to the Nilo Peçanha platform, in 2.017, IFRS had approximately 14 thousand students, with the population offering 311 course options, ranging from initial continuing education courses to postgraduate courses. To meet this demand, the IFRS had approximately 2.173 civil servants, with approximately 1.221 professors and 952 administrative technicians.

It is worth noting that in the state of Rio Grande do Sul there are 3 (three) Federal Institutes, namely: Federal Institute of Rio Grande do Sul (IFRS), Federal Institute of Rio Grande do Sul (IFSul) and Federal Farroupilha Institute (IFFarroupilha). Each institute is independent and has distinct rectory and campuses.

C. Training of federal civil servants

There is an understanding in basic and higher education institutions that teacher training has contributed to improving learning. Duarte [15] explains that teacher qualification has impacted on student learning, but also improved the quality indicators of public and private educational institutions, as it is understood that the more capable the employees, the better the work will be.

Law 8.112/1990, which establishes the Legal Regime of Civil Servants of the Union, of autarchies, including those under special regime, and of federal public foundations, in particular Articles 81 and 87, assures the employees of the removal of their activities to carry out of training according to the level of qualification [16]:

"Art. 87. After each five-year period of effective exercise, the civil servant may, in the interest of the Administration, withdraw from the exercise of the effective position, with the respective remuneration,

for up to three months, to participate in a professional training course";

"Art. 96-A. The civil servant may, in the interest of the Administration, and provided that the participation cannot occur simultaneously with the exercise of the position or by compensation of time, withdraw from the exercise of the effective position, with the respective remuneration, to participate in a *stricto sensu* graduation at a higher education institution in the country."

In Decree nº. 9.991, of August 28, 2.019, published in the Official Diary of the Union – Brazil [17], he restructured the policy for the development of employees. Now, for the civil servant to request a license for training, he will have to meet criteria such as preparing a work plan, containing the description of the action's objectives in the perspective of development for the civil servant, the results to be presented to the agency, duration and load weekly hours.

This and other measures are part of the implementation of the National Policy for the Development of People – PNDP. In addition to providing for the PNDP, this decree also regulates provisions of Law nº 8.112/90, regarding licenses and removals for development actions.

All this effort to encourage the training of professionals confirms the importance of this study, which helps institutions to better understand the profile of their professionals, as well as their own needs for improvement.

The development of employees, through training, is of such relevance that on the IFRS website there is a space reserved for training, where information such as Recommended Institutions for Training, People Development Plan, Needs Assessment is made available Training, among others.

D. Analysis of Social Networks - SNA

For Serrat [19], Social Network Analysis is a method with increasing application in Social Sciences and has been applied in areas as diverse as: Psychology, Health, Business Organization and Electronic Communications. Aragon et. al. [20], used the method of analysis of social networks through graphs to represent the movement of animals through the Animal Transit Guide – GTA, in the state of Pará.

II   OBJECTIVE

The object this paper was the build a Social Network Analysis of employee of Federal Institute of Rio Grande do Sul – IFRS.

III   MATERIAL AND METHODS

Employees (administrative technicians and teachers of Basic Technical and Technological Education) participated in this study in the training process of the seventeen units of the Federal Institute of Education, Science and Technology of Rio Grande do Sul, and a rectory

It is important to mention that the data were obtained directly from the IFRS website and that they were analyzed in order to verify the numbers of both teaching staff and administrative technicians.

Through actions that allowed the transparency of public information, it was possible to obtain the qualification data to carry out this research, dispensing with any interactions or interventions related to public servants of the Federal Institute of Education, Science and Technology of Rio Grande do Sul, the aforementioned opinion on research ethics for human beings is unnecessary.

Subsequently, sample data from 310 civil servants were extracted from the website of the Federal Institute of Rio Grande do Sul, distributed into three groups: Total civil servants (310), administrative technicians (163) and professors (147), from which the following were selected: the employee capacity unit, the qualification course and the total number of employees enrolled in the respective qualification.

With this, the records were pre-formatted for the Comma-separated values model (.csv extension), which allowed us to build the graph network, with the help of the Gephi software [21]. Successively, the document containing the information of the sample groups was processed using the Social Network Analysis – ARS, through the Degree and PageRank algorithms. The vertices (nodes) are represented by employee, stocking unit and qualification courses, whereas the edges (Edges) represent the interactions between the stocking unit and the respective qualification course.

The Gephi software was adjusted for graph network analysis using as a layout option, the circular layout, with a diameter size of 500.00; ordering nodes (Node) ID and transaction steps of 1.000.000.

The training data were submitted to algorithmic analysis, with the aid of the Degree and PageRank techniques.

IV   RESULTS

In the analysis carried out through the Nilo Peçanha Platform (PNP 2.018 - Base Year 2.017), the Federal Institute of Rio Grande do Sul (IFRS) had 952 administrative technicians, 16 with elementary education, 61 with high school, 79 with technical education, 217 with

graduation, 394 with specialization, 162 with master's and 23 with doctorate.

Also in PNP 2.017, it was possible to analyze that the IFRS has 1,221 professors, of which 31 are graduates, 74 have specialization, 656 are masters and 460 are doctors. The indicators for the distribution of employees by stocking units in the process of improvement are presented in Figure 1.
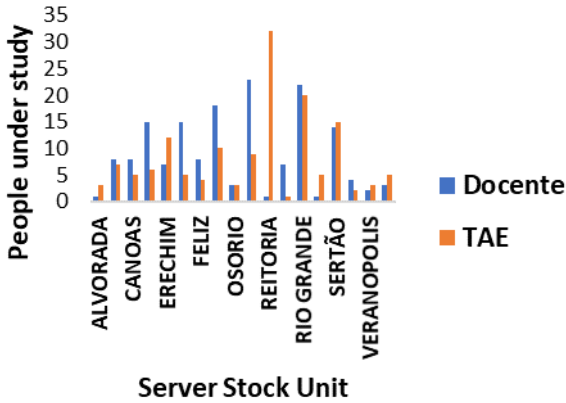
Fig.1: Employees of the Federal Institute of Rio Grande do Sul in the process of qualification by college.

In Figure 2, the qualification levels that civil servants have been looking for can be observed. Of the 147 administrative technicians in qualification, 45 were enrolled in Specialization; 74 in the Master's course and 28 in the Doctoral program. Regarding professors, about 163 are enrolled, of which 3 are in Specialization courses (3), 15 in Master's, 138 in Doctorate and 7 in post-doctoral internships.
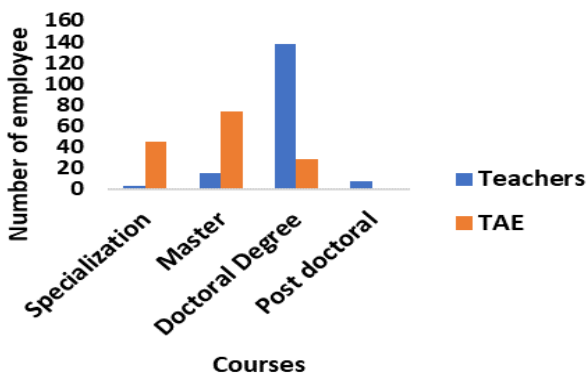
Fig.2: Distribution of employees in training by level of study.

In Table 1, it was possible to assess the number of professors, administrative technicians and their training courses through the Nodes (nodes) and the interactions between them through the edges (Edge).

Table 1. Quantitative of relationships between employees and qualification courses.

Description	Nodes	Edge
All employees	109	208
Teachers	69	112
Administrative Employees	83	119

Table 2 shows the number of employees by qualification level. Of the total number of employees in qualification analyzed, 48 are attending Specialization, 89 Master's, 166 Doctorate and 7 Postdoctoral. Data analysis also showed the level of qualification that the employees are looking for. Of the 147 administrative technicians in qualification, they are enrolled in Specialization (45), Masters (74) and Doctorate (28) courses. Of the 163 professors, they are enrolled in Specialization courses (3), Master (15), Doctorate (138) and Post-doctorate (7).

Table 1. Quantitative of relationships between employees and qualification courses.

Descritpion	Specialization	Master	Doctorate	Post doctorate
Teacher	3	15	138	7
Administrative employees	45	74	28	0

Present in this study, the Social Network Analysis - Degree characterized in Figure 3, presented the total amount of civil servants in qualification. In this network, it is inferred that the Rio Grande campus (42) is the unit with the largest number of employees in qualification, followed by the Rectory (33), Porto Alegre (32), Sertão (29) and Ibirubá (28) units.
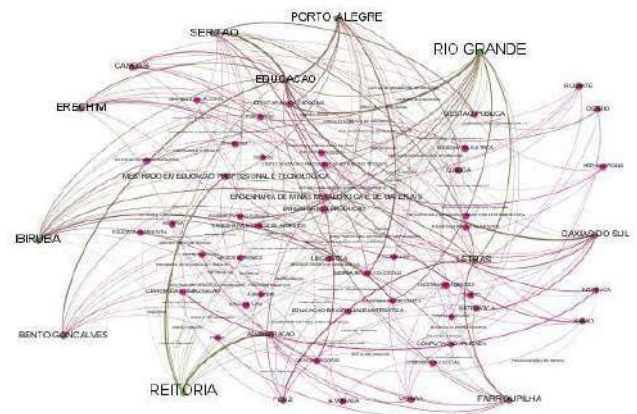
Fig.3: Degree characterization of all employees of the Federal Institute of Rio Grande do Sul in the qualification process.

To identify the most sought after courses, a PageRank analysis was performed (Figure 4) of all civil servants in qualification, with emphasis on the civil servants who

attended the following postgraduate courses: Education (42), Languages (26), Masters in Education Professional and Technological (12), Public Management (10) and Applied Computing (7).
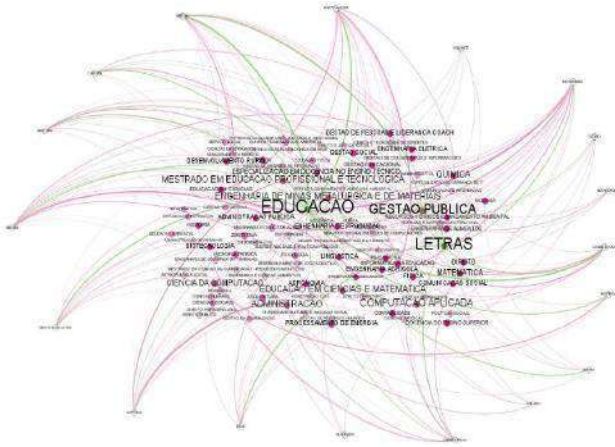
Fig.4: Analysis of Social Networks of all person by PageRank algorithm.

In the group of professors, when running the Degree algorithm (Figure 5), a large number of people on the Porto Alegre campus (23) were in qualification, followed by Rio Grande (22), Ibirubá (18), Caxias do Sul (15)) and Ragamuffin (15).

Fig.5. Analysis of Social Networks of all Faculty using the Degree algorithm

In the results for the courses most sought after by teachers, the algorithmic analysis of PageRank (Figure 6), there was a great demand for the Education course (27), followed by Literature (16), Applied Computing (6) and Specialization in Teaching in Technical Education (3).
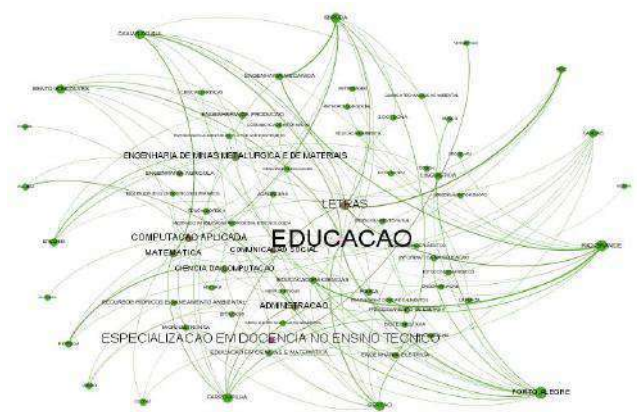
Fig.6: Analysis of Social Networks of all Faculty by PageRank algorithm.

In the results of the Degree analysis (Figure 7) of administrative technical servants, it can be seen that the Rectory (32) is the unit with the highest quantity of civil servants in qualification, followed by Rio Grande (20), Sertão (15), Erechim (12) and Ibirubá (10).
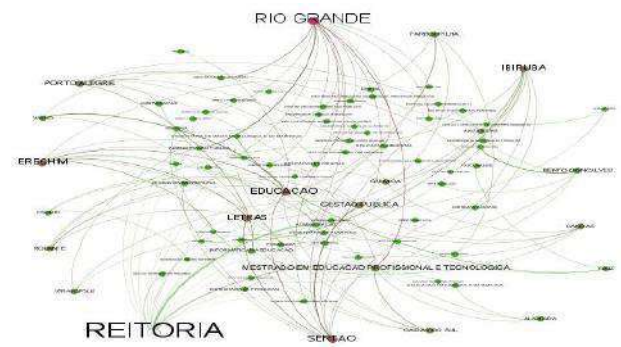
Fig.7: Analysis of Social Networks of all technical administrative employees by the Degree algorithm.

In the results of the PageRank algorithm (Figure 8) for the specialization, master's and doctoral programs, applied to technical administrative staff, it is noted that the Education course (13) is the most sought after, followed by Literature (14), Masters in Professional Technological Education (11) and Public Management (10).
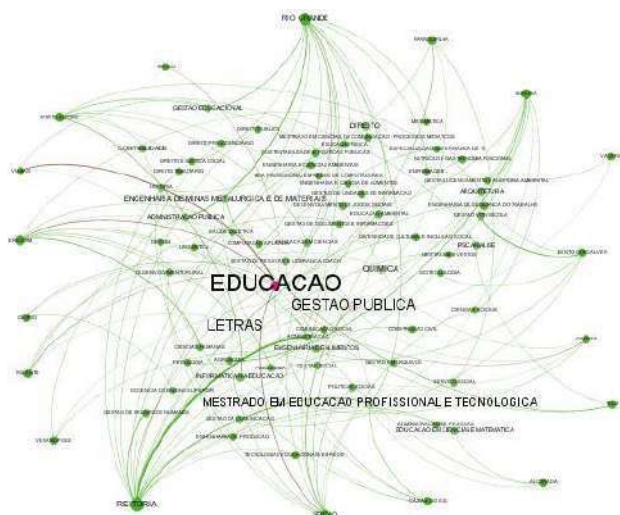
Fig.8: Analysis of Social Networks of all technical administrative employees by PageRank algorithm.

V   DISCUSSION

Through this study, it was possible to observe that the faculty showed greater demand for *stricto sensu* courses at the doctoral level. The justification for this demand can be seen when analyzing the titles of professors in the Nilo Peçanha Platform 2.018, which records, in the base year 2.017, 31 professors with an undergraduate degree, 74 with specialization, 656 with a master's degree and 460 with a doctorate. Thus, it is evident that the greatest demand, for the teaching class, would be for the doctoral level, since the majority (53.73%) have a master's degree.

In this work, it was also possible to observe that administrative employees had a greater demand for *stricto sensu* courses at the master's level. As for the faculty, the justification can also be observed when analyzing the title of Administrative Technicians in the Nilo Peçanha Platform 2.018, which records, in the base year 2.017, 217 Administrative Technicians with graduation, 394 with specialization, 162 with master's and 23 with doctorate. Therefore, it is evident that most of these person have specialization and, therefore, it is evident that the greatest demand would be, in fact, courses at the master's level. It should be noted that, for administrative employees, there are still 156 civil servants who do not have a degree.

In Figure 01, there was a high rate of administrative technical servants, attending a master's and doctoral degree in the rectory, as observed in the Nilo Peçanha Platform 2.018, in the rectory the vast majority of employees working are administrative technicians, which justifies this finding.

Another important factor to note is that in 2.017, according to data obtained from the Ministry of Education, via Nilo Peçanha Platform, it was a year with appointments, mainly

of administrative technical employees for the Federal Institute of Rio Grande do Sul.

Several other analyzes can be carried out from this work together with a more detailed survey of Nilo Peçanha Platform and IFRS. One of these analyzes is linked to Figure 01, where it is possible to observe that on the campuses of Rio Grande and Porto Alegre there is an expressive number of teachers and administrative technicians in qualification, in addition to being in an equivalent proportion. The number of administrative employees in qualification, higher than the number of professors in qualification that some campuses have, also proves to be an interesting analysis that can be explored. These and other analyzes can be the objectives of other works that may be based on the work presented here. In addition, we emphasize that according to data from the Nilo Peçanha Platform in IFRS 91.40% of teachers are masters or doctors, which given the number of administrative technicians, there should always be a greater number of administrative technicians attending a master's course, it is also important to emphasize that there are unit with about 85% of professors with master's and doctoral degrees, which will be very evident to have a campus with a greater number of employees studying master's and doctoral degrees than another given campus.

VI   CONCLUSION

The present study showed that the use of Social Network Analysis - ARS applied to civil servants in the qualification process at the Federal Institute of Rio Grande do Sul - IFRS allowed a complete and accurate visualization of the civil servants in qualification in relation to graduate programs. In this way, the use of the ARS can help managers in offering postgraduate courses with a higher rate of demand. Still, such networks can be improved according to the availability of complementary and more accurate data by the Federal Education Institutions – IFE. The results also showed the level of qualification of the servants and that they always seek to be growing, which, as portrayed in this work, helps in valuing educational institutions and the knowledge they have of their servants.

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Teacher capacitation at the Federal Institute of São Paulo through Social Network Analysis -SNA.

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Abstract— In Brazil, there are numerous decrees, laws and regulations that promote the training of personnel, aiming at the improvement of public services provided. However, there is a difficulty in mapping which trainings are being carried out by employees of Federal Education Institutions and through Social Network Analysis it is possible to solve this issue. The objective of this study was to characterize the training of teachers at the Federal Institute of São Paulo through Social Network Analysis. For this, teachers enrolled in master's and doctoral programs were selected. With this, it was possible to identify the college with teachers in training and their respective training courses. The data were separated by level and course and through gephi software it was possible to build networks of graphs. The values of Social Network Analysis for teachers enrolled in the Master's program indicated that the São João da Boa Vista and Presidente Epitácio colleges have the highest number of teachers and the most popular courses: Education, Mechanical Engineering and Mathematics. As for the doctorate, São Carlos and São João da Boa Vista have the largest number of employees in training and the courses in Electrical Engineering, Education and Computer Science are in greatest demand. We can conclude that the Social Network Analysis indicated a great demand for training courses in the exact sciences area (Mechanical Engineering, Electrical Engineering and Computer Science), moreover Education has a great impact on teachers who seek Master's training.

I INTRODUCTION

Professional training is one of the main pillars for improving processes and high productivity in public and private initiatives. In several countries, teachers have constantly invested in training to provide quality public education.

In Brazil, federal employees, especially those in education, are governed by laws 8.112/1990 [1] and 12.272/2012 [2]. Law 8.112, which regulates the legal regime of civil servants of the Union and of autarchies, in its art. 87 details the possibility of dismissal of employees with remuneration every five years, for a maximum period of 3 months.

Already in article 96, in turn, deals with paid leave for postgraduate courses, masters up to 24 months, doctorate up to 48 months and postdoctoral up to 12 months.

However, Federal Educational Institutions (FEIs) don't have any control over the courses that their employees seek to train, much less the level of training intended. A major gap pointed out by managers (Deans, Deans and General Directors) is to indicate the level of course and training to be offered.

For Cavalcante [3], training is an important labor qualification mechanism used in the private sector. However, for some years now, the public sector has adopted strategies to improve the knowledge of its public servants.

A. Training in the Federal Education Network

According to the Nilo Peçanha platform [4], in 2.019, the Federal Education Network (formed by the Federal Institutes of Education, Science and Technology, Federal Technological University of Paraná - UTFPR, Federal Centers of Technological Education Celso Suckow da Fonseca in Rio de Janeiro - Cefet -RJ and Minas Gerais - Cefet-MG, Technical Schools linked to Federal Universities and Pedro II High Schools), had about 46.688 teachers distributed in 6 levels of training (Basic Education, Graduation, Improvement, Specialization, Master's Degree and Doctorate Degree), in which 67.97% of the teaching staff have academic qualifications up to a master's degree.

For an effective and efficient public service, there must be investments in training at its various levels in order to promote the improvement of services provided [5].

In Brazil, the Coordination for the Improvement of Higher Education Personnel – CAPES is the government agency that regulates training programs at Masters and Doctoral levels. According to CAPES, in 2020, there are approximately 2.186 Master's and Doctoral programs across the country. In the Federal Education Network there are several *stricto sensu* training programs (Academics and professionals)

To implement training programs within the federal public administration, the government has used its National Personnel Development Policy (NPDP). In this context, Pantoja et al. [6] report that the NPDP brings new perspectives of training and allowing a change in the competency-disciplined management model

B. Social Network Analysis – SNA

The Social Network Analysis has been used in studies in several areas such as: Computer Science, Information Science, Social Sciences, Health and Education [7].

Oliveira et. al [8], used the technique to characterize the training of employees of the Federal Institute of Education, Science and Technology of Santa Catarina - IFSC through Social Network Analysis.

In Medical Informatics, Oliveira and Gouveia [9] used the technique to measure the displacement of people in the northern region of Brazil to perform X-Ray and Bone Densitometry exams.

C. The Federal Institute of Education, Science and Technology of São Paulo – IFSP.

In 2.008, through Law nº 11.892 [10], the Federal Institute of Education, Science and Technology of São Paulo – IFSP was created. The IFSP is composed of 37 college, 3 of which have an unity advanced - small college structure (from 20 to 40 professors), 1 college under implementation, 1 rectory and 32 college (from 70 to 90 professors). According to the Nilo Peçanha platform, in 2017, there were about 2.481 effective teaching staff at the institution. Thus, the aim of this study was to characterize the training of teachers at the Federal Institute of São Paulo through the Analysis of Social Networks -SNA.

The Federal Institute of São Paulo, is a century-old technical school in Brazil, originated from the School of Apprentice Artifices (SAA) of São Paulo, had its creation through Federal Decree 7.566 [11] of September 23, 1909, signed by the then President Nilo Peçanha.

Over the years, the SAA were transformed into Industrial Schools through Federal Law nº 378/1937 [12], which were later transformed and named Industrial and Technical Schools by means of Decree-Law No. 4.127/1942 [13]. In 1.959, the Federal Technical Schools (FTS) were established and became autarchies through Federal Law nº. 3.552/1959 [14] and, over the years, through Federal Law nº. 6.545/1978 [15] converts the Etecs of Minas Gerais, Paraná and Rio de Janeiro in the Federal Technological Education Centers (Cefet), an organization that Efet de São Paulo acquired with the enactment of Law No. 8.948/2004 [16], which lasted until its transformation into a Federal Institute in 2008.

Inaugurated as President of the Republic of Brazil in 1909 Nilo Peçanha had in mind that only professional and technological education could change the whole reality of this country, so in just 3 months of his government he created the Schools of Apprentices and Craftsmen (EAA) originating what we have today the Federal Network of Professional, Scientific and Technological Education, a centenary network with hundreds of campuses installed in Brazil with more than 1 million enrolled students, Nilo Peçanha is the patron and creator of the Federal Network.

In honor of the patron and creator of the Federal Network, the Nilo Peçanha Platform was created, where all the information of the Federal Network is included in this platform, available for public consultation. Location where all the academic and management information that was achieved each year is available for consultation. Also a place for data collection, validation, and dissemination of official statistics from the Federal Education Network. It also aims to gather data related to the faculty, students, administrative technicians and financial expenses of each unit of the Federal Education Network.

The objective of this study was to characterize the training of teachers at the Federal Institute of São Paulo through Social Network Analysis.

II   METHODOLOGY

In this study, the teaching staff of the Federal Institute of São Paulo - IFSP, who were enrolled in *stricto sensu* postgraduate programs (Masters or Doctorate), in 2017 were selected.

With this, data from public employees in training were consulted through the service bulletin available on the portal of the Federal Institute of São Paulo. Then, the teaching staff were separated by staffing unit and their respective level of training (Masters and Doctorate).

Through the Lattes platform [17], the teacher's course was obtained and with this it was possible to build the network of graphs (Social Network Analysis)

Data were separated by level and graduate course, with this, the gephi software was used to project graph networks.

In the study, the Degree and PageRank algorithms were used to verify the relationship between professors and postgraduate courses and also the influence of the course on the qualification of professors.

III   RESULTS AND DISCUSSION

The values obtained from the Social Network Analysis (Degree) for professors enrolled in master's programs indicated that the São João da Boa Vista and Presidente Epitácio college have the largest number of employees enrolled in master's courses (figure 1). When analyzing the Nilo Peçanha 2020 Platform (base year 2019) we observed that the Presidente Epitácio college has 82 professors, and of these, 28% are doctors and 49% have master's degrees. Which confirms the result of the Analysis Networks study.
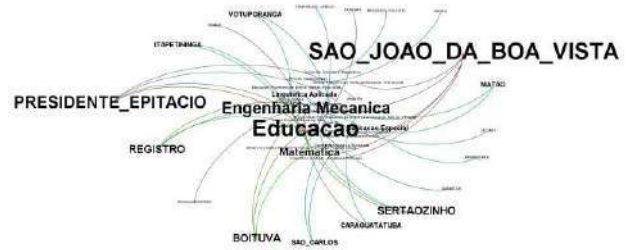
Fig.1: Degree Network graph of teachers registers on Master's degree.

Regarding the courses most sought after by IFSP professors, it is observed that Education, Mechanical Engineering and Mathematics are the most sought-after courses (Figure 2).
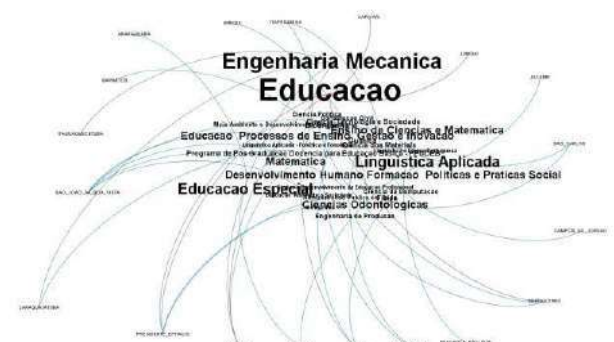
Fig.2: Page Rank network graph of teachers registers on Master's degree.

With regard to professors who attended a doctorate, the values calculated by the Analysis of Social Networks demonstrate that the São Carlos and São João da Boa Vista colleges have the largest number of employees in training. When analyzing the Nilo Peçanha Platform 2020 (base year 2019) he observed that the São Carlos campus has 80 professors, of which 59% have a doctorate and 34% have a master's degree. A lower situation was observed on the São João da Boa Vista college, which has 83 professors, of which 41% have a doctorate and 44% a master's degree.
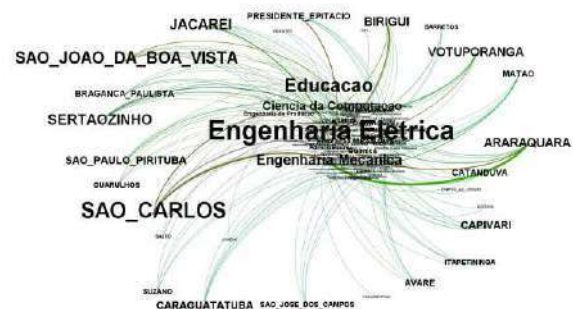
Fig.3: Degree network graph of teachers registers on Doctorate degree.

As shown in Figure 2, the courses most requested by IFSP professors, it appears that Electrical Engineering, Education and Computer Science are the programs most sought after by professors.
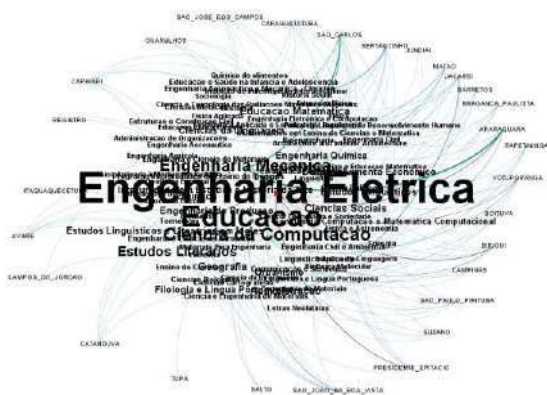
Fig.4: Page Rank network graph of teachers registers on Doctorate degree

The public service in general has gone through several changes in its structure, mainly the reduction of bureaucracy in the states. Mello and Amâncio Filho (2010) show that training through competency management is undoubtedly the best way for institutions to develop competencies

Teixeira Filho et al. [18] reports that one of the legal frameworks of managerial models in the management of people in the Brazilian public administration was established through Decree nº. 5707/2006, which is a policy focused on the development of employees through training. This policy, with a focus on competency-based management, established the Policy and Guidelines for the Development of Personnel (PGDP) of the direct, autonomous and foundational federal public administration, in accordance with the provisions of Law No. 8112/1990 [19].

According to Appugliese [20], through Decree No. 5.707/2006 [21], it was possible to create the National Policy for Personal Development, whose objectives were: to improve the efficiency, effectiveness and quality of public services provided to the citizen, so a permanent development of the public servants. The author adds that training is investing in public servants, as it allows for improvements in individual and institutional work processes.

This decree was later revoked and replaced by Decree nº. 9.991/2019 [22] with some changes. Fostering the training and development of people allows the professionalization of civil servants, obtaining greater organizational performance in the public service, enabling the achievement of the Education Institution's objectives and goals.

At the federal institutes, Sakamoto et. al. report that there are some initiatives for the development of people, aimed at improving the services provided by IFE.

Mello, Melo and Mello Filho [23], on the other hand, identified that structural problems and accumulation of service are decisive factors for the implementation of training through competency management.

In training, Oliveira et. al. (2019) [8], carried out a study of Analysis and Social Networks of teachers in training at the Federal Institute of Santa Catarina. In this study, the authors concluded that the Linguistics, Computer Science and Letters courses were the most requested by the professors, contrary to the results of this study, which demonstrated Mechanical Engineering, Education, Electrical Engineering and Computer Science. What explains these differences found are the courses offered by each Federal Educational Institution, with their teachers being directly linked to these areas.

IV   CONCLUSION

In this study, we can conclude that the Social Network Analysis showed a search for courses in several areas, with an emphasis on *stricto sensu* courses in the exact sciences (Mechanical Engineering, Electrical Engineering and Computer Science). a great impact on professors seeking master's training.

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Seroprevalence for *Rickettsia* spp. and *Borrelia* spp. in horses from non-endemic areas at the Southeastern Brazil

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Abstract— Spotted Fever Group (SFGR) and Baggio-Yoshinari Syndrome (BYS) are described as important tick-borne zoonosis. Horses do not participate directly in the cycle of these diseases, but they work as sentinels of epidemiological studies. We analyzed the distribution of Rickettsia spp. and Borrelia spp. in horses and ticks of two non-endemic areas from Southeastern Brazil. Blood serum from 102 horses of different ages (> 12 months) and breeds were analyzed by the indirect immunofluorescence reaction (IFR) with the aid of specific antigens for R. rickettsii, R. parkeri, R. rhipicephali, R. amblyommatis and R. bellii, besides the indirect immunoadsorption assay (ELISA) aiming to detect homologous IgG antibodies against B. burgdorferi (American strain G39/40). Free-living and parasitic ticks were collected for PCR and Nested-PCR tests to detect both Rickettsia spp. (citrate synthase gene) and Borrelia spp. (flagellin gene). The data showed 51.96% (53/102) of seropositive horses at least in one of the five tested Rickettsia antigens, and 10.78% (11/102) were considered serum-specific for R. parkeri. Besides that, a total seroprevalence of 13.73% (14/102) for immunoreactive antibodies of the IgG class against B. burgdorferi were obtained from the indirect ELISA. Three hundred and fifty-three ticks were collected, all identified as Amblyomma sculptum and negative for PCR and Nested-PCR. The obtained results suggest the circulation of SFGR and Borrelia spp. in a non-endemic area of Brazil, added to a large occurrence of vector ticks. This scenario deserves attention for the possibility of a zoonotic cycle in the region.

I. INTRODUCTION

Rickettsioses from the Spotted Fever Group (RSFG) and the Baggio-Yoshinari Syndrome (BYS) are emergent diseases transmitted to men through the bite of infected ticks. Thereby, domestic and wild animals are important for both epidemiology and spreading of these diseases [1,2].

Brazilian Spotted Fever (BSF) caused by the bacteria *Rickettsia rickettsii* is the most important among those

from the RSFG, with great lethality. However, the 'Mata Atlântica' strain from *Rickettsia parkeri*, and the *Rickettsia parkeri sensu stricto (s.s.)* have been described in some regions of Brazil, but without reports of seriousness. Generally, the RSFG have an endemic nature in many regions of the country, and they have been reported both in rural and urban areas, with many cases in the Southeastern Region [3–6].

The complex *Borrelia burgdorferi sensu lato (s.l.)* comprises a group with a large number of spirochetes that cause diseases as Lyme Disease (LD), mainly in the USA and Europe. In Brazil, there is a suspicious that the BYS is regarded to the *Borrelia* species, and its occurrence was described both in humans and animals through serological and molecular techniques [7–9].

The *Amblyomma* genus has been reported as the main vector for RSFG in Brazil [3,10]. Nevertheless, vectors of BYS are not well-described yet. Considering that, it is suggested that the wild cycle can occur among species from the *Ixodes* genus [11], while the domestic cycle occurs by ticks from *Amblyomma* and *Rhipicephalus* genus [1,9].

About this context, as horses are ticks' hosts, mainly of *Amblyomma sculptum*, besides they are often used for work or leisure in rural areas, these animals can be important dispersers of infected ticks [2, 12].

Many serological and molecular studies have been carried out at areas with notification of human cases, or at endemic areas for RSFG or BYS. Conversely, there are few studies about non-endemic regions. Thereby, the knowledge about the epidemiology in regions with the biotic potential to develop these vector diseases is essential to prevent new outbreaks. In this present study, we analyzed the distribution of *Rickettsia* spp. and *Borrelia* spp. in both horses and ticks of two non-endemic areas from Southeastern Brazil.

II.   METHODOLOGY

The study was carried out at municipalities of Guaxupé, Minas Gerais state (21° 18' 18" S 46° 42' 46" W) and Tapiratiba, São Paulo state (21°27'20"S 46°43'31"W) Brazil, from May to November 2018. These municipalities did not have notification of BSF and BYS. The samplings occurred in six farms chosen according to the availability of animals, besides their similarities regarding the morphoclimatic characteristics, presenting favorable epidemiological conditions to maintain the cycle of diseases transmitted by ticks. For example, fragments of tropical forests, pastures, water collections, humans and animals living together, besides the presence of capybaras

and domestic animals were conditions found out in both municipalities.

Blood samples were collected from adult horses (with different breeds, aged over 12 months) through jugular venocentesis. The blood serum was obtained by centrifugation at 3000 rpm and 10 minutes, following by freezing into polypropylene tubes at -20°C until the analysis. These samples were identified according to each animal and farm. Aliquots of 15 μL from each diluted serum (buffer phosphate – PBS pH 7.2) were submitted to the indirect immunofluorescence reaction (IFR) [13] Antigens from the five species of *Rickettsia* found out in Brazil were submitted to the IFR: *R. rickettsii* strain Taiaçu, *R. parkeri* strain At24, *R. amblyommatis* strain Ac37, *R. rhipicephali* strain HJ5 and *R. bellii* strain Mogi. The serum of a naturally infected animal, confirmed as positive, was used as the positive control, and a serum sample of a previously tested animal, stored at -20 °C, was used as the negative control. Samples with reaction at dilutions over 1:64 were considered positive ones to the final titration, and tested until present themselves as negatives in series. All samples with titres at least four times greater than the other ones were considered homologous for the greatest titre, for each species of *Rickettsia* [14].

The indirect Enzyme-Linked Immunosorbent Assay (ELISA) was used to analyze the antibodies of the IgG class against the crude antigen of *B. burgdorferi* strain G 39/40 [15]. The serum of a healthy young animal, which was vaccinated with the crude antigen of *B. burgdorferi*, was used as the positive control. Negative controls were made of ten serum samples obtained from healthy animals, without historical affection by ticks. The assay cut-off was defined by the arithmetic average of optical density values from the negative controls added to three times their standard deviation [16]. The optical density index was calculated based on the formula: DO $\times$ 100/cut-off, for each sample.

Living-free ticks were collected from pastures owned to the farms through the methodology of CO_2 chemical traps [10,17], and the flannel dragging [18], for the assessment of ectoparasites population. The complete scraping of the animal's body surface was made to collect the ticks at parasite stage. All ticks were preserved with the aid of isopropyl alcohol. Thereafter, they were identified [19,20] and individually submitted to DNA extraction, according to the boil protocol[21] for non-engorged larvae and nymphs, besides the phenol-chloroform protocol for engorged adults and nymphs [22]. The extracted DNA was tested by PCR using the primers CS-239 and CS-1069, which amplified a fragment with 834 pb from the *citrate synthase (gltA)* gene, found out in all species of *Rickettsia* genus

23,24. For the DNA detection of *Borrelia* spp., the Nested-PCR was used with primers that amplified parts of the *flagellin B* (*flaB*) gene found out in *Borrelia* spp. [24]. For the primary reaction, the primers *FlaLL* and *FlaRL* were used, while for the Nested reaction, the used primers were *FlaLS* and *FlaRS*.

The research project was approved by the Comitê de Ética em Pesquisa em Animais / UNIFENAS, under the 10A/2018 endorsement.

III.   RESULTS

The total seroprevalence for immunoreactive antibodies (≥1:64) in the IFR, for at least one of the five *Rickettsia* antigens, was 51.96% (53/102) and titres varied from 1:64 to 1:1024 (Table 1). In Guaxupé-MG municipality there was found 36.4% (12/33) of seropositive horses for at least one of the five-tested *Rickettsia*, while in Tapiratiba-SP, 59.42% (41/102) were found out. Regarding the serum specificity of reactions, 18.63% (19/102) of all animals presented homologous serum for *R. bellii,* while 10.78% (11/102) showed it for *R. parkeri* with titres varying from 1:64 to 1:1024 for both species. It was cannot possible to identify the probably antigen from 22.55% of the reactions, and because of that, they were classified as unspecific. In Guaxupé-MG, 30.30% (10/33) of the horses were considered serum-specific for *R. bellii*, 3% (1/33) for *R. parkeri* and one reaction was classified as unspecific (3%; 1/33). In Tapiratiba-SP, 14.49% (10/69) of horses were serum-specific for *R. parkeri*, 13.04% (9/69) for *R. bellii*, and 31.88 (22/69) of the reactions were unspecific.

Serum analysis also revealed a total seroprevalence of 13.72% (14/102) for immunoreactive antibodies from IgG class against *B. burgdorferi*, by the indirect ELISA. All seropositive horses owned to only one farm located at the Tapiratiba-SP municipality. This overestimated the region prevalence to 20.28%. None tested horse from Guaxupé-MG was serum-reactive.

All the 353 collected ticks were identified as *Amblyomma sculptum*. Only one adult female was captured and the other ticks were nymphs. All analyzed ticks were negative regarding all tested bacteria.

Most of all assessed farms had presence of capybaras and wild animals during the assay. In two of the six farms, capybaras were observed at the time of data collection. There were also rural communities near to these capybaras' habitats and the *A. sculptum* presence.

IV.   DISCUSSION

The municipalities of Guaxupé-MG and Tapiratiba-SP have areas where rural tourism is economically important, and there are many horse stables and training centers. Furthermore, there are rivers, abundant native vegetation, and wild animals as capybaras, which can maintain many species of ticks that often are vectors of diseases like the ones mentioned here. These specific regions are non-endemic, and no notification of suspicious or confirmed cases of RSFG was reported until this moment. Moreover, there were no studies about infections in humans, horses, dogs, or other vertebrates.

In this present study, the seroprevalence of immunoreactive antibodies to *Rickettsia* in horses was 51.96% (53/102), values greater than those ones reported (25% and 27.3%) in other studies also carried out at non-endemic areas of Brazil [13,25,26]. Contrariwise, studies carried out in endemic areas, or with confirmed human cases, showed serological results near to those found in our study [13,27]. Besides that, Souza et al. [27] verified that horses largely exposed to the infection by *Rickettsia* spp. (prevalence from 6.1% to 54.7%), but with a geometrical average of titres greater in endemic areas, can suggest a possible underestimation of cases reported by the health surveillance of BSF. This fact points out the importance of sentinel animals on the diagnosis and observation of areas without human cases report.

Our survey showed 19.6% of reactive samples for *R. rickettsii*, but none can be considered serum-specific because they were reactive to other tested species, which suggests a crossed reactivity among *Rickettsia* species or a previous exposition to infection by different species. Many studies showed the occurrence of a large crossed reactivity among the RSFG, mainly between *R. rickettsii* and *R. parkeri* [27–29]. Only one sample did not present crossed reactivity for *R. rickettsii* and *R. parkeri*. Nevertheless, not all reactive samples for *R. parkeri* reacted to *R. rickettsii*. It was not possible to determine the probable antigen involved in 43.4% (23/53) of all reactions, once there were positive reactions with similar titres at least two of the studied *Rickettsia* species.

Contrasted with that, 33.33% (34/102) of all horses were reactive to *R. parkeri*, and 10.78% (11/102) were considered serum-specific with titres varying from 64 to 1024. Horta et al. [13] investigated infections by *Rickettsia* spp. in animals, humans, ticks and fleas collected in areas from São Paulo state, and verified serological reactivity for *R. parkeri* in animals, even in a non-endemic area.

In Brazil, *R. parkeri* was found out in tick species from *Amblyomma* genus [30] such as *A. tigrinum*, *A. triste*, and *A. ovale* [31,32], and most recently in the *A. sculptum* [9,33].

Previous studies experimentally demonstrated the infection by *R. parkeri* in *A. cajennense sensu lato* [25], which suggests this tick species as potential vector of Spotted Fever caused by this bacteria. Our study showed that all serum-specific horses for *R. parkeri* resided into farms with *A. sculptum* occurrence, which can point out the necessity of complementary studies to elucidate it.

Regarding the indirect ELISA with antibodies from class IgG *B. burgdorferi* strain G 39/40, 13.73% of all horses were positive, which are results near to those found by Montandon et al.[8] and Salles et al.[15]. All horses positive to indirect ELISA were from the municipality of Tapiratiba-SP, owned to only one farm that had the presence of cattle, *A. sculptum* and capybaras. This fact is relevant because some studies already indicated that the coexistence between cattle and horses allows parasitism on horses by *Rhipicephalus microplus*, the main vector of *Borrelia theileri* [34]. It is possible to have crossed reactions between different *Borrelia* agents, due to the great phylogenetic association among *Borrelia* spirochetes [35,36]. Moreover, according to Rogers et al.[35], possible crossed reactions between *B. theileri* and *B. burgdorferi* should be considered on the analysis of serological tests for *B. burgdorferi* in ruminants, mainly regarding the crude antigen. Vector aptitude of ticks from both *Amblyomma* and *Rhipicephalus* genus on the transmission of the *B. burgdorferi* was not defined yet. However, Rezende et al.[37] reported embryonic cells from *Rhipicephalus microplus* and *A. cajennense s.l* as possible substrates for the growth of *B. burgdorferi sensu stricto* strain G39 / 40. Recently, Higa et al.[9] described the first molecular evidence of *Borrelia* spp. in *A. sculptum*, which were collected in the Midwest region of Brazil.

Both presence of *Borrelia* spp. and *Rickettsia* spp. were analyzed through the detection of specific DNA sequences, but all tests were negative. Negative results for PCR can be explained by the lower samples of examined ticks, besides the deleterious effect on these ticks caused by pathogenic *Rickettsia* [4,38] and spirochetes [39,40]. Even epidemiological surveys in endemic areas for RSFG in Brazil demonstrate a low frequency of DNA detection, varying from 0 to 1.28 [10,41].

V. CONCLUSION

Horses' seropositivity for RSFG, mainly for *R. parkeri* and *Borrelia* spp., added to a large occurrence of vector ticks deserve attention for the possibility of an enzootic cycle with zoonotic potential at the studied regions, once these vectors coexist with humans on the same niche. Nevertheless, the etiological agents that are responsible for the serological reactivity of horses must be well-defined yet.

Geographic amplitude added to the distribution of human communities near to the rural and native areas, and the large biodiversity from these areas make them a priority regarding the investigation of potential diseases transmitted by ticks.

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Table 1 – Titres variation of antibodies for species of Rickettsia tested by the indirect immunofluorescence reaction (IFR), and probable homologous antigens by positive horses (≥1:64) and origin location (region), Brazil, 2019.

Sample identification	Gender	Breed	Region	*R. rickettsii*	*R. parkeri*	*R rhipicephali*	*R. amblyommatis*	*R. bellii*	*PAIHR* *
E2	F	MP	Guaxupé - MG	-	-	64	128	512	*R. bellii*
E3	M	MP	Guaxupé - MG	-	-	64	64	1024	*R. bellii*
E12	F	MP	Guaxupé - MG	-	-	-	-	512	*R. bellii*
E13	F	MP	Guaxupé - MG	-	-	-	-	1024	*R. bellii*
E14	F	MP	Guaxupé - MG	-	-	-	-	1048	*R. bellii*
E15	F	MP	Guaxupé - MG	-				1024	*R. bellii*
E17	M	MP	Guaxupé - MG	-	-	-	-	1024	*R. bellii*
E18	M	MP	Guaxupé - MG	-	-	256	64	1024	*R. bellii*
E19	M	MP	Guaxupé - MG	-	-	-	-	1048	*R. bellii*
E28	F	QH	Guaxupé - MG	-	-	-	-	256	*R. bellii*
E30	F	MP	Guaxupé - MG	-	128	-	-	-	*R. parkeri*
E31	M	SRD	Guaxupé - MG	-	256	-	-	512	Unspecific
E93	M	SRD	Tapiratiba – SP	512	512	256	256	512	Unspecific
E95	M	SRD	Tapiratiba - SP	256	1024	512	512	1024	Unspecific
E96	M	SRD	Tapiratiba - SP	256	512	512	256	512	Unspecific
E98	M	SRD	Tapiratiba - SP	128	256	-	128	-	Unspecific
E99	M	SRD	Tapiratiba - SP	512	512	512	512	512	Unspecific
E100	M	SRD	Tapiratiba - SP	512	512	512	512	512	Unspecific
E102	M	SRD	Tapiratiba - SP	256	128	512	512	1024	Unspecific
E72	M	MP	Tapiratiba - SP	-	-	-	-	256	*R. bellii*
E73	M	MP	Tapiratiba - SP	128	256	-	-	-	Unspecific
E74	F	MP	Tapiratiba - SP	256	64	-	-	512	Unspecific
E75	F	MP	Tapiratiba - SP	64	-	-	-	128	Unspecific
E76	F	MP	Tapiratiba - SP	128	1024	-	-	64	*R. parkeri*
E78	F	MP	Tapiratiba - SP	256	512	-	-	-	Unspecific
E79	M	MP	Tapiratiba - SP	-	1024	-	-	64	*R. parkeri*
E80	F	MP	Tapiratiba - SP	-	64	-	-	-	*R. parkeri*
E81	F	MP	Tapiratiba - SP	128	256	64	-	128	Unspecific
E82	F	MP	Tapiratiba - SP	-	128	-	64	512	*R. bellii*
E84	F	MP	Tapiratiba - SP	-	-	-	-	1024	*R. bellii*
E86	M	MP	Tapiratiba - SP	-	128	-	-	64	Unspecific
E89	F	MP	Tapiratiba - SP	64	256	128	-	512	Unspecific
E90	M	QH	Tapiratiba - SP	-	128	-	-	-	*R. parkeri*
E40	M	SRD	Tapiratiba - SP	-	256	-	-	-	*R. parkeri*
E41	F	SRD	Tapiratiba - SP	64	512	-	-	64	*R. parkeri*

E42	F	SRD	Tapiratiba - SP	-	512	-	-	-	*R. parkeri*
E43	M	SRD	Tapiratiba - SP	-	256	-	-	256	Unspecific
E44	M	SRD	Tapiratiba - SP	-	256	-	-	512	Unspecific
E53	M	SRD	Tapiratiba - SP	128	512	-	-	-	*R. parkeri*
E54	M	SRD	Tapiratiba - SP	-	512	-	-	-	*R. parkeri*
E55	F	SRD	Tapiratiba - SP	128	512	64	-	256	Unspecific
E57	M	SRD	Tapiratiba - SP	256	256	-	-	-	Unspecific
E60	M	SRD	Tapiratiba - SP	-	-	-	-	128	*R. bellii*
E61	M	SRD	Tapiratiba - SP	512	512	-	-	-	Unspecific
E63	M	SRD	Tapiratiba - SP	-	256	128	-	-	Unspecific
E64	M	SRD	Tapiratiba - SP	-	256	-	-	64	*R. parkeri*
E65	M	SRD	Tapiratiba - SP	-	-	-	-	64	*R. bellii*
E67	M	SRD	Tapiratiba - SP	-	128	-	-	512	*R. bellii*
E68	M	SRD	Tapiratiba - SP	-	-	-	-	64	*R. bellii*
E20	F	MP	Tapiratiba - SP	-	-	-	-	1024	*R. bellii*
E22	M	MP	Tapiratiba - SP	-	-	-	128	64	Unspecific
E103	M	SRD	Tapiratiba - SP	256	128	-	512	1024	Unspecific
E1	F	MP	Tapiratiba - SP	-	-	-	128	1024	*R. bellii*

Abbreviations: F = female; M= male; SRD = crossbreed horses; MP = 'Mangalarga Paulista' breed; QH = Quarter Horse breed; SP = São Paulo; MG = Minas Gerais. *PAIHR* = possible antigen involved in a homologous reaction. *A homologous reaction was determined when a final titre for a *Rickettsia* species overcome at least four times the values observed for other *Rickettsia* species. In this case, the species with the greatest final titre was considered the possible antigen involved in a homologous reaction (*PAIHR*).

Information Engineering: Strategic decision based on data science

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Abstract— The contemporary society of the 21st century is composed and grounded in data. This scenario was made over the years and centuries of history. The technology, however, is recent in human history and began about 400 years ago, simultaneously with the emergence of modern science. We are no longer an industrial society, but an information society. This is a conception of a new social organization, based on information technology. The Information Society is supported by the acquisition, storage, processing and distribution of information by electronic means, in Information and Communication Technologies. The interaction between individuals and institutions became predominantly digital. Up-to-date managers must make data-driven decisions. Those who are able to unite domain expertise with data science can make more accurate strategic decisions. Knowledge is linked to its context in a broader way, with social and cultural implications as well. Industry 4.0 makes it possible to gather and analyze data between machines, faster and more efficiently, thus having an effect on the competitiveness between companies and even regions, even altering the economy. Information Science is a vast growing field of research and development of solutions, including, and mainly, for Knowledge Management and Strategic Management, in decision-making by public and private institutions.

I. INTRODUCTION

The contemporary society of the 21st century is composed and grounded in data. This scenario took place over the years and centuries of history. In summary, human knowledge since the dawn of man, with the discovery of primitive techniques, originated in the discovery of fire, in the polishing of stones and in the cooking of food, even in the Paleolithic period (VARGAS, 1985). Knowledge managed to be better passed on from one generation to another when writing rudimentary came to represent human thought and language. Initially pictorial, then cuneiform. This all started more than 3,000 years before Christ. Afterwards, many techniques were created and improved in order to optimize the communication, information and, why not say, training process.

Knowledge is the result of a codification/decoding process since its beginning:
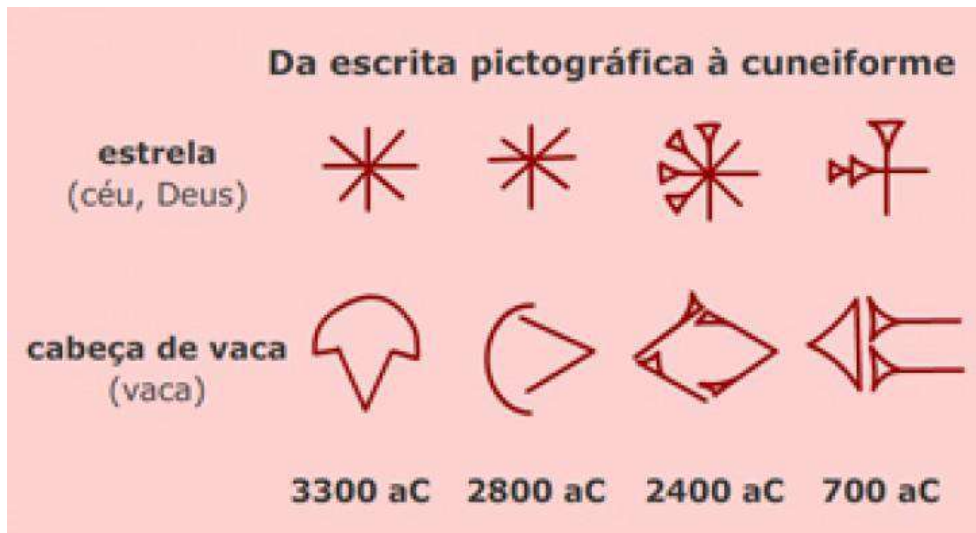
Fig.1: From pictography to cuneiform writing.

Font: <http://www.invivo.fiocruz.br/cgi/cgilua.exe/sys/start.htm?infoid=911&sid=7> (Invivo – Fiocruz) (Creative Commons - CC BY 3.0)

The ways of recording knowledge went through changes in the alphabets adopted throughout human history and the respective domain of this system of encoding and decoding recorded messages.
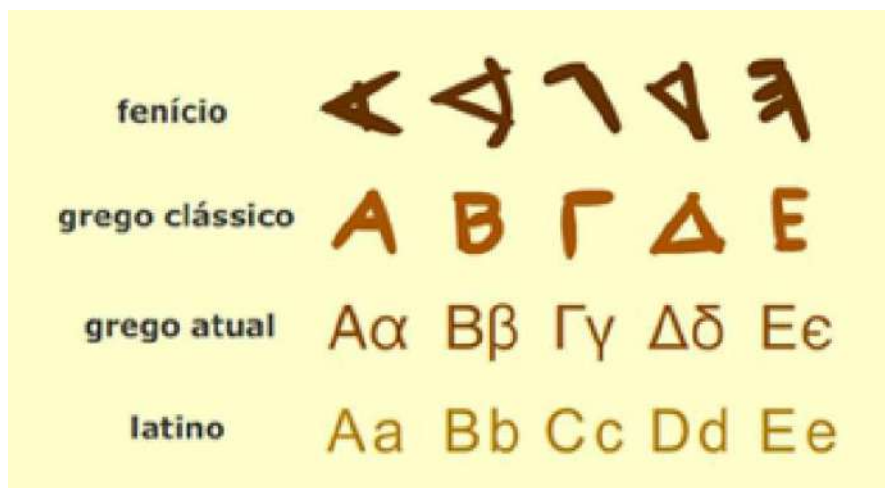
Fig.2: Phoenician_Greek_Latin.

Font: <http://www.invivo.fiocruz.br/cgi/cgilua.exe/sys/start.htm?infoid=911&sid=7> (Invivo – Fiocruz) (Creative Commons - CC BY 3.0)

According to Nobrega (2009), language is alive and constantly changing, even today. In the author's opinion, the press is a daily example that accompanies movement and transformation, including the inclusion of slang in the journalistic repertoire. It is undeniable that information, based on facts, is the basis of a pyramid of human knowledge. Barreto (2003) shows us that information, knowledge and intelligence are amalgamated structures in order to organize, to transfer and constitute human knowledge.

The technology, however, is recent in human history, according to VARGAS (1985). It began about 400 years ago, simultaneously with the emergence of modern science. But it only took shape with the Industrial Revolution. Technique and technology merge in a choreography of complementary actions and converging results. They make it possible to combine technical knowledge, which allows us to have a precise look at a specific solution. Meanwhile, scientific knowledge drives us away, forces us to see a problem from the perspective of a wide-angle lens, which allows for context analysis and

the advancement of knowledge. Science, in itself, is a search for truth. The search for answers to phenomena, natural or artificial (man-made).

II.   METHOD

Vargas (1985) also shows us that the origin of science lies in a type of theoretical knowledge invented by the Greeks in Ionia (6th century BC). The "*epistéme theoretiké*":

> "The Greek word episteme can be translated to know. But the knowledge that was established in the Greek world in the sixth century BC was, by themselves, adjectived as theoretiké; this is theoretical knowledge. The Greek word theoria comes from the verb theorein which means 'to see'. Therefore, 'epistémetheoretiké' is a knowledge acquired by the 'eyes of the spirit', capable, according to the Greeks, of discovering reality o it actually is. Theory is thus linked to the truth; in Greek, 'truth' is said to be aletheia what is discovered." (VARGAS, 1985, P01)

Classical science, from ancient Greek, still remains intrinsic to the essence of modern science, theoretical knowledge. The man in his childhood, youth and old age remains in his essence the same man, despite changing his figure. It is what remains that allows us to logically reason and construct theory. The basis of science. The ideas in Plato's theory and the changing appearances of Aristotle are substances, which are behind, for example, Geometry (3rd century BC), with its points, lines and planes; postulates and theorems.

Libraries are the representation of the need for information and knowledge. Humanity accumulates and loses knowledge because of the way it stores and preserves information. The organization of information, therefore, is a science that every day proves to be more necessary and even vital for organizations and people. First they were crystallized and rigid catalog information, today they are digital libraries, with fluid organization to be able to encompass the content. Scientific work is based on content management, with methods and strategies, production and organization. Castells (2001) already tells us that we are no longer an industrial society, to be an information society. This conception of a new social organization, based on information technology, pointed out in the article by Gouveia (2004), which highlights not only the use in related activities, such as banking and mobile phones, for example, but also in video systems, linked to surveillance and traffic control. Gouveia (2009) also reveals that the Information Society is supported by the acquisition, storage, processing and distribution of information by electronic means, in Information and Communication

Technologies (ICT). He also points out that the beginnings of centuries have been periods of great changes and transformations for Western civilization, and the 21st century is no exception. As a product, immense changes in the habits of the individual and in nature; in the activities of organizations and the use of information as a strategic resource.

Saracevic (1996) traces that the origin of Information Science can be identified after World War II, in the wake of the scientific and technical revolution, in an MIT article, by Vannevar Bush, in 1945:

> "In this important article, BUSH did two things: (1) succinctly defined a critical problem that had been on people's minds for a long time, and (2) proposed a solution that would be a technological tweak, in keeping with the spirit of the time, in addition to strategically attractive. The problem was (and basically still is) 'the massive task of making a growing body of knowledge more accessible'; BUSH identified the problem of information explosion - the irrepressible exponential growth of information and its records, particularly in science and The solution he proposed was to use the incipient information technologies to combat the problem. And he went further, proposed a machine called MEMEX, incorporating (in his words) the ability to associate ideas, which would duplicate 'mental processes artificially.' The anticipation of the birth of IC and even of artificial intelligence is quite evident."(SARACEVIC. 1996. P02)

III.   RESULTS

The information society changes its focus and uses information as a strategic and central resource for all human activity (CASTELLS, 2001). The interaction between individuals and institutions becomes predominantly digital. Currently, not only social and interpersonal relationships are mediated by sociais networks, present in the vast majority of mobile phones. Business relationships between companies, such o banking institutions and even the simple ordering of a pizza at night, are already a digital reality due to the applications available to practically everyone. This social structure that we are now experiencing makes users providers of online digital data (digital footprints), but at the same time they provide feedback and strengthen the system, as evidenced in the text "Big Data: The Management Revolution":

> "After purchasing online, customer understanding increased dramatically. Online retailers could track not only what customers buy but also what

else they were looking at; how they navigated the site; how much they were influenced by promotions, reviews and page layouts; and similarities between individuals and groups. Before long, they developed algorithms to predict what individual customers would like to read next."(MCAFEE. 2012, P04).

In analogue society, strategic management decisions were based on scarce data, costly to obtain or not available in digital formats. People made management decisions based on accumulated experience and patterns of inference, deduction and induction, or intuition. Also according to McAfee (2012), to date there are few data scientists. The technologies are new and it is very easy to confuse causal correlations and find wrong patterns. Up-to-date managers must make decisions based on data. Those who are able to unite domain expertise with data science can make more accurate strategic decisions and, possibly, we can infer, determine investments and future actions more confidently.

IV. DISCUSSION

But this strategic knowledge management is based on a succession of concepts and principles, which clearly demonstrate the importance of knowing how to deal with and understand the correct feeding of information systems, from the simple task/action of data entry. Initially, as Weinberger (2010) points out, the proposal of the data-information-knowledge-wisdom hierarchy, characterized in the DIKW (Data, Information, Knowledge and Wisdon)

pyramid, seemed like a great idea, based on the logic of Computer Science, where one learns that information is a refinement of mere Dice. Information, therefore, is the value we extract from the data.
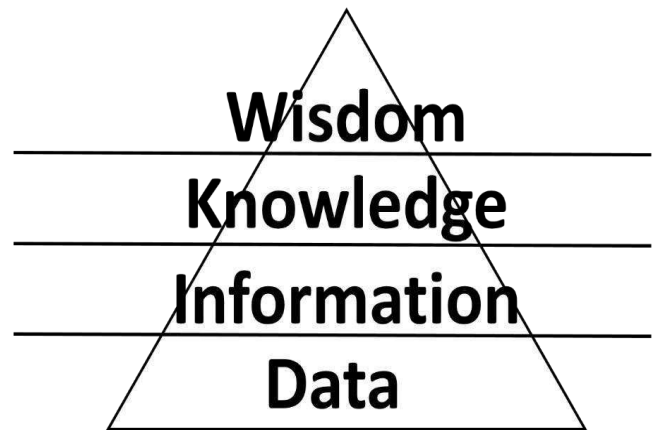
Fig.3: Pyramid DIKW.

Font: authored by the author himself

This graphic model was used by several authors and sought to reflect not only the concepts of knowledge management, but the functions and attributions related to the information flow in an organization.

The amount of data generated and available, exposed or not, leads to a chain of activities relevant to Information Science, which seeks to systematize and organize in order to generate information and knowledge. In short, they can be used in strategic intelligence planning.
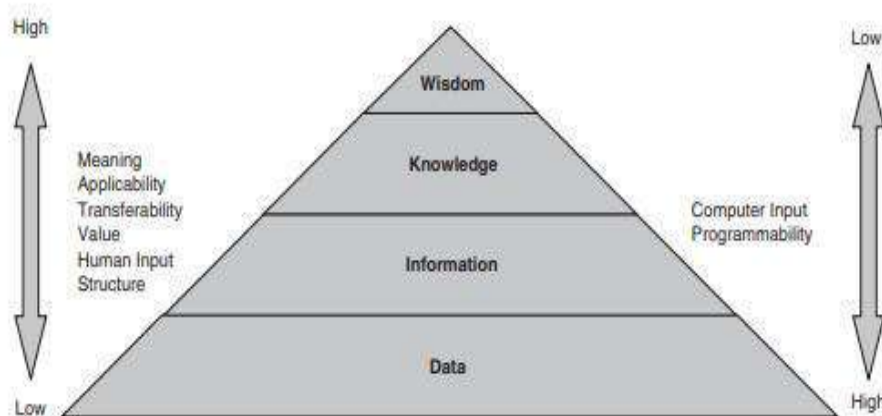
Fig.4: Knowledge hierarchy. ROWLEY (2006).

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Management and information science seek to systematize and usually represent the hierarchical structure that leads to decision making, based on a pyramid symbol. The base is composed of data, which pass information, which, in turn, generates knowledge and which, finally, generates

intelligence, where strategic decision-making occurs (or should at least occur).

According to Remor, Fialho&Queiroz (2017), the data (1st step of the pyramid) is composed of no assigned value and individual (of things and people). The information level (2nd step of the pyramid) is where the data becomes meaningful and can be categorized and measured. At the level of knowledge (3rd step of the pyramid) is where the information can be absorbed and memorized; where learning is positioned. At the top (4th step of the pyramid) is where understanding, reflection, more precisely: wisdom; and where the decision-making process is expected to take place.

"... the view of greater consensus in the literature, about the structure of the hierarchy, perceives data as simple facts that become information as data is combined in structures that make sense or have purpose, which subsequently become knowledge as information is put into practice. context and can be used to make predictions."(REMOR, FIALHO & QUEIROZ. 2017. P04)

However, the changes in stages of this pyramid encounter problems of clear definition, for example, when it comes to the change of knowledge and wisdom. Other forms of representation of the structure of knowledge, although less widespread, incorporate other factors and even portray the participation of human interaction, as this model proposed by Choo (2006) points out.
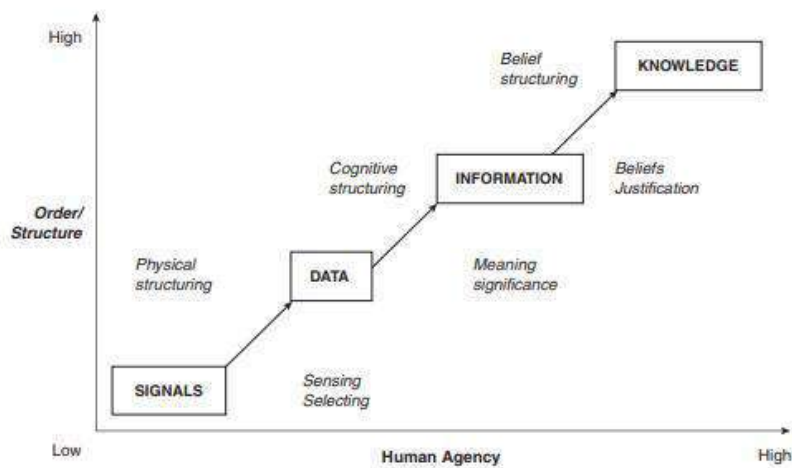
Fig.5: Data, Information and Knowledge. CHOO (2006)

Font: < http://choo.fis.utoronto.ca/FIS/ResPub/KOart.html >

This graph shows that the higher, on the scale, or closer to the pyramidal top (by direct analogy), the more there is a need for human participation and interaction. Now, going back to the authors Remor, Fialho&Queiroz (2017), we have that "wisdom would be the ability to project the consequences of an act, and assess the scenario taking into account what is desired. "Still, in conclusion, and for that reason the graphic of Choo (2006), we see this statement that the subjective value competences are of predominantly human characteristics, with Ackoff (1989) apudRemor, Fialho&Queiroz. (2017):

"Wisdom would be the ability to project the consequences of an act, and assess the scenario taking into account what is desired. Ability to inquire about what is not understood, and through that, goes far beyond understanding itself, it would be the essence of 'philosophical proof'. It is the process by which we can discern or judge between right and wrong, good and bad, says Ackoff (1989). The author personally believes that computers will never possess the capacity for wisdom."(REMOR, FIALHO & QUEIROZ. 2017. P04)

According to Weinberger (2010), knowledge is when information is transformed into instruction. Citing the official guide to good practices in Knowledge Management, from "*The European Committee for Standardization*" (CEN), "Knowledge is the combination of data and information, to which is added expert opinion, skills and experience, to result in a valuable asset which can be used to aid decision making. Knowledge may be explicit and/or tacit, individual and/or collective."Still, continuing in CEN' text, "Knowledge Management is the management of activities and processes for leveraging knowledge to enhance competitiveness through better use

and creation of individual and collective knowledge resources."

Knowledge is a much more complex process than a game of assembling pieces and discovering hidden images in it. "Knowledge is not determined by information, as it is the knowledge process that first decides which information is relevant and how it should be used" (Weinberger, 2010. P3). Knowledge is linked to its context in a broader way, with social and cultural implications as well.

The search for the desired results requires current organizations to constantly plan and consequently manage existing data sources. Organizational knowledge management is strategic for more accurate decision making. The volume of data available in this Information Society, in this Digital Century, is incomparable with any analog storage available in the past. It takes investment and mastery of digital tools to store and collect data, process and obtain information. Then, generate knowledge that can then be a strategic asset. Finally, increase the "wisdom" to be able to feed back this information system or choose to discard data that could generate distortions of reality.

Due to the large volume of data available in these times of the Information Society, the need for investments in skills and people is undeniable, but much depends on machines and processes.

Computers

This current social reality, which mixes the real world and allocated and processed data, in a virtual world with processing capacity increasing with each generation of new chips, forces us to think about the rapid technological evolution of computers, but more specifically the evolution of processors, as these are the main hardware components. This is exactly where software is processed and executed. There is no room for a detailed description of the entire evolution of the generations of processors and computers here, but it is worth highlighting Moore's Law:

> "On April 14, 1965, Intel founder Gordon Moore published an article in Electronics Magazine about increasing the processing power of computers. Moore states in the article that this capacity would double every 18 months and that growth would be steady. This theory became known as 'Moore's Law' and remains valid to this day. " (ALMEIDA, 2009, P01)

The consequence of this technological race led us from the first commercial microchip, launched in 1971 by Intel (Intel4004), to a series of new processors, whether produced by Intel itself or by competitor AMD, which

already achieve high performance in processing capacity, when compared to the precursor Intel4004 core. Currently, Intel, for example, makes explicit on its official website that:

> "**We believe that data is dramatically shaping the future of all humanity**. Intel is working tirelessly to unlock the potential of data, leading to more capable and efficient networks and pervasive AI in smart devices. **Moore's Law** set the pace for the digital revolution and continues to inspire us to this day." [emphasis added](INTEL. 2021)[1].

Microchips that have 18 colors (processing cores) on a single i9 chip are already produced and are on sale for consumers in general, as in Intel's X-series (i9-10980XE)[2]. However, the Information Society always needs more and more processing, as the volume of data grows daily on an exponential scale. The days of computing based only on a binary system, of 0 and 1, already demonstrates exhaustion with the appearance of the chip with quantum processing, which can use more variables and execute a much higher number of instructions per second. Released only for commercial use by the Canadian company D-Wave[3], this new paradigm of computational processing is now free to operate with other sets of variables and consequently new horizons of use in the real world. D-wave itself already indicates that this processor can be used for "airline programming, **election modeling**, quantum chemistry simulation, automotive design, preventive health, logistics and much more". [our emphasis] D-WAVE[4]. This company has even been selected to demonstrate its real usability for the Australian Department of Defense[5]. What may appear to the common user as something distant is already a reality in research spaces and in some corporations, as IBM, Intel and Google are already investing in the development of the new quantum chip model.

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[1]https://www.intel.com/content/www/us/en/company-overview/company-overview.html

[2] https://www.intel.com.br/content/www/br/pt/support/articles/000005505/processors.html

[3] https://www.dwavesys.com/

[4] https://www.dwavesys.com/

[5] https://www.dwavesys.com/press-releases/nec-d-wave-and-australian-department-defence-collaborate-quantum-computing-initiative
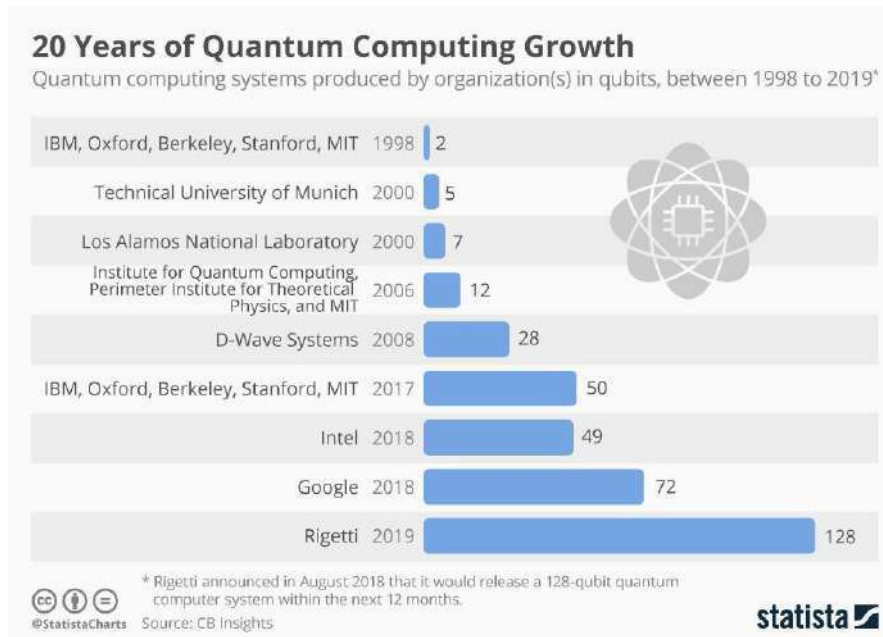
Fig.6: Quantum Chip History and Performance. (STATISTA)

Font: <https://www.statista.com/chart/17896/quantum-computing-developments/>

The most advanced quantum chip available today [2021] is the latest generation of D-wave, with a capacity of 5,000 qubits[6].

> "As an example, a 128-bit AES (symmetric) cipher has 2128 (about 1038) possible keys. A classical computer, which generally executes 1 trillion instructions per second, would take about 10.79 quadrillion years to test every possibility. Conversely, for an n-bit cipher, a quantum computer operates on the order of 2n = 2n/2. For an 128-bit cipher, this is 264 (about (1019) steps and it would take about 6 months to test every possibility."(KIRSCH. 2015.P8)

However, the innovations and applications of new processors also permeate other frontiers, as already published in the scientific magazine "Sientific American Brazil"[7],which shows us another option that also goes beyond the binary set (0 and 1), but starts using A, T, C and G, the components of DNA, to perform mathematical calculations and logical deductions. In addition to the broad spectrum of processing, based on 4 information sources (A, T, C and G), this type of processor is under development with a focus on disease detection and can be easily inserted, or incorporated into the human body, as it is a biological material (with a non-silicon-based substrate)

and has the potential for numerous application possibilities at the cellular level. "Because biomolecules are able to access data encoded in other biomolecules, they are compatible with living systems as electronic computers will never be." (Scientific American Brazil, 2020)

Industry 4.0

Costa (2017) points out that the third Industrial Revolution began in 1970, due to the digital revolution, as a result of the increase in the use of semiconductors, automation and robotization of production, in addition to advances in communications and the internet (COSTA, 2017).

Now, according to Rüßmann, Lorenz, Gerbert&Waldner (2015), we are experiencing the fourth wave of industrial revolution, driven by technological advances, where machines, parts and IT systems will be connected beyond a single company, using cyberphysical systems, which can connect with each other using the Internet. Industry 4.0 makes it possible to gather and analyze data between machines, faster and more efficiently, thus having an effect on the competitiveness between companies and even regions, even altering the economy.

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[6] https://www.dwavesys.com/d-wave-two%E2%84%A2-system

[7] https://sciam.com.br/computadores-de-dna-ganham-vida/
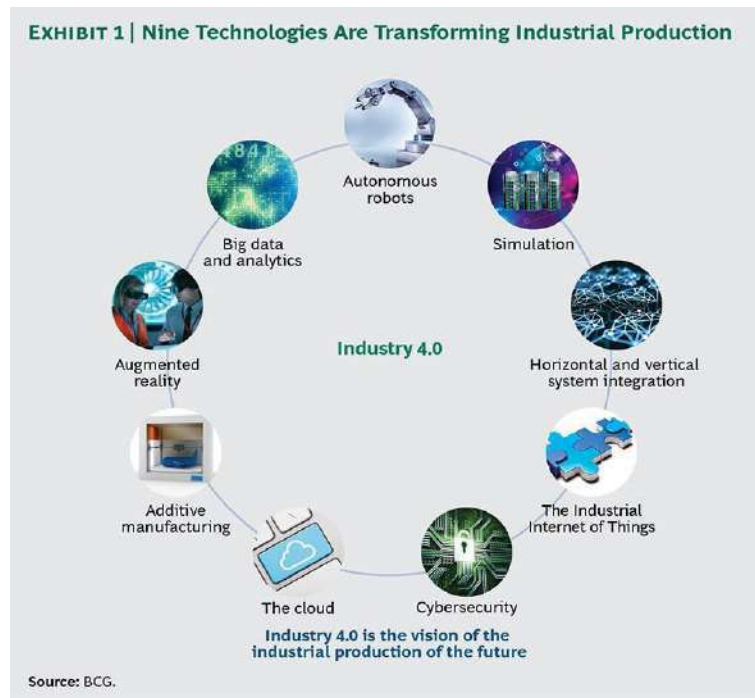
Fig.7: 9 foundations for Industry 4.0

Font: <https://www.bcg.com/pt-br/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries>

Although Rüßmann, Lorenz, Gerbert&Waldner (2015) point out 9 bases for Industry 4.0, Costa (2017) presents a summary proposal, based on only 3 pillars: Internet of Things, Cyber-Physical Systems and Big Data. In this investigation, the aspect that is outlined is the importance of using data, in a treated and polished way, for analysis and consequent strategic decision-making, in public or commercial institutions.

BIG DATA

Big Data is a fundamental technology for I4.0, as pointed out by Ottonicar, Atayde and Santa-Eulalia (2021), and the trend is for companies to increasingly use these systems. This happens because not only will people be producers of data and information, but also biological objects and elements. Also, as the authors claim, Big Data banks store a huge amount of data generated by the internet, mainly by the Internet of Things, and feed strategic (or intelligent) decision-making.

The scale of industrial evolution takes us to this level with possibilities for the production of many different data, whether individual or legal entities, which can be collected, processed and analyzed through the Internet and will certainly have impacts on education, and especially on universities. Whether in the curriculum or in bureaucratic

routines, but certainly also in fields of research and technological innovation, among them Information Science.

Still in the argument of Ottonicar,Atayde&Santa-Eulalia (2021):

> "I4.0 has several technologies that make it up in the organizational environment, including Big Data. This technology helps to store a large amount of data produced by people and objects. This technology and the advent of I4.0 bring changes to universities and can be leveraged to develop new ways of learning." (OTTONICAR, ATAYDE &SANTA-EULALIA.2021. P 159)

One of the main concerns is the issue of individuality and privacy, as, according to PIMENTA (2013), we leave digital footprints of political trends, purchase and sale relationships, and other private data that are collected through surveillance technologies and monitoring. As noted by McAfee (2012), the developed algorithms are able to predict the actions of users, based on their preferences. However, as a tool, when well used, it can contribute to citizen and democratic education, with public access to data, information and even analysis of these, such as state spending and other areas of society.

We can call this virtual universe, where the data are, the Big Data, the datasphere, as described by Magaly Prado (2021): "The datasphere has been the object of study by this researcher since 2005" (PRADO, 2021. P140). Thus, personal data are already available in the datasphere and with consequences that go beyond responsible and democratic use.

Panama Papers

The concentration of large volumes of data can also have drastic consequences for the security system, which needs constant improvement against intrusions or simple leaks. A classic example in the world of communication is the case called Panama Papers, when the German newspaper SüddeutscheZeitung received and shared a volume of data on financial transactions from the Panamanian law firm Mossak Fonseca, with the International Consortium of Investigative Journalists (ICIJ). Explained in detail by the BBC (2016), which is part of the 107 organizations that analyze the 11 million documents, it is clear that the company helped clients avoid sanctions and pay taxes and launder money, from many people, and even from 72 heads of state.

Cambridge Analytica

An article in the magazine Direitoem Debate, by FORNASIER and BECK (2020), shows in detail what has also become known worldwide as the case of the misuse of a large volume of data. According to Fornasier and Beck (2020), it was first denounced by journalist Harry Davies, from the English newspaper The Guardian, on December 11, 2015, saying that the company Cambridge Analytica (CA) had illegally collected millions of personal data from the social network Facebook, unbeknownst to users, for use in political and electoral campaigns.

> "The Guardian has continued the journalistic investigation since February 2017, with renowned journalist Carole Cadwalladr, as well as the independent online newspaper The Intercept, since March of the same year. On May 7, 2017, Cadwalladr wrote for The Observer, together with The Guardian, an article with a provocative title: The great British Brexit robbery: how our democracy was hijacked, using a source as the main means of accessing information, then anonymous. The article at the time went viral, gaining more than 63,000 shares."(FORNASIER& BECK, 2020. P3)

It was a scandal in the world press, an example that used Information Science practices on Big Data, security and privacy to manipulate elections in democratic countries such as the United Kingdom and the United States.

> "March 17, 2018: the day that sealed CA's fate forever. On that day, three of the world's leading journal and newspaper organizations – The Observer, The Guardian and The New York Times – jointly published the article titled How Trump Consultants Exploited the Facebook Data of Millions ('How Trump Consultants Explored the Facebook data of millions'). The article was only viable after Carole Cadwalladr was very convinced to demonstrate the right, ethical and democratic path – despite having a huge personal cost – of her anonymous source publicly denouncing the CA of its data mining practices (Data Mining) and data processing (interpreted here as the practice of Data Scraping) **and efficiently interfere in the results of democratic processes**." [our emphasis] (FORNASIER& BECK, 2020. P4)

V.   CONCLUSION

"Big data studies are often linked to extremist positions of exaggerated optimism or exaggerated pessimism. Related to this duality polarized in the consideration of Big Data (on the one hand the miraculous bets of the enthusiasts and on the other the warnings of the extreme danger of radical critics)" (SOUZA & GONZALEZ. 2021. P11); however, it is a solid understanding that Big Data is an important source of data and information for strategic decision making.

The reality that presents itself, with new and more powerful processing technologies, whether in hardware or software, with the formation of huge databases on users of social networks or applications with common access to all mobile phones, available on a large scale through the world, shows us that Information Science is a vast growing field of research and development of solutions, including, and mainly, for Knowledge Management and Strategic Management, in the decision-making of public and private institutions.

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Analysis of the Production Capacity of a Packaging Machine in the Plastic Components Sector in a Company of the Manaus Industrial Complex

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Abstract— *The industrial scenario demonstrates a production dispute not only with other companies competing in the market, but competition within the organization in order to demonstrate excellence in the production process. Establishing a correct manufacturing goal will aid in production planning, determine concise objectives with actual plant capability, and ensure that outliers are identified in advance for the correct solution and application of efforts to improve the process. These steps will ensure the correct evaluation of the plant before other business units, as well as stipulation measures that are adopted so as not to impair the real perception of the process and to consider the indicators without any margins of disagreement. The production to be studied comes from the work of packaging plastic components performed by a machine divided into two stages of operation, first manual and manufactured and then automated packaging. The production data is improved by shifts of eight hours through those used and subsequently entered into the company's database. In these, statistical tools will be used, helping to better compose the data, where a qualified sample is sought for the study, which through the OEE - Overall Equipment Effectiveness indicator provided in this set, will measure the efficiency through the indices of availability, quality and productivity and whether the disposition of values and their representativeness within what has been established is practicable. The grouping of generated data demonstrates a condition expected by the production team, but that only through numerical results can be explained, a target based on the nominal capacity of the machine does not represent the current state of the process and becomes infeasible to achieve the normal conditions of production. Consider a value below what was previously stipulated, non-demonstration to be an erroneous strategy because of the history of the demonstration process and also because the calculations demonstrated are in accordance with the reality and production volumes achieved. Understanding a real productive capacity and working on concise numbers will allow accurate decision making.*

I. INTRODUCTION

Production targets established by companies do not represent the actual production capacity of machines. The determined values are based on the machine's nominal value, the design capacity. As explained by [1], design capacity does not take into account losses during the process. Also, according to the authors, production capacity is the maximum amount of output of a good or service in a given period of time.

Planning the production capacity is an advantage for companies, as with the correct value set to achieve the results, it is possible to prepare for the demand, in addition to structuring project expenses and manufacturing inputs. The degrees and levels of capacity may vary depending on authors and different companies; however, the meaning of the content remains the same [1].

Statistical calculation, based on the global production indicator called OEE – Overall Equipment Efficiency, was used to study the equipment's production capacity. The OEE is an indicator that shows how efficient a factory is based on the assets installed in it [2].

As stated by [3], the overall efficiency of an equipment is established by the TPM as an indicator that continuously assesses the machine's production capacity to deliver what was theoretically calculated in the manufacturing design. The authors explain that the OEE can identify values and measure losses during the manufacturing process, which is divided into three (3) factors: availability, productivity and quality.

The OEE indicator uses simple methodological models and non-complex tools to stratify problems. With this, it seeks to achieve, in the short term, and gradually, improvements which should eventually become continuous and long-lasting. This reachability through indicators, which are fragmented for better understanding, also allows for an in-depth study in order to increase results [3].

As developed in the study by [4], it is essential to analyze alternative indicators to Overall Equipment Effectiveness (OEE). To complement and structure industrial management that is up to date with market demands, the form of application of OEE can be adapted to suit the context in which it will be used.

With the data and numbers related to the company's production in hand, it is possible to organize and conduct a statistical study. Statistics, as a science, comprises the studies based on the collection of data, understanding and analysis of this information to present the results of a group in an explanatory manner, to understand a general picture and observe the whole scenario.

Statistical studies support production capacity studies through the OEE. Statistics avoid presenting biased information, being able to study the whole from a set of data. Data is understood as a set of values, numerical or not. Through its models, statistics allow knowing determining factors for various events [5].

This article aims to study the production history of a company of the Manaus Industrial Complex (MIC), by comparing it with its current productivity, using mathematical principles to analyze the current production capacity of a packaging machine in the plastic components sector.

II.   MATERIAL AND METHODS

The company under study, part of the Manaus Industrial Complex (MIC) and consolidated worldwide, makes plastic components for packaging, distributed in the domestic and foreign markets. Increase in efficiency is an improvement pillar for the structure of this company. The sector to be studied is the production of final packaging for shipment to customers, whose process is divided into two parts: manual and automatic.

It is necessary to define goals that are tangible and achievable, according to the statistical reality and based on the study of the Overall Equipment Effectiveness (OEE) production indicator. Thus, these goals can be compared with the goals currently established, and it is possible to verify if they were achieved and are consistent with the values shown in this study.

A general data spreadsheet (Microsoft Excel® 2019, Redmond, WA, USA) extracted from production reports will be presented, and statistics will be used as a tool to obtain a correct average to represent the real status of the machine. Subsequently, these values will be compared with OEE values to analyze machine numbers and actual production by shifts.

The OEE metrics are shown through productivity, quality and availability equations. Multiplying the three factors results in the OEE value [6]:

Productivity equals good production divided by theoretical production:

$$P = GP \div THEORP;$$
$$THEORP = OT * PPM;$$

OT is the operation time and PPM stands for pieces per minute.

The calculation only considers the time the machine is running, discarding any machine downtimes, scheduled or not. The pieces per minute value is the machine standard, informed by the manufacturer and defined by process engineering.

Quality is calculated by dividing Good Production (GP) by Total Machine Output (TP).

$$Q = GP \div TP;$$

The calculation of availability takes into account all production times that are managed in production. Operation time (OT), Planned Operation Time (POT), which is calculated by discarding all scheduled machine downtimes.

Machine losses that directly affect availability are those that are unforeseen and require corrective maintenance actions [7]. Scheduled downtimes are those that involve planning and are previously scheduled so as

not to impact the production schedule, such as preventive maintenance, cleaning, machine lubrication, shutdowns due to high inventory.

The equation is defined as:

A = OT ÷ POT;

Thus, the OEE formula is:

OEE = P * Q * A

Due to the high number of shifts to be analyzed, statistical calculations with standard deviation can be used. This study will make it possible to use a model with reduced range, closer to the mean curve of the data set, centralizing the information for analysis. This enables the analysis to disregard cases that are exceptions, out of the ordinary, and unusual to the standard process, which do not contribute to the case study [8].

Standard deviation is a calculation made from the mean to observe how values vary in the dataset. It indicates what the average error will be, also understood as the deviation made when trying to replace each observation with the average [9].

Standard deviation helps to understand the dispersion of values in the dataset. By transforming its value into a unit, the number of factors that are grouped in a given region of the complete set can be visualized [10].

To have a more accurate measurement of the total data set, it is necessary to separate the sample into classes and limit the range to values closer to the mean. Class distribution makes it possible to study a sample and verify the reliability of the data, allowing to analyze representativeness according to the object of study [11].

As described by [10], when the raw data is defragmented and distributed into classes, some information is lost due to no longer being able to observe the individual characteristics of each value; however, compared to the gain in concise information and real representation, it is considered that this loss can be dismissed.

In a distribution into classes, data are divided into value ranges or intervals. A class is a line of frequency distribution, in which the difference between the lowest and highest observed value of variable X is called total amplitude (AT = xmax – xmin); the lowest value of the class is called the lower limit; and the highest value of the class is called upper limit [11].

III.   RESULTS AND DISCUSSIONS

Table 1 shows a total of 1046 work shifts, in which each individual has a production value, with a standard time interval of eight work hours. Furthermore, there can be more than one productive shift per day. The Shifts/Day reference helps to check the number of shifts needed to reach the production average.

Table 1. Production values per shift

Years	Shifts	Days	Shifts /Day	Average production / shift (output)	Average production/ day (output)
2018	345	149	2.3	32,106	69,018
2019	421	284	1.5	30,183	72,710
2020	280	106	2.6	32,436	82,129
Total	1,046	539	1.9	31,420	73,638

It was possible to verify that the values are historically below 40,000 units produced, which is the number set as the production target of the packaging machine. In 2020, to get to an average output per day that reached the goal, in this case, 80,000, as it involves two production shifts, it was necessary to work 23% more, with an average of 2.6 shifts per day.

Table 2, using standard deviation to limit the amplitude, obtained higher averages than the previous table. This is because this analysis excludes outliers, reducing the sample to 60% of the population.

Table 2. Production considering the standard deviation.

Year	Standard deviation	Production average in the standard deviation range ($\pm 1\sigma$)
2018	10,235	34,170
2019	8,475	30,823
2020	7,959	33,262
Total	9,017	32,434

Comparing the values shown in Tables 1 and 2, there is an increase in average output when using the standard deviation to limit the sample values. With the increase in average, it can be inferred that limiting the sample increases the production average, as it reduces the number of elements outside the production proportionality.

Table 3 presents the number of shifts and divides them into classes to check the region with the highest number of elements, in order to calculate the average that represents the production.

Table 3. Distribution of shifts into classes

Number of shifts				
Class/Year	2018	2019	2020	Period total

x < 30K	115	186	89	390
30 ≥ x < 35	66	102	77	245
35 ≥ x < 40	76	84	70	230
x ≥ 40k	88	49	44	181
Total n. of shifts	345	421	280	1046

As can be seen, 46% of the shifts have values greater than 30k and less than or equal to 40k. The 40k machines target is reached in only 17% of the shifts, which represents 181 shifts out of 1046. In addition, 37% of the shifts have output of less than 30k.

Analyzing the high number of shifts that do not reach 30k of units made, it should be considered that the factory operation system has two shifts with reduced time every week, for general cleaning (5S program). Thus, production below 30k does not always represent machine failure; it may also be due to planned downtime. This shorter production time cannot impact the assessment indicators. Based on this information, one can choose to study the class that presents production values between 30k and 40k of units made, as the statistical values of this area are in closer agreement with the reality of machine output (Table 4).

Table 4. Average of units made in classes 30 ≤ x < 40 between 2018 and 2020.

Year	Average of units made between 30k and 40k
2018	35311
2019	34737
2019	35040
Total average	35003

It can be seen that the production averages using the separation by class have less variation than the other averages and sets of values. This represents a more uniform process, excluding shifts that were outside the normal process pattern.

The OEE will be calculated according to the averages of the shifts per year, and before the collection of the interval that was analyzed: shifts that produced more than 30k and less than 40k.

The values obtained from the total shifts in 2019 were 75.6% productivity, 99.8% quality and 85.2% availability. In 2020, 73.5% productivity, 99.9% quality and 89% availability. The analysis found an evolution in availability, which is a result of improvements and

machine failures that were fixed; in contrast, there was a decrease in productivity.

This can be explained by the increase in production time, process failures and micro-stops have become more frequent, directly impacting the productivity indicator.

Micro-stops (less than 10 minutes) are not included in lost time that affects availability. These micro-stops affect the productivity indicator. This is the beginning of the comparison of the OEE and the good production volume. Considering the range with output of more than 30k and less than 40k, we have:

- Operation time = 359 minutes
- Planned Production Time = 385 minutes
- Good production = 35040 products
- Total production (shavers) = 35076 products
- Theoretical production (shavers) = 47372 products

Considering these averages in a 480-minute shift:

Production loss (Planned Production - Good Production) is 12332 products; the machine downtime (Planned Production Time - Operation Time) is 26 minutes. These 12332 shavers represent, in terms of time, 132 parts per minute produced by the machine; dividing these numbers 12332/132, the result is 93 minutes.

During the shift, the work process has 93 minutes of micro-stops; this represents the losses and downtime inherent to the process, and which do not directly affect availability, but rather productivity.

Considering the target of producing 40,000 products, and the Theoretical Production Average, the machine will have a loss of 7372 shavers, which represents 55 minutes.

Calculations proved that the nominal target does not represent the actual machine operation process, as the number of shifts that reached the target is 17%, which does not represent even half of the total shifts. The total average is that of 2020 compared to the nominal target, with a difference of almost 8 thousand, that is, 1/3 of the achieved value. It would take 33% more productivity to reach the goal; analyzing the machine history, this number cannot be reached.

The average between 30k and 40k represents the process better, due to the characteristics of the machines and the statistic calculation as well. As stated by [9], the choice of intervals is arbitrary and the researcher's familiarity with the data is what will suggest how many and which classes (intervals) should be used. However, it

should be noted that a low number of classes can mean loss of information, and with a high number of classes, the objective of summarizing data is impaired.

Based on the OEE, and simulating a production shift, 55 minutes is the maximum time of micro-stops to meet the real production volume target equal to 40000. This value assumes that quality and availability will be 100%, which represents 79% of productivity and, consequently, of the overall equipment effectiveness.

The time for loading the raw material into the machine, calculated based on the averages, and taking into account good working conditions, will be at least 28 minutes, as in a shift that has good output numbers, the plastic packages are refilled four times. If the machine is in good working order, it will take 30 minutes to adjust it. Just the time for reloading and adjusting the raw materials already reaches the maximum downtime minutes to reach the established target.

According to [4], it is of paramount importance to concatenate the numerical values with the interpretation of OEE data. These values must be considered by management in order to understand the real production scenario.

The analysis of the volume production history and the packaging production process was shown. The calculation, reducing the number of shifts to the total average, considering shifts that produced more than 30k and less than 40k, results in a new average: 35k.

IV. CONCLUSION

Considering the overall process, the number of 35,000 was proven to be the actual and current capacity of the packaging machine. To gain efficiency and, consequently, increase productivity, it is necessary to tackle problems and improve the engineering of the packaging machine, enabling it to work with lower loss values. Stipulating 40,000 as a production target is not consistent with the real numbers, as it is reached few times, which causes frustration and poor representation of productivity.

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Flexible Pavement Analysis - Study of a critical stretch on the AM highway - 010

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Abstract — The main means of transport used in Brazil to move people and cargo are highways, making it indispensable to maintain and recover the highway network to attend the socioeconomic demands of the country. Therefore, it is essential to evaluate the need of each highway, according to the performance and durability of the pavement and according to the types of pathologies presented. This study aims to analyze the pathological problems existing in a stretch of the state highway AM - 010, between the capital of Amazonas, Manaus, and county Rio Preto da Eva, analysis to be done post photographic survey. Then the images of the pathologies were evaluated, diagnosed and classified accordingly norm of the National Department of Transport Infrastructure, DNIT. In the section evaluated the most common pathologies were: cracks, sinking, slippages, patches executed irregularly and pot holes, in addition to points without roadsides, compromised structure or obstructed, impossible to be used.

I. INTRODUCTION

In Brazil, since the 1950s, the highways have been highlighted in the national economy as the main alternative for the movement of people and goods. The highways are the one that has the largest participation in the transport pattern, concentrating approximately 61% of the movement of goods and 95% of the passenger movement (CNT, 2019).

These data reinforce the need and importance of road infrastructure to aid the economic development of the country and for the basic safety of citizens by exercising their right to come and go with quality and comfort. However, at the moment it is possible to describe that the high demand of the highways uses and the lack of investments in maintenance of the existing roads are contributing to degradation and safety of the present structure.

In Brazil, there are 1,720,700 km of highways, 1,349,938 km are not paved, only 213,453 km are paved,

that is, 12.4% of the network (CNT, 2019). In addition to the Brazilian paving mesh being small, a large part is in a state not suitable for traffic, presenting pathologies, mainly such as cracks, sinking, slippages, poorly executed patches and pot holes, among other defects.

The 2019 survey of the National Transportation Confederation (CNT), according to the extent evaluated, classified the federal and state highways of Amazonas in the general state as: 45.5% regular, 19.07% bad and 35.5% terrible; and classified the pavement as: 65.5% regular, 7.6% bad and 26.9% terrible.

Cited the problems, this article presents a case study of the AM-010, with photographic survey, the stretch is located between the state capital, Manaus, and the county Rio Preto da Eva, starting point at km 22 and end point at km 25.

The AM-010 is a state radial highway that connects the capital to the interior of the state, with a path Manaus - Rio

Preto da Eva - Itacoatiara, is approximately 252 km long, paved.

II. DEVELOPMENT

2.1 Pavement

Pavement is a structure of multiple layers of finite thicknesses, built on the final surface of earthmoving, in order to resist traffic efforts and climate actions, providing comfort, economy and safety to users (BERNUCCI, et al., 2010).

The DNIT Paving Manual (2005) defines pavement as the contact of structured layers with materials of different strengths and deformities.

2.2 Types of Pavements

Road pavements are classified according to their deformability and the materials of their composition. The choice of which pavement to use is made after taking into account the following items: flow of the traffic, the resistance of the soil and the quality of the available materials.

The National Department of Transport Infrastructure, DNIT (2005), classifies the floors into:

- Flexible, when the load is distributed in equivalent plots between layers;

- Semirigid, have the base cemented by some binder with cementitious properties;

- Rigid, when the stiffness of the coating is high in relation to the other layers, absorbing practically all the tension.

2.3 Paving situation in Brazil

The use of flexible pavement is predominant in the Brazilian road network, which is the object in this study.

According to the CNT, 2019, each of the layers that make up the floor has a specific function, that is:

• The coating is intended to withstand the actions of traffic; must be impervious in order to prevent rainwater penetration from reaching the other underlying layers; and should be comfortable to better meet rolling conditions and provide safety to the user. The coating is the only layer noticeable to the via user.

• The base is the layer that has the purpose of resisting the actions of traffic in order to relieve tensions in the coating and distribute them to the lower layers. • The sub-base is the complementary layer to the base, with the same functions as this, performed when, due to technical and economic circumstances, it is not advisable to build the

floor directly on the regularization or reinforcement of the subbed.

• The reinforcement of the subbed is the layer executed on the properly compacted and regularized subbed, used when it becomes necessary to reduce high thicknesses of the sub-base layer, originated by the low support capacity of the subbed.

• The regularization layer has variable thickness, and may cease to exist in some stretches, and has the function of correcting faults of the final layer of earthmoving or an old bed of dirt road.

• The bed is the transition between the foundation ground and the pavement body.

• The subbed is the ground of the floor foundation or the original terrain, so it is not considered a layer.

Fig.1: Pavement layers (CNT, 2019)

2.3.1 Pathologies existing in the flexible pavement

The speed that a pavement will deteriorate depends on several factors, such as: environmental issues, climate, the support capacity of the pavement and subbed, the traffic, the quality of the materials used and the execution process and the loads supported by type of vehicle.

According to a CNT study conducted in 2019, these are the most common types of pathologies and their possible causes:

Fissure: there are capillary cracks in the asphalt coating that do not yet cause functional or structural problems on the highway. They are positioned longitudinally, transversely or obliquely and are noticeable in the sight of those up to 1.5 m away. The extent of the cracks is less than 30 cm. **Main causes**: poor asphalt dosage, excess fine (or filling material) in the coating; excessive compaction or at inappropriate time (CNT, 2018).

Transverse crack: isolated crack in the direction perpendicular to the axis of the track. If the extension is up to 100 cm, it is called short cross crack. When the extension is more than 100 cm, it is called a long cross crack. It is a functional defect (large cracks cause irregularity) and structural (weaken the floor covering).

Main causes: contraction of the asphalt cover caused by low temperatures or hardening of asphalt; propagation of cracks in the layers below that of the road cover (CNT, 2018).

Fig. 2: Transverse crack (CNT, 2019)

Longitudinal cracks: isolated crack in a direction predominantly parallel to the track axis. If the extension is up to 100 cm, it is called short longitudinal crack. When the extension is more than 100 cm, it is called long longitudinal crack. Functional defect (large cracks cause irregularity) and structural (weaken the floor covering). **Main causes**: poor execution of the longitudinal separation joint between the two traffic lanes; differential recalque; asphalt cover contraction due to low temperatures or asphalt hardening; propagation of cracks in the layers below that of the road cover (CNT, 2018).

Fig. 3: Longitudinal crack (CNT, 2019)

Alligator Cracks: set of interconnected cracks without defined directions, resembling the aspect of alligator leather. They're a structural defect. **Main causes**: asphalt coating collapse due to repeated traffic actions; under sizing or poor quality of the structure or one of the pavement layers; low ground support capacity; floor aging (end of life); hard or brittle asphalt (CNT, 2018).
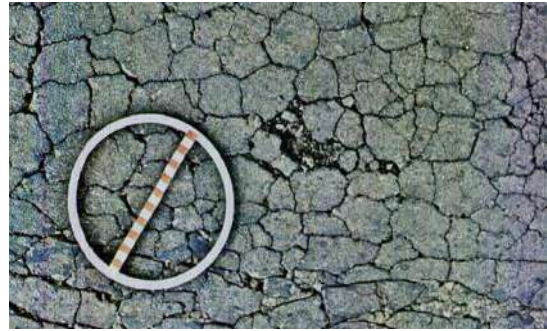
Fig. 4: Alligator crack (CNT, 2019)

Block cracks: set of interconnected cracks forming rectangular blocks with well-defined sides. This is a functional defect (large block cracks cause irregularity) and structural (reduce the structural integrity of the pavement). **Main causes**: contraction of the asphalt cover due to alternating between high and low temperatures; low tensile strength of the asphalt mixture (CNT, 2018).

Fig. 5: Block crack (CNT, 2019)

Plastic sinking: permanent (plastic) deformation characterized by depression of the floor surface accompanied by lifting of ends (lateral volumetric compensation). When the extension is up to 6 m, it is called local plastic sinking. For extensions larger than 6 m and if it is located along the wheel track, it is called plastic wheel track sinking. **Main causes**: plastic fluency of one or more layers of the pavement or subbed; failure in asphalt mixture dosage - asphalt ligant excess; failure to select type of asphalt coating for the requesting load (CNT, 2018).

Fig. 6: Plastic sinking on wheel track

(Inova Civil,2019)

Consolidation sinking: permanent formation characterized by depression of the floor surface without being accompanied by lifting of the ends (lateral volumetric compensation). When the extension is up to 6 m, it is called local consolidation sinking. For extensions greater than 6 m and if it is located along the wheel track, it is called wheel track consolidation sinking. **Main causes**: plastic creep of one or more layers of the pavement or subbed; densification or rupture by shear of layers underlying the coating; compaction failure in construction; drainage problems (CNT, 2018).

Fig. 7: Sinking by consolidation in wheel track

(Inova Civil, 2019)

Fig. 8: Localized sinking by consolidation

(Inova Civil,2019)

Ripple or corrugation: plastic movement of the coating, characterized by ripples or corrugations (which are wrinkles) transverse on the surface of the floor. **Main causes**: lack of asphalt mixture stability; excessive subbed soil moisture; contamination of asphalt mixture; lack of aecization of liquid asphalt mixtures (CNT, 2018).

Fig. 9: Corrugation (CNT, 2019)

Slippage: movement the coating in relation to the underlying layer of the pavement with the appearance of slits in half-moon. **Main causes**: construction and bonding paint failures (CNT, 2018).

Fig. 10: Slipping (Inova Civil, 2019)

Exudation: layer of bituminous material that appears on the surface of the pavement creating a vitreous brightness, caused by the migration of the ligant through the coating. **Main causes**: excessive amount of ligant; low content of voids (CNT, 2018).

Fig. 11: Exudation (CNT, 2019)

Abrasion: effect of progressive pullout of the floor aggregate, causing surface roughness of the coating. **Main causes**: ligant-aggregate adesivity failures; presence of trapped water and overlap in voids of the coating layer, generating ligant displacement; deficiency in the content of ligant; executive problems or mixing design (CNT, 2018).

Fig. 12: Abrasion (CNT, 2019)

Pot hole: cavities of varying sizes in the floor covering. **Main causes**: fatigue cracks (process that occurs due to the accumulation of traffic requests over time); disintegration located on the floor surface; deficiency in compaction; excessive moisture in soil layers; failure to print (CNT, 2018).

Fig. 13: Pot hole reaching the base (Inova Civil,2019)
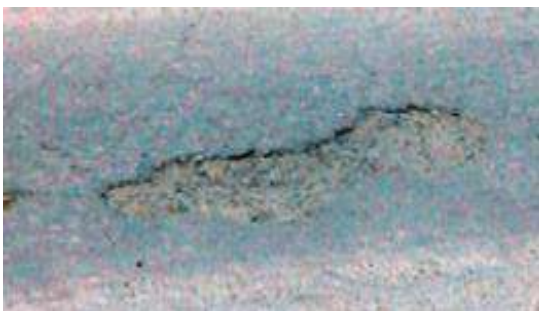
Fig. 14: Pot hole (Inova Civil, 2019)

Patch: pot holes filled with one or more layers of paving. Despite being a conservation activity, it is considered a defect because it points to a place of fragility and because it impacts the comfort in the bearing. The deterioration of patches is the set of existing damage in a patch area. **Main causes**: traffic load; use of poor quality material; environmental action; poor construction (CNT, 2018).

Fig. 15: Poorly executed patch (Inova Civil,2019)

Fig. 16: Patch well executed (Inova Civil,2019)

2.4 Conservation of highways

According to the Manual of Road Conservation of the National Department of Infrastructure and Transport (DNIT, 2005), the set of routine, periodic and emergency operations that are carried out in order to maintain the characteristics of the road system.

Conservation tasks are divided into five groups, as set out below:

1- Routine Corrective Conservation: are the conservation operations assigned to repair or remedy a defect and restore the operation of the highway providing comfort and safety to users.

2- Periodic Preventive Conservation: operations carried out periodically with the purpose of avoiding the appearance or aggravation of defects. The frequency of execution depends on traffic, topography and climate.

3- Emergency Conservation: repair operations or reconstruction of stretches or structures of the highway that have been modified and are causing interruption of traffic on the highway.

4- Restoration: set of measures aimed at adapting the highway to current and future traffic conditions, prolonging the life of the pavement.

5- Road improvements: operations that modify the characteristics of an existing highway or add new characteristics to this highway (DNIT, 2005).

It is understood that operations for road conservation, when well executed, extend the life of the roads, reducing the operational costs of vehicles, is given more safety in their traffic and keeps the operational routes in service.

III.   MATERIALS

A photographic survey was carried out to record and diagnose the existing pathologies on the flexible floor.

The highway chosen to carry out this work, was the AM-010, Amazonas state highway, specifically the stretch between km 22 and km 25.

Fig. 17: Study location: AM - 010

(Google Maps, 2021)

IV.   METHODS

In this work, bibliographical research was used from books, published articles, documents and field research, where it is necessary to go to the study site to collect ground-based data. The process was initiated by choosing the initial and final section, followed by the analysis of pathologies and diagnoses. All pathologies were classified and diagnosed according to DNIT/2003 Standard 005. To ensure a high-quality product, diagrams and letters must be elaborated or computer-designed using ink from India.

V.   RESULTS AND DISCUSSION

The construction process of Brazilian highways is a real and significant problem. Failures in the execution process and the lack of maintenance of the structure of flexible floors can be attributed to several factors such as the deficiency in the supervision of maintenance, use of lower quality materials, incorrect use of the material quantity required in the construction process, lack of diagnoses and specialized labor, often seeking to reduce costs and increase profit margins.

The photographic survey was carried out on the afternoons of 21st and 22nd of May 2021, the stretch has an extension of 3 km, presents problems such as: cracks, pot holes, sinking, patches poorly executed, the sideways in some stretches is non-existent or is obstructed.

The cracks are common pathologies to arise, are linked to the life of the flexible pavement and are enhanced by environmental actions and the region's traffic. The following figures represent the most common types of cracks in the analyzed snippet.

Fig. 18: Longitudinal cracks (Copyright Images)

Fig. 19: Alligator cracks (Copyright Images)

The pot hole is a cavity formed on the surface of the coating that can reach the base and originates from the evolution of cracks, snooses or wear (SILVA, 2011).

Fig. 20: Pot hole reaching the base, on the pathway

(Copyright Images)

Fig. 21: Pot hole reaching the base, on the sideway
(Copyright Images)

Next, it is possible to see that a patch was performed previously, the opening of the pot hole allows the view of the patch and the base.

Fig. 22: Pot hole with old patch, reaching the base
(Copyright Images)

Next, the images show patches executed incorrectly, at levels higher than the pathway, some have already begun the process of deterioration in the margins of the clipping.

Fig. 23: Patch poorly executed (Copyright Images)

Fig. 24: Pot hole between poorly executed patches
(Copyright Images)

In the next image we have a follow-up of patches, by a large extent of the pathway. In this case it could be evaluated the possibility of performing the full recovery of this extension, the excess of patches, poorly executed, can aggravate the emergence of new pots and still make traffic in the region more turbulent and less safe.

Fig. 25: Patch extension poorly executed
(Copyright Images)

The sinking is considered a permanent deformation, the presence of a patch is visible, evidencing that there has already been an attempt to solve the problem, however, and this type of maintenance does not solve this defect.

Fig. 26: Sinking (Copyright Images)

VI. CONCLUSION

The causes of infrastructure deficiencies in Brazilian highways can be diverse or a set of factors, among them it is possible to mention: the lack of a specialized supervision on pavements, the lack of coordination between the agencies responsible for the road structure, the call of correct maintenance made with specialized labor, at the correct time. It is shown that in the present, the main problem of Brazilian highways is primarily bureaucratic. Thus, it is essential to implement a pavement management system that meets the entire road network and allows the proper planning of the maintenance interventions necessary to ensure greater durability of Brazilian highways (CNT, 2019).

After analyzing the chosen section, located in the AM-010, the critical state statement is easily verified, having evident problems of easy identification and classification. During the *in loco* evaluation, it was possible to identify longitudinal, transverse and alligator cracks, by significant extension, in addition to pot holes, of different sizes on the pathway and sideways, sinkings and patches, slippages were less seen defects. At some points the sideway was totally obstructed by vegetation, and in some others points presented major pathological problems, being pot holes the most common in the analyzed stretch.

After study, the main recommendation to solve such problems is the corrective and preventive maintenance of the highway, idealized and made by specialized professionals and with updated materials of excellent quality, this would reduce the defects in the roads, increase the quality and comfort of traffic, plus road safety.

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Theoretical and experimental study on determining the elastic coefficients of grain-reinforced composites

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Abstract — Currently, there are two main methods to determine the elastic modulus of grain-reinforced composite materials: experiment and theoretical method. The advantage of the experimental method is to determine the elastic modulus for the composite exactly, but this method does not reflect the influence of the component material phases on the mechanical properties of the composite in general. The analytical method can solve this problem. In this paper, the author studies how to determine the elastic coefficients of grain-reinforced composites by both theory and experiment. The results of this paper give us reliable values of elastic coefficients to serve for the calculation of structures made of grain-reinforced composite.

I. INTRODUCTION

Composite materials are popular due to the following advantages: Flexible combining with other materials to increase durability and reduce cost; Lightweight, durable, resistant to corrosive environments, inert to the environment, not corroded by seawater and oysters; Easy to apply, easy to repair, easy to shape, has high surface gloss and aesthetics, needs simple construction equipment; Long life more than 20 years.

Besides the above advantages, composite materials still have disadvantages such as permeability, flammability, easy abrasion, low hardness, and low impact strength. To improve these disadvantages, besides the fiber reinforcement, particles are often added to the polymer matrix. Particles are added to the polymer matrix to produce a mixture of higher density and improved mechanical properties. In general, the particle increases the elastic modulus and the shear modulus, and many theories have been developed to explain this effect.

In this study, the elastic coefficients of the grain-reinforced composite were determined both theoretically and experimentally. The theoretical method is built on the basis of a mechanical problem model, which introduces a two-phase composite model with particle reinforcement, (particles are considered to be spherical). The advantage of this method is that the elastic coefficients are determined depending on the properties and distribution ratio of the component materials. Changing these parameters, new composites with different physical-mechanical properties can be obtained, and their values can also be calculated in advance. This is the basis for calculating the new material optimization design [4,5]. The experimental method was conducted with the aim of verifying the theoretical results found. Then, the elastic coefficients are used as input data for the strength, stiffness, and stability problems of structures made of grain-reinforced composite materials.

II. DETERMINATION OF THE ELASTIC COEFFICIENTS FOR THE GRAIN-REINFORCED COMPOSITES

For two-phase polymer composite materials, the determination of the elastic coefficients is how to calculate

the elastic coefficients of the material, which is expressed through the mechanical - physical parameters and the geometric distribution. of the component materials. Considering a two-phase composite consisting of the initial matrix phase and particles, such a composite is considered to be homogeneous, isotropic, and has two elastic coefficients [2,3]. The determination of the elastic coefficients for composites filled with spherical particles is determined, taking into account the interaction between the particles and the matrix. The elastic coefficients of the grain-reinforced composite are now called hypothetical composites.
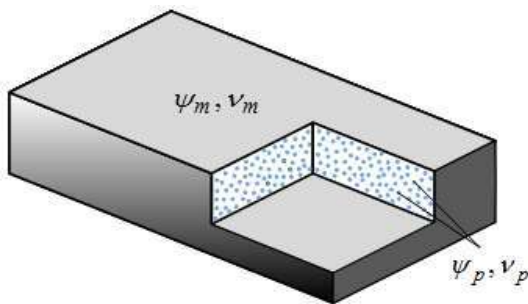
Fig. 1: Polymer composite model with grain-reinforcement

Assuming the components of the composite are all homogeneous and isotropic, then E_m, G_m, K_m, v_m, ψ_m; E_p, G_p, K_p, v_p, ψ_p are denoted by the modulus of elasticity, modulus of elasticity of shear, modulus of volume deformation, Poisson's coefficient, and composition ratio (by volume) of the matrix and particles, respectively. From here on, the quantities related to the matrix will have the *m*-index; relative to the particle is the *p*-index. According to [6], the elastic modulus of the assumed composite as follows:

$$\overline{E} = \frac{9\overline{K}.\overline{G}}{3\overline{K}+\overline{G}}; \quad \overline{v} = \frac{3\overline{K}-2\overline{G}}{6\overline{K}+2\overline{G}} \qquad (1)$$

where:

$$\overline{G} = G_m \frac{1-\psi_p(7-5v_m)H}{1+\psi_p(8-10v_m)H};$$

$$\overline{K} = K_m \frac{1+4\psi_p G_m L(3K_m)^{-1}}{1-4\psi_p G_m L(3K_m)^{-1}} \qquad (2)$$

with:

$$L = \frac{K_p - K_m}{K_p + \frac{4G_m}{3}}; \quad H = \frac{\frac{G_m}{G_p}-1}{8-10v_m+(7-5v_m)\frac{G_m}{G_p}} \qquad (3)$$

$$G_i = \frac{E_i}{2(1+v_i)}; \quad K_i = \frac{E_i}{3(1-2v_i)} \qquad (i=m,p)$$

III. NUMERICAL CALCULATIONS AND EXPERIMENTS

3.1. Numerical calculations

Considering the influence of particles on the physical and mechanical properties of two-phase composite materials according to the above algorithm, considering two-phase composite materials with the characteristics in Table 1.

Table 1. Parameters of composite component materials

Material	Modulus of elasticity (GPa)	Poisson's coefficient
Glass beads reinforced polyester composite materials		
Polyester AKA	$E_m = 1.43$	$v_m=0.345$
Reinforced glass beads	$E_p = 22,2$	$v_p=0.24$
Glass beads reinforced Epoxy composite materials		
epoxy	$E_m = 4.81$	$v_m=0.3$
Reinforced glass beads	$E_p = 22,2$	$v_p=0.24$

Substitute the values in Table 1 into the formulas (1) (3) to determine the elastic coefficients of two-phase composite materials as in Table 2.

Table 2. Calculation results of elastic coefficients of two-phase composite materials

$\square_c$	Modulus of elasticity CPS ($\overline{E}[GPa]$)		Poisson's coefficient CPS ($\overline{v}$)	
	Polyester - glass beads	epoxy-glass beads	polyester-glass beads	Epoxy-glass beads
0.2	2.037	6.203	0.311	0.278
0.3	2.436	7.052	0.291	0.266
0.4	2.930	8.033	0.268	0.253
0.5	3.557	9.183	0.240	0.239
0.6	4.379	10.54	0.205	0.223
0.7	5.505	12.192	0.160	0.204

The graph shows the relationship between the ratio of material composition and the elastic coefficients of the two-phase composite.
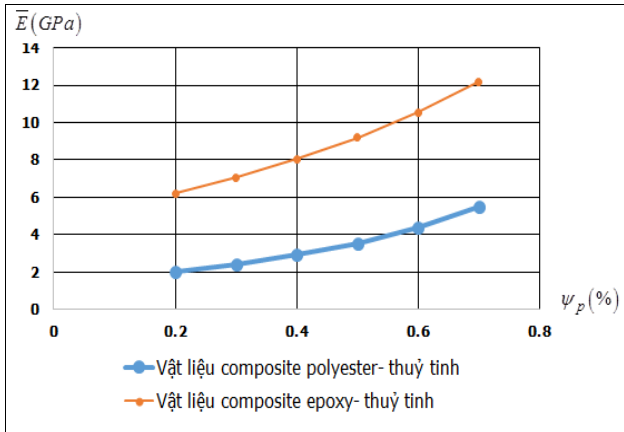
Fig.2: Relationship between $\overline{E}$ and ψ_p
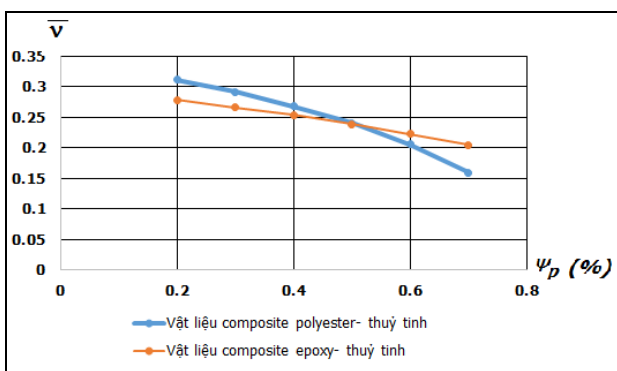
Fig.3: Relationship between $\overline{v}$ and ψ_p

From Fig.2 and 3 we observe that with the composite material shown above, changing the reinforcement structure significantly changes the elastic modulus and the porosity coefficient of the composite. Thus, we can calculate for three-phase composite materials. When in the base material additional filler particles are added (these particles may be of the same type or different from the fibrous material). Or it can also be understood as the material consisting of the base and the filler particles with the addition of a third phase, the reinforcement fibers. The inclusion of fibers as reinforcement for the composite increases the shear modulus, increases the stiffness and strength of the material.

3.2. Experiment

The goal of experiments is to verify the theoretical results that have just been found. Component materials for making samples are list in Table 1. Specifications for making samples according to combinations: 1) 20% glass beads +80% polyester; 2) 30% glass beads +70% polyester; 3) 40% glass beads +60% polyester; 4) 50% glass beads +50% polyester; 60% glass beads +70% polyester; 70% glass beads +30% polyester and the

manufacturing process of two-phase composite materials is as follows: - Weigh and measure the proportion of component materials. First, mix the glass beads into the polyester resin in the form of a paste according to the specified ratio. Using a stirrer with a speed of 750 rpm, stir within 24 hours for the glass to be evenly mixed into the resin. - Start processing the sample, proceed to solidify. To avoid the creation of air bubbles, an iron roller is usually used to roll from the top of the plate to the end of the sample plate. The test sample is processed according to standards BS EN ISO 527-4: 1997 [1] as Fig. 4.

Equipment for tractors, universal compressor MTS-810 Landmark (USA). These experimental machines produced since 2010. The MTS-810 Landmark is the most modern universal energy system in Vietnam at the present time, the machine operates on the principle of electronic-hydraulic combination. It is capable of tests: tensile, compression, bending, shear, and creep tests under static and dynamic loads, under normal or high-temperature conditions up to 1200^0C. In the test process, the strain response to the load is carried out through the mechanical-electrical extensometers and signal processors integrated into the machine. This vitality system has been calibrated and certified by the Bureau of Standards, Metrology, and Laboratory Equipment.
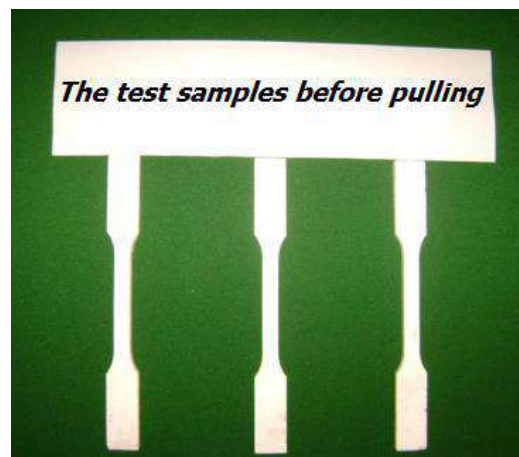
Fig. 4: Sample used for the experiment

The basic parameters of the MTS-810 Landmark system are as follows:

Maximum load: 500kN;

Maximum distance between 2 sides of the sample: 2108mm;

Distance between two columns: 762mm;

Maximum test temperature range: 1200^0C;

Loads: Static and dynamic (pulse: sawtooth, triangle, square and sinusoidal variable load);

The maximum longitudinal oscillation frequency of clamping head: 12Hz.

Standard of extensometer: 10mm, 20mm, 50mm.
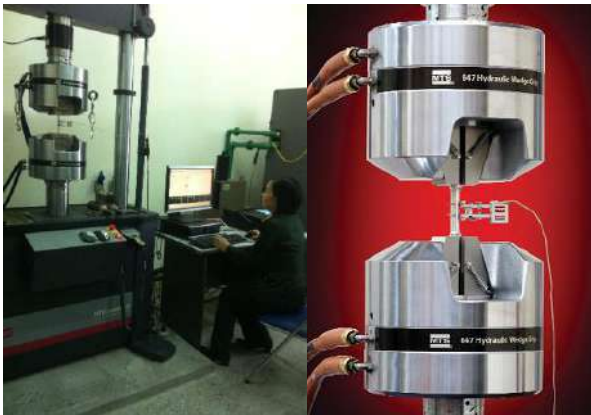
Fig.5: Experiment to determine the mechanical and physical properties of the grain-reinforced composite materials

The results of the theoretical calculation according to the formula (1)÷(3) compared with the experiment are presented in Table 3.

Table 3. Results of comparison between theory and experiment of glass-grain reinforced polyester-based composites

Composite		Results	
		$\overline{E}$ *(GPa)*	$\overline{v}$
20% glass beads +80% polyester resin	Experiment	2.356	0.308
	Theory	2.037	0.311
	Error	**13,53**%	**1,05**%
30% glass beads +70% polyester resin	Experiment	2.592	0.283
	Theory	2.436	0.291
	Error	**6,0%**	**2,89%**
40% glass beads +60% polyester resin	Experiment	2.764	0.256
	Theory	2.930	0.268
	Error	**5,68%**	**4,62%**
50% glass beads +50% polyester resin	Experiment	3.297	0.245
	Theory	3.557	0.24
	Error	**7,32%**	**1,78%**
60% glass beads +40% polyester resin	Experiment	4.125	0.215
	Theory	4.379	0.205
	Error	**5,81%**	**4,21%**
70% glass beads +30%	Experiment	4.525	0.207
	Theory	5.505	0.160

polyester resin	Error	**17,81%**	**22,69%**

Similarly, the theoretical and experimental results with epoxy resin materials and reinforced glass beads according table 4 as follows:

Table 4. Results of comparison between theory and experiment of glass-reinforced epoxy-based composites

Composite		Results	
		$\overline{E}$ *(GPa)*	$\overline{v}$
20% glass beads +80% epoxy resin	Experiment	6.835	0.265
	Theory	6.203	0.278
	Error	**9,23%**	**4,74%**
30% glass beads +70% epoxy resin	Experiment	7.485	0.263
	Theory	7.052	0.266
	Error	**5,78%**	**1,1%**
40% glass beads +60% epoxy resin	Experiment	7.693	0.25
	Theory	8.033	0.253
	Error	**4,24%**	**1,37%**
50% glass beads +50% epoxy resin	Experiment	8.495	0,229
	Theory	9.183	0.239
	Error	**7,49%**	**4,26%**
60% glass beads +40% epoxy resin	Experiment	9,885	0,225
	Theory	10.546	0.223
	Error	**6,27%**	**0,82%**
70% glass beads +30% epoxy resin	Experiment	10.834	0,215
	Theory	12.192	0.204
	Error	**11,13%**	**4,8%**

Tables 3 and 4 show that: In the actual construction of composite materials, a good ratio between the reinforcement and the foundation is about 30% ÷ 60%, which is reasonable, when the particle volume is less than 30% and greater than 60%, the error is between theory and experiment increased significantly. From that, an important parameter can be derived that characterizes the structural distribution which is the volume coefficient (volume of aggregates) / volume of the whole composite), this coefficient is usually from 0.3-0.6 – that is, the reinforcement composition is usually 30% and not more than 60% of the composite volume. Especially when the distribution of reinforcement occupies more than 70% of the volume, they are too close together, between them arise interactions leading to stress concentration, and reduce the strength of the material.

IV. CONCLUSION

In this article, two approaches, theoretical and experimental, have been presented to determine the elastic coefficients of grain-reinforced composite materials. Both the theoretical and experimental results are relatively coincidental. The article gives a reasonable parameter that characterizes the structural distribution as the volume coefficient from 0.3-0.6. The results of this paper give reliable elastic modulus to serve for the calculation of strength, stiffness, and stability for structures made of grain-reinforced composite.

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Brainstorming as a Support Tool for Industry 4.0 Advances in the PIM

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Abstract— This paper discusses Brainstorming as a tool to support Industry 4.0 advances in PIM and how this tool can match the needs of Industry 4.0. Considering the current time and assuming that brainstorming is a quality tool responsible for the emergence of new ideas, demanded by the market, it is worth considering that the ideation process is crucial to match the needs of Industry 4.0, which more than ever is expanding worldwide. With all this search for improvement companies seek better tools and management support techniques to develop projects with higher quality, productivity and brevity thus becoming a more competitive industry. For this, the concept of brainstorming will be exposed, its use and application of the tool in the process of project idealization implemented in a guided way, contribute to the control of processes and provide gains in the operational sector of the quality system adopted. The methodology used consists of field research in the very industry where the researcher works, observing and collecting relevant data regarding the use of the tool in the work environment. The main objective is to understand how Brainstorming influences Quality 4.0 in the development of the so-called 4th Industrial revolution, where the evolution of information technology and its introduction in production processes are modifying traditional industries, taking them to different levels of quality and development and thus maximizing its use in the PIM. The results indicate that the tool is very useful for development and problem solving.

I. INTRODUCTION

With the advent of the new industrial revolution, quality is translated into an intelligent process for the modernization and improvement of industries, therefore, in face of this new reality, quality tools enable the understanding on productivity and efficiency in Industry 4.0. Brainstorming is a tool commonly used in the industry and it is necessary to reflect on its role in this new context.

This new paradigm drives and optimizes advances in the production process. Thus, the use of brainstorming, as a quality tool, is a strategic point to meet the needs of the customer and the market, since it seeks to stimulate and present, as a team, possible solutions or ideas, in addition to organizing them.

Brainstorming Applicability in Industry 4.0

The quality tools are reconfigured to meet the new challenges in the quality management process arising from the Industrial Revolution itself. We are in the fourth Industrial Revolution, which is characterized by automation and connectivity, generating a significant advance in the relationship between man and machine.

Quality today is more present and active, as it is not limited only to the product or service. The term quality nowadays applies to several segments of life, such as:

quality of life, quality of air, quality of ethical standards, etc.

According to [1] there is a vision that quality is necessary for the strategic positioning of the company in the market, where there are more conscious and demanding consumers. In this way we live more than ever in the quality era. Currently, quality represents the search for satisfaction not only of the customer, but of all the publics of a company and also of its organizational excellence.

According to [2], the increasing complexity of the organizational activities brought as consequence the increase of the difficulty degree to solve problems. Nowadays, problems require a multidisciplinary intervention for their solution, since only one person, no matter how much skills and knowledge he possesses, will not be able to solve complex organizational problems, generating the need for teamwork.

Within this vision, quality tools provide an increase in the skills and competencies of the team, introducing new techniques and methods for problem identification and resolution.

[3] says that quality tools are all the process employed in obtaining improvements and positive results, thus allowing a better exploitation of its products in the competitive market.

[4] describes that the quality tools are divided into basic ones, with instruments to help the professional in the analysis of the problems and complementary ones, which serve as support to the use of the first ones.

Among the tools used in the quality and project management system, the following can be cited: the Cause and Effect Diagram, Pareto Diagram, Scatter Diagram, Histogram, 5W2H, Brainstorming, Flowchart, and Control Chart.

The quality tool targeted by this research is brainstorming, due to its method for generating group ideas in a short period of time and the contribution of all members in order to obtain innovative and creative solutions to the problem.

Brainstorming

Created in 1938 by the Englishman Alex Osborn, brainstorming is a tool for generating group ideas in a short period of time, also known as "brainstorming". The objective of this tool is to potentiate the individual's creativity, putting it at the service of his objectives.

According to [5] the technique is divided into three parts: Finding the facts; Generating the ideas or ideation process; Finding the solution. From finding the facts in solving a problem there are two subparts: Problem Definition and Preparation.

This tool can be used by anyone in the organization and at any stage of the problem-solving process, but it should be conducted by a single person to maintain order during the process, as in the identification and selection of issues to be addressed.

The objective of this method is to focus the attention to the most important aspect of the problem, developing the reasoning for the visualization of the problem, solutions and improvements in different and amplified angles. According to [6] in a problem-solving process this tool serves as a "lubricant", since the causes of problems are difficult to identify and the direction to follow or options for solving the problem are not apparent.

Because it is associated with creativity, brainstorming is widely used as an auxiliary tool in the development of other tools, for example, it can be used to develop the PDCA cycle planning.

Brainstorming in Industry 4.0

The brainstorming is used today as a tool to solve the problems developed in the advancement of Industry 4.0, widely used in Design Thinking (DT), popularized by [7], which is the approach to problem solving that uses the sensitivity of designers and their methods to identify the needs of users and transform them into business opportunities.

Brainstorming ties in with this tool assisting in the development of innovative and radical solutions allowing industry to excel in the industry 4.0 market.

Design Thinking has three pillars: Inspiration, Ideation and Implementation. Inspiration or also known as immersion, can be divided into two stages: Preliminary and In-Depth. The first aims at the reframing and the initial understanding of the problem, while the second aims at the identification of opportunities and needs that will guide the generation of solutions in the next phase of the project, and the ideation [8].

For [7], ideation is the process in which ideas and concepts are generated and prototyped with the aim of generating innovations on the problems identified in the Inspiration stage.

After the solutions are well defined and inspired in the user needs (focus of the whole analysis), the solution implementation is taken to the market. [7] still cites that, in the implementation stage, one must plan the method that will achieve the expected future reality, which implies the creation of business model prototypes to evaluate the impacts on the organization's activities. It is imperative, at this point, that the organization: identifies the reasons to drive the solution's success; prioritizes the activities of the sectors that commit to deliver the related strategies; defines the strategic, operational and economic relationships; and defines the venture's economic impact.

With the ability to solve complex problems, brainstorming, is applied in one of the three (3) pillars of Design Thinking, ideation process. During the Ideation process the best ideas are submitted to an evaluation by the team itself. Those approved take shape with the rapid elaboration of prototypes, spending only the time, investment and efforts necessary to generate information that will be useful for the progress of the idea [9].

The transformations associated to the concept of Industry 4.0 present potential to increase the flexibility, speed, productivity and quality of the production processes [10]. Its impacts, however, will go far beyond: they will affect the economy, businesses, governments, people and work. Industry 4.0 is the product of a profusion of technologies applied to the production environment, what [11] calls "megatrends". Among them, Cyber-Physical Systems (CPS), Internet of Things (IoT), Internet of Services (IoS), autonomous vehicles, 3D printers, advanced robots, artificial intelligence, Big Data, nanomaterials and nanosensors [10], [11], [12] stand out. It is in this context that brainstorming emerges as an empowering tool for the development and improvement of Industry 4.0, bringing better ideas and improving the projects developed in this revolution.

The objectives of the study are: to understand through theoretical survey about the quality tools, directing the look to the brainstorming and how it accompanies the development of Industry 4.0; and expose the impacts of brainstorming in the industry.

II.　MATERIAL AND METHODS

The applicability of brainstorming in the industry enhances its adaptability capacity, regardless of the context. Data was collected in the Industrial Pole of Manaus through data made available arising from a survey by means of questionnaires in Google Forms, in order to understand and collaborate with the existing practices.

The investigation, of paramount importance for scientific development, leads the researcher to delve into the problem at issue, leading him to seek solutions and/or results that answer positively or not the questions raised in the research [13].

According to the need raised for the development of the project, it is necessary a scientific approach to the efficiency and use of brainstorming as a working tool to aid the development of Industry 4.0 in the PIM.

To this end, it will be used as a method of data collection the field research and the theoretical basis on the subject within the area of the established theme.

Nature of the Investigation and the Method

The following research will be of qualitative nature, due to the fact that this methodology provides a better view and understanding of the context of the problem in order to use the ideas and narratives of the companies investigated, thus observing the motivation of the use of the brainstorming tool or the reasons for not using it.

Qualitative research is appropriate for this research, because according to [14] it is seen that it is directed to interpret its object of study, has a subjective, evaluative character, where the researcher is the one who analyzes the concepts and results, bringing to the research a particular view on various factors that influence the result itself.

Considering that the industrial development happens to better serve society, the environment and the industry itself, it is necessary a deeper understanding about the tools used to develop and enhance the Industry 4.0 at the PIM, especially raising the question about the use of the brainstorming tool, as one of the possibilities of developing Industry 4.0, expanding the understanding about the possible reasons that led the PIM to introduce or not such a tool in the process of ideation and improvements in the PIM itself.

Field of Observation and Subject of the investigation

Established in the city of Manaus, the economic model entitled the Manaus Free Trade Zone was created in 1967, through Decree-Law 288. Still in the government of President JuscelinoKubistchek in 1957, Law No. 3,173 created the Manaus Free Trade Zone, which actually only became effective 10 years later [15].

When it was implemented, the main objective of the Free Trade Zone was to foster the economic development of the region. Besides, it focused on the integration between the Northern States and had the intention of promoting the occupation of this space. This is because the North region is the least populated in Brazil [15].

With approximately 600 industrialists, divided into: Two-wheeled pole, Electro-electronic pole, Mechanical pole, Watchmaking pole, Metallurgical pole, Chemical pole, Plastic poleand Miscellaneous pole. Due to the vast number of factories installed in the PIM, the research field approached will be only three (3) or four (4) factories, this choice is due to the fact of the approach of the researcher with the team responsible for applying the improvements required by the 4th Industrial Revolution.

Data Collection and Information Processing Mechanisms

As an initial activity for the identification of the use and application of brainstorming, the researcher will make a participant observation of the use of the brainstorming tool in the environment in which a plastics pole factory works.

This instrument of data collection will be applied by the simple fact that as a technique used in research, it should be emphasized that its objectives go far beyond the detailed description of the components of a situation, allowing the identification of the meaning, the orientation and the dynamics of each moment [14].

Among according to [14], in the approach by "Participant Observation" it should be emphasized that its objectives go far beyond the mere description of the components of a situation, allowing the identification of the meaning, the orientation and the dynamics of each moment. In view of the intersubjectivity present at each moment, observation in situation allows and facilitates the apprehension of the real, once essential aspects are gathered in the field.

First, it was observed during meetings and team comments how the brainstorming tool is understood and used by the same, then the researcher problematized the observations and generated seven (7) guiding questions that led him to generate the data to better understand the use of the tool as a tool to manage projects.

III.   RESULTS AND DISCUSSIONS

The ascendancy of brainstorming as a tool in the PIM is visible and proven by the results collected by this research. The responses obtained were observed from the project follow up meetings.

The team observed uses brainstorming and is composed of individuals from various areas, thus making it a multidisciplinary team.

When questioned about which tools are used by each team, they exposed: Pareto diagram, kanban, Brainstorming, 5W2H, Ishikawa diagram, PDCA, Business Model Canvas (BMC), designer thinking, project portfolio, flowchart, control chart, GUT matrix, FMEA and Quality Function Deployment QFD. It is worth mentioning that the members who did not include brainstorming, pointed out only the tools that help brainstorming.

The use of brainstorming in the aid of the projects is guided by each member, having as a result: a. To help in the agility in developing the project; b. In the macro view of the risk analysis (this answer appeared five times); c. In the elaboration of more complete scopes; d. In the decrease of expenses in the development of the project; e. In the raising of ideas to solve the problems found in the MVP (Minimum Viable Product); f. In the development of the pre-project. Assist in the development of the pre-project; f. Assists in solving complex problems (this answer appeared three times); g. In quality control and project management; h. Assists in GUT matrix through problem solving; i.

Assists in PDCA; j. Assists in decision making for the development and choice of projects.

In the questioning made about the use of brainstorming as a main tool and/or as an auxiliary tool, we obtained the following answers: no participant uses it only as a main tool; five participants answered that they use it only as an auxiliary tool to other tools, such as, for instance, PDCA, FMEA, designer thinking and GUT matrix and 3 other participants assumed that they use it both as a main tool and as an auxiliary tool, helping in the PDCA and designer thinking tools.

The changes perceived by participants regarding the use of brainstorming were commented in meetings, presenting the following information as: a. Cost reduction (six answers appear); b. Agility in the creation process; c. Better team harmony (two answers appear); d. More complete and complex projects; e. More comprehensive scopes; f. Higher rate of project approval at the board; g. Decreased problems found in products (three answers appear); h. More competitive products on the market; i. Quicker problem solving; j. Decrease of risks arising from new projects (appeared twice); k. Decreased problems caused by the products; l. Organization of the manufacturing process.

Therefore, brainstorming is a tool that presents itself in different contexts of the industry. In obtaining the collaboration of eight participants from two different teams and regardless of which one they belong to, it is clear that the tool is of added value for the results expected in Industry 4.0.

It is understood that even if the tool is used in an auxiliary way by the members, it achieves unquestionable positive results, defended by [16] such as: reduction of costs, risks, problems and agility in their resolution. Due to the composition of a multidisciplinary team, which enhances the brainstorming tool itself, it is perceived by it that there is a greater competitiveness of products when launched on the market.

IV.   CONCLUSION

It is clear that the needs of Industry 4.0 have given rise to quality enhancing tools. The complex and dynamic structure of the industry, as well as the context in which it operates, allows us to reflect on a new take on this new methodology.

Brainstorming itself, values interdisciplinarity, the exchange of ideas, group dynamics, the search for relevant and quick solutions, corroborating with the industry itself, the society and the being that composes it.

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The Effect of Knowledge Management on Employee's Job Satisfaction

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Abstract— Knowledge management (KM) is considered as a vital component in constructing a viable advantage in a corporation. According to the earlier studies, Knowledge Management implementation in Ghana is comparatively overlooked. Most societies in Ghana remain uncertain whether the assured routine enhancement through the execution of Knowledge Management practices is simply experiencing declination. Hence, the paper targets to satisfy this necessity by evolving the theoretical structure. The theoretical structure within the research is written by the method of adapts and adopts from the earlier studies. The Knowledge Management practices which will be deliberated during this research work are the creation of knowledge and retention of knowledge, acquisition of knowledge, and sharing of knowledge. It layouts the theoretical structure for the study and know the factors which will impact task satisfaction in an organization. The hypothetical design area will clarify the itemized reasonable structure utilized in this study which comprises of four independent variables, acquisition of knowledge, sharing of knowledge, creation of knowledge and retention of knowledge and one dependent variable which is job satisfaction. Again, the review will cover the effect of practices of knowledge management on the job satisfaction of employees. The paper closes with suggestions on additional exploration that ought to be assigned in order to support the comprehension of the ideas and consequently the impact of Knowledge Management on the job satisfaction of employees.

I. INTRODUCTION

As identified by Alavi et al. (2001), in an exceedingly period where knowledge is increasingly observed as a society's greatest vital wealth, several societies have realized knowledge management with a cessation aim to pile, seizure and allocate knowledge everywhere in the association. Kianto et al. (2016), suggested that the management of knowledge has been the foremost portion of building, giving, supporting and empowering rational learning situations within an organization, to inspire and permit skillful people to develop and allocate their understanding and make new knowledge.

Davenport et al. (1998) explained knowledge as an information combined by means of reflection, locating, clarification and understanding. It is a high-esteem form of data that is equipped to be used for choices and activities. Organizations must see correctly which information will give them a favorable position. Wenger et al. (2002) stated contend that it is information or the know-how which can give the association a resourceful and focused edge. Information has become the means of its accomplishment. It is essentially substantial as an advantage, making it unbearable to be missing to shot (Wenger et al., 2002). Assuming the meaning of information and its understanding, many societies are challenged with problems of handling themselves in view of the requirements of the training-driven economy. The

purpose of knowledge management could be a humming subject today in many organizations, scholarly establishments, and different parts of the economy. Learning has been seen to possess a critical part among the standard assets of land, work, and capital in making and supporting monetary esteem.

According to Wiig et al. (1997), a critical study conducted has been focused on the former era in evaluating knowledge and the way it was effectively managed. It has been acknowledged as essential elements specifically, scholarly capital (human), culture and procedure in knowledge management. The discerning of the review is to show a theoretical casing work model to boost learning administration rehearses through compelling reconciliation of those factors and effective use of knowledge assets. It'll focus on the integrative influence of techniques, academic assets (human), values and methods on the management of knowledge.

1.1. An Overview of Knowledge Management

The dispatch of the notion of Knowledge Management (KM) is often followed from the foremost recent period of the 20th century, when it started and faddish within the business domain. The business domain perceived the groundbreaking of knowledge within the global economy of the knowledge age. Within the innovative knowledge economy, the care of critical and strategic knowledge and its relentless recovery enable the corporate part to addendum-focused benefits. The uses of information management have gotten diverse sections, including Colleges, Governmental entities, Research and Development zone and many more. (Lee, 2005)

Pruzinsky et al. (2017) pointed out that knowledge management can be the way to develop and empower educated people to use and allocate their vision and produce innovative information. Pruzinsky et al. (2017) analyzed if the way knowledge management practices will be utilized to market worker job satisfaction in an organization. They again recommend that knowledge management will help endure the satisfaction of the job and boost great managerial performance.

Knowledge Management (KM) could be a gathering of processes that characterize the formation, dispersion, and practice of knowledge within a company (Newman, 1991). As indicated by IFLA, KM is a technique of creating (making, taking), pushing away (shielding, positioning, organizing), distribution (teaching), administer (implementing), and reprocessing (transforming) certified knowledge to allow a corporation to achieve its purposes and endpoint. It includes the administration of explicit knowledge, thus knowledge that has been categorized as pages, reports, databanks, and

many others and the allocation of disguised knowledge thus abilities, mastery, and knowledge (Ajiferuke, 2003).With some organizations, explicit knowledge has been formed an inmost association, for instance, records of meetings, proposals, reminders instructions, reports, or attained from unnecessary sources, including catalogs, files, government data, and journal articles. On the other side, tacit knowledge, surrounded bythe intelligence of employees having in-depth knowledge of strategies and controls, labor schemes, and many others (Wijetunge, 2002). Tacit and explicit knowledge are both the utmost vital wellsprings of knowledge of a company, the controlling of the company that must be finished with most extreme carefulness which should be the main criticism of a company (Ajiferuke, 2003).

1.2. Knowledge Management in Ghana

Javed et al. (2012) supported the earlier studies that show when people are pleased with the kind of occupation, they're ready to execute their work conventionally which makes them extra creative and inventive. Pruzinsky et al. (2017) outlined that there haven't been many studies on management of knowledge and satisfaction of job toward organizations. Therefore, the researcher planned to review comprehensively about job satisfaction once they are practicing knowledge management as their work task. As shown by Tsai (2001), worker performance may be raised higher if advanced fragments have central scheme positions which wish to access new learning established by several divisions inside a corporation. By exposed confirmation of knowledge, knowledge management exploitation and their specific influences on worker performance, networks are acknowledged by Knowledge Management and performance (Kalling, 2003).

Woods (2005) pointed out that the advancement and also the appreciation of the management in knowledge in Ghana are restricted to worldwide organizations and government agencies and foundations. Small scale initiatives are perceived as less on modifying management of knowledge within the societies. Knowledge Management practices within Ghana are always at the experimental phase in which real execution is truncated. Such comprises of some high-rank groups regarded as extremely knowledge-designed corporations (Norzanahet al. 2006)

II.   LITERATURE REVIEW

2.1. Perception of Management of knowledge

The theme for this research is the Impact of Knowledge Management on Job Satisfaction of employees.

Considering the relevance of the topic, the scholar has to consider and examine how the practices of knowledge management can impact the satisfaction of employees. Knowledge Management is an organization's capability to collect, pile, allocate and relate to data with a particular final goal to promote its endurance and attainment.

In line with Moffet and Hinds (2010), the efficiency of practices of knowledge management set free representatives. Knowledge workers have compliance and elasticity to control their labor per their own specific vision, know-how and action. They bolster each different and additionally by data and knowledge, which resultantly benefits both themselves and also the organization. With the advancement within the business field and prospering rivalry, organizations are relying upon its bookkeeping esteem likewise the commitment of its knowledge (Lin and Tseng, 2005).

In line with Syed et al. (2004), most specialists emphatically recommend the choice and execution of Knowledge Management practices as principal in constructing the associations favorable position, for instance, capturing and sharing best practices viably overseeing client connections and conveying aggressive insight. Notwithstanding the accumulation on the positive consequence of Knowledge Management, several researchers in Ghana (example: EPU, 2004; Rahman, 2004; Toh et al., 2003) explained that Knowledge Management was still mostly within the Ghanaian setting. By and huge, organizations that had high information power, for instance, electrical/hardware, concoction/compost, and administrations showed more elevated amount of KM practices contrasted with organizations with lower learning force (e.g. material, elastic items, metallic items, nutrition preparing, agricultural items, plastic and many more) (EPU, 2004; Toh et al., 2003). By and by, regardless of the anomaly among industry areas, Ghanaian organizations were all remaining behind their distant partners from motivating markets (EPU, 2004). Rahman (2004) overviewed 303 training and government agencies established that only 46 percent thus 139 organizations had constructed recognized activities of Knowledge Management. Irritatingly, just a bit of the 46 percent has actually started the practice thus (32 organization) and observing (18 organizations). However, there was a greater part of the associations still within the primary stages of studying, scrutinizing, preparing or setting, spending and planning. The slow implementation is not on the grounds that organizations did not realize KM. Rather, maximum of Ghanaian societies were accepting the 'sit back and watch' method regarding the implementation of

Knowledge Management schemes within their organizations (Woods, 2005) as they could not realize the possible benefits of Knowledge Management. The absence of expository validation of the connection among the practices of knowledge management and satisfaction of job powers the unwillingness among societiesto understand KM. More or fewer scholars who got pragmatic provision utilizing the correlated investigation strategy. (Zaim, Tatoglu, and Zaim, 2007) underlined that albeit positive connections were found among KM practices and KM execution, the discoveries could not be summed up to a more extensive populace. Henceforth, this exploration expects to fill this hole by giving exact approval to make sure there is a connection between these components for many organizations particularly for information-based firms. Knowing so would encourage the reception of suitable KM practices to encounter expanded competitive advantage.

2.2. Knowledge Management Practices

KM alludes to distinguishing and utilizing the combined information in a company to supply assistance to the organization (von Krogh, 1998). In line with Lee et al. (2003), KM supposedly consists of knowledge processes like knowledge creation, acquisition, sharing, transfer and application.

Nonaka et al. (1995) stated isolated KM process into knowledge storage, transfer and creation. Practices of knowledge management have been proposed by Demarest (1997) and Pruzinsky et al. (2017) as knowledge acquisition, sharing, creation, codification, and retention.

2.2.1. Acquisition of Knowledge

Conferring to Zahra et al. (2002) acquisition of knowledge remains for definitive practices for the collection of information from extra-organizational sources. Outside systems and collaborative courses of action are pivotal sources of information for an expansive extend of organization. Clients outline an awfully basic gathering from which information ought to be picked up in case the organization succeeds. For occasion, the client input frameworks, information handling, trade insights, and collaboration with accomplices and research institutions are ordinary of exceedingly created Knowledge acquisition practices.

Acquisition of Knowledge could be a constant and dynamic manner. Acquisition of Knowledge contains the power to plan exceptional thoughts, bits of information, arrangements and associate it inside the association (Bhatt, 2001; Bose, 2004; Tiwana, 2003).

2.2.2.Sharing of Knowledge

As indicated by King (2007), conjointly found that sharing or dispersal of data is one of the indispensable components of data management practices. It chooses the progression to that delegates can grant their contemplations and beneficial data to managers and partners for accomplishing their assignments and up yield. On the alternative hand, it is used to address the system used by workers for chase or corporate greed data inside shifted divisions and individuals from the affiliation (Becerra-Fernandez and Sabherwal, 2014).

Upheld by Awad et al. (2007), Information management is the technique that associations aggregate, make, and give partner degreed use data in a very suitable way for achieving explicit targets. It is essentially a multidisciplinary technique similar to different instruments and strategies. The human issue is one of the fundamental elements to be considered because it relies on points of staff to impart data to others.

As indicated by Trivellas et al. (2015) upheld the past investigations that, while no responsibility from staff, the association cannot keep up flourishing the practices of management of knowledge if the staff does not share data with each other. This study conjointly has been supported by King (2007) however, a few investigations have distinguished the piece of construction culture and design in data sharing, and they need to look out its outcome on worker's work fulfillment.

2.2.3. Creation of Knowledge

Creation of Knowledge is the association's ability to develop new and valuable arrangement and game plans with pertinence totally various segments of design exercises, from innovative cycles, item and body practices.

The creation of knowledge is made once an organization and its kin learn and improve the ability or data. In accordance with Scharmer (2001), information creation associations sort out for progression of laborer potential and self-ascending higher than information to foster profoundly new encounters, advance turn of events and insightful improvement inside the smallest degree levels of the association.

2.2.4.Retention of Knowledge

Kianto et al. (2016) simply characterize knowledge retention as partner degree exercises identified with directing worker turnover and conjointly the associated loss of talented data that allude to a key association quality. Proficient information is normally lost once staff leaves the association for reasons unknown. As people born after World War II polish off, pulling in and keeping up the viable premier staff can grow significantly

and extra pressure challenge in regards to information retention. (Kianto, 2016)

2.3. Job Satisfaction

Spector (1994) announced, job satisfactionis generally addressed as what some people like (satisfaction) or abhorrence (dismay) in their occupations. Occupation fulfillment will raise mental accomplishment at work (Robbins et al., 2003). In accordance with Shaikh et al. (2012), job satisfaction suggests the state inside that staffs show pride from their work or the reformist and fervor condition of the specialist when investigating their occupation and execution.

As indicated by Fritzsche and Parrish (2005), the significance of job satisfaction changes from the feelings a laborer has with respect to their occupation. Per John Locke expressed work fulfillment has similarly been described as "a piece of the evident relationship between what one longing from one's business and what one considers it to be promoting" and to the reason that a worker feels oppositely towards their occupation (Locke, 1976). The term work is near the view of specialist fulfillment. As pronounced by Grant et al. (2007), specialist fulfillment is the overall idea of a laborer's inclusion and managing at work. The definition joins three estimations of fulfillment: mental, physical and social. The consequence of helpless fulfillment is reflected in under-execution, delinquency, presentism, depleted leave and turnover (Baptiste, 2008)

Supported by Vroom (1964) the satisfaction of a job likewise identifies with the exchange of inspiration, where the source of job satisfaction is often associated with social thus having an area, confidence and self-actualization.

2.4. Knowledge Management in Organization

Much the same as the expression "knowledge," the expression "Knowledge Management" (KM) is moreover hard to characterize. Truly, the setting within which KM is used and the varieties of issues it has utilized to understand ultimately decide its proper definition for any organization. What is essential, in any case, is that most of those definitions center on the KM to boost methods for working together and making esteem. Despite the actual fact that KM has gotten an awful name during a few circles because of the fizzled cases of experts out to make a fast dollar, KM is actually digging in for the long-term. Spiegler (2000), tending to the problem of whether or not knowledge Management is "another thought" or "reused plan," established that knowledge Management is largely another thought separated and isolated from knowledge frameworks, alternative showing emotion adjunct networks, and management of knowledge overdue

to the distinctiveness "knowledge" element. The significance of knowledge has been supposed all through the past. Sir Francis Bacon wrote in 1597, stating that "Knowledge is power." a lot of as of late, associations have begun to travel up against a comparable read perceiving that information, rather than data is the foremost deliberately noteworthy authoritative quality (Drucker, 1993; Earl, 2001; Nidumolu et al., 2001; Zack, 1999) conjointly the means to future association accomplishment, superiority (Korn/Ferry, 2000; KPMG, 2000) and development (Amidon, 1997; KPMG, 2000).

In line with Becerra-Fernandez (2001), there is broadly conviction that the wealthiest asset of today's organization is that the learning living independently and by and huge among workers mirrors the importance of procedures for advancing the creation, sharing, and utilizing of learning. Fahey and Prusak (1998) stated that notwithstanding the developing significance of information and learning forms, it had been perceived that organizations do not oversee either exceptionally well. They endeavor to focus on and better oversee learning and knowledge forms has prompted the advancement of the thought and routine with regards to KM.

2.5. Knowledge Management and Satisfaction of Job.

Bimpitsos and Petridou (2012) explicit that organizations add a website represented as weakness, shoddiness and alter which motivate the presence of varied hitches. This circumstance integrates several parts which extend the economic process, fast automated modification, which conjointly advances the demand for competent workers and increased progress (Vanhala and Stavrou, 2013).

Savaneviciene and Stakeviciute (2011) expressed that the strong point of a society to undertake and quest for resources as its transfer inside selected finish objective to realize a positive position.

As stated by Glisson et al. (1998), conditions aimed at primed satisfaction of job are wide premeditated, and conjointly approved past history embody, role uncertainty, work style, and ability selection. However, problems of Knowledge Management have not however been enclosed between many factors of job satisfaction that are examined. Universally, it appears that klick collected works have solely seldom self-addressed in former researches.

As stated by Dominguez (2011), KM viewed as basic element adding to an organization's satisfaction. Supported by Othman (2009), utilizing KM in a very vital way is required to beat the distinctive difficulties organizations confront. In this way, viably handling these assets is significant to any or all association (Juhdi et al., 2011). In line with Ortega-Parra and Sastre-Castillo (2013), managing KM corporation requires the use of varied practices that assume an enormous part in helping organizations make and manage the performance they require as they impact the states of mind and practices of employees (Lew, 2011). Supported by Yew (2013),societies express to make up a presented force (Yew, 2013) and result the foremost model technique to embrace their workers from revenue (Riveros and Tsai, 2011). As declared by Tiwari and Saxena (2012), a group's behavior is also improved in such regions as employee duty, experience, and adaptableness by managing the knowledge Management accessibility in this organization. Additionally, it has accounted for that few km practices which will influence worker responsibility and inspiration that incorporate enrollment and choice, making ready and improvement, performance analysis, cooperation, and remuneration and reward (Fong et al. 2011). As declared by Fong et al. (2011), data subsist inside the psyches of workers but that data is also effectively lost if workers opt to leave the organization. As a result of that reason organizations look to spice up the (KM) procedures of securing, appropriation, appreciative, and stratified retention (Jimenez-Jimenez and Sanz-Valle, 2013). The explanation for this research is to review the link among KM and satisfaction of employee's job, stratified obligation from a particular viewpoint and their organization with knowledge management, on the former side. In order to accomplish this reason, the principal examines the hypothetic foundation, inquire concerning the system, and examine model and theories.

2.6. Theoretical framework and hypothesis

The abstract framework used for the paper is delineated by the method of adapts and adopts from earlier readings and literature. The practices of knowledge management that have been tailored as independent variables are acquisition of knowledge, sharing of knowledge, creation of knowledge and retention of knowledge, whereas for dependent variable is employee's job satisfaction being an indicator. The definition of each variable may be found during this section aboard the variable explanation and relative with different studies. During this research work, the link between the independent variables and dependent variable are surveyed and theories are planned during this segment.

2.6.1. Acquisition of knowledge and job satisfaction

Acquisition of Knowledge includes the capability to plan original thoughts, bits of information and provisions and incorporate them among the organizations (Tiwana, 2003).

Based on a study from Jayasingam et al. (2014), the study used the knowledge Management scale established by Darroch (2003) to measure knowledge Management practices utilized inside organizations studied. This scale consists of acquisition of knowledge. In line with Jayasingam et al. (2014) as knowledge Management outcome is tough to measure, this study centers on the presentation of knowledge Management projects as perceived by people who expertise the implications of knowledge Management projects instead of adopting objective measures.

According to Bose (2004), knowledge Management projects are in progress and continuous projects, measures of performance of knowledge Management projects should be determined as factors of the organization's expansion or improvement. Hence, the level of expansion is utilized as performance measuring instead of the level of accomplishment.

Then the researcher argues the finding between acquisition of knowledge and employee's job satisfaction and so projected for the subsequent hypothesis

• Hypothesis 1: there is a vital connection between Acquisition of knowledge and Job Satisfaction

2.6.2. Sharing of Knowledge and Satisfaction of Job

Sharing of knowledge is the discussion of information between individuals, amongst teams, structure units, and organizations. (Nonaka and Takeuchi, 1995).Based on the finding from Saeed (2016), the link between the satisfaction of job and sharing of knowledge is very correlative with a worth of 0.934. In line with the findings, Saeed (2016) urged that the higher the sharing of knowledge, the upper will be worker performance. Once workers are inspired to segment knowledge with different workers, they acquire additional chances to advance new concepts, explore information and donate meritoriously in achieving organization's purposes. This is often additionally manifest by this study's conclusions that workers request to share knowledge with others getting to build vital enhancement in their job performance. This results in line with Trivellas et al. (2015), who additionally explored the positive association between sharing of knowledge and job satisfaction.

Then the researcher argues the finding between sharing of knowledge and employee's job satisfaction and so projected for the subsequent hypothesis

• Hypothesis 2: there is a vital connection between Sharing of knowledge and Job Satisfaction

2.6.3. Creation of Knowledge and Job Satisfaction

The creation of Knowledge confers with the organization's ability to develop new and valuable thoughts and resolutions with regard to totally different components of organizational activities, from things and technology methods to management practices (Nonaka, 1991, Kianto and Andreeva, 2011).

According to the study from Prunzinsky et al. (2016), the creation of knowledge is not an element that has an effect on job satisfaction which can be attributed to the setting of the study. It has attainable sort of labor allotted during this municipal organization needs neither acquisition of knowledge (mainly from sources or associates outside the organization) nor the design of the new knowledge. These activities are not inspired by either support within the organization and thus need no result on job satisfaction.

Then the researcher argues the finding between the creation of knowledge and employee's job satisfaction and so projected for the subsequent hypothesis

• Hypothesis 3: there is a vital connection between the creation of knowledge and Job Satisfaction

2.6.4. The Link between Retention of knowledge and Job Satisfaction

Retention of Knowledge denotes the actions connected to handling personnel revenue and also the connected loss of skillful knowledge, an important strategic resource. (Kianto, 2016).

Retention of Knowledge was the key knowledge Management method for this cluster, which means that knowledge continuity and preservation are necessary for guaranteeing their work satisfaction. This is often to be expected because the tactical piloting of a company needs an intensive and profound understanding of its history to make path-dependent means. It is once more vital for this mass to hold peripheral services and also the established and legislative atmosphere during the operations of the organization.

Based on a study by Kianto et al. (2016), the remaining knowledge retention and also relations with job satisfaction. Precisely, outcomes show that intra-organizational allotment of information is that a very important knowledge Management method, encouraging the satisfaction of job for several worker teams.

Then the researcher argues that the finding between retention of knowledge and employee's job satisfaction and so projected for the subsequent hypothesis

• Hypothesis 4: there is a vital connection between Retention of knowledge and Job Satisfaction.

III. CONCLUSION

In the sum up, this abstract paper offers a comprehension on knowledge management and job satisfaction. The literature from past studies is looked into visible of research papers and abstract papers written by scholars and researchers within this field. Each variable utilized as a part of this study has been analyzed. This study investigated additional guaranteeing the ultimate aim to allow higher explanation and conception regarding the impact of knowledge management on job satisfaction of employees from totally different former reviews. A theoretical review audit is additionally done to review the elements that will be incorporated into this study that covers the knowledge management practices and additionally job satisfaction. Insight of the reading, employee's satisfaction may be shown by measurement of the work satisfaction of an individual through knowledge Management practices. Utilizing the concept of adopts and adapts, an abstract framework is suggested because is the model to steer this study. Additional research ought to be conducted so as to reinforce the understanding of ideas and also result of knowledge Management on employee's job satisfaction.

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Survey on Application of IoT and its Automation

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Abstract— Life is getting more straightforward and easier to utilize as current technologies of automation continue to progress. Automatic systems are favored over manual ones in today's society. The internet has become an integral part of everyday life as its user base has grown tremendously over the past decade, and the Internet of Things (IoT) is the most current and rising internet technology. The Internet of Things is a rapidly expanding network of everyday objects, ranging from industrial robots to consumer gadgets that can exchange data and execute activities while you are away. A smart house, often known as an automated home, is a system that uses computers or mobile devices to monitor your home. Simple house operations and features are automated and accessible from anywhere in the globe through the internet. Its mission is to protect both human and natural resources. The home automation system varies from earlier systems in that it enables users to remotely operate the system from anywhere in the globe through the internet. We propose a Home Automation system (HAS) based on Intel Galileo that combines cloud networking and wireless communication to enable users to remotely control lights, fans, and appliances while also storing data in the cloud. The gadget will modify itself automatically depending on sensor data. This system is inexpensive and versatile, which enables it to operate a large variety of devices.

I. INTRODUCTION

The development and application of technologies that enable the production and delivery of products and services with little or no human interaction is known as automation. Thanks to the application of automation technologies, techniques, and procedures, many tasks that were previously performed by humans are now more effective, reliable, and/or rapid. Automation is used in manufacturing, transportation, utilities, security, facilities, processes, and, more recently, information technology.

Automation is typically used to reduce labor costs or to replace humans in the most menial or repetitive activities. Automation can be used in almost all industries and niches, but it is most common in manufacturing, utilities, transportation, and defense. The IoT is a term that describes the process of linking ordinary physical objects to the internet, ranging from light bulbs to medical devices to wearable, mobile devices, and even smart cities. At many levels, the Internet of Things speeds up engagements and connections. It provides a high level of automation and power [1, 18, 19]. IoT also allows you to gather more data in one location, enabling you to make well-informed choices.

- Real-time tracking is now possible.

- Interactivity and Customization Efficiency Monitoring

- Exceptional perspectives

II. AUTOMATION AND INTERNET OF THINGS

The IoT plays a significant role in industrial automation as it begins to research and utilize IoT ideas and technologies. IoT aids in the streamlining, collapsing, and development of efficient, cost-effective, and responsive system architectures [10]. To improve versatility and increase manufacturing, the main goal is to establish communication and cooperation in manufacturing field input/output, such as analyzers, actuators, and robotics that is free of conflicting perceptions. Industrial automation has used IoT to optimize commercial technology in big applications, such as PLCs replacing banks of relays.

2.1. Internet of Things Nodes

The Internet of Things (IoT) is the next big thing in technology, and it simply refers to internet-connected devices that can collect data. Many Internet of Things (IoT) gadgets blend easily into daily life by making routine chores easier. IoT products come in a range of shapes and sizes, and they can be used in a variety of industries [6].
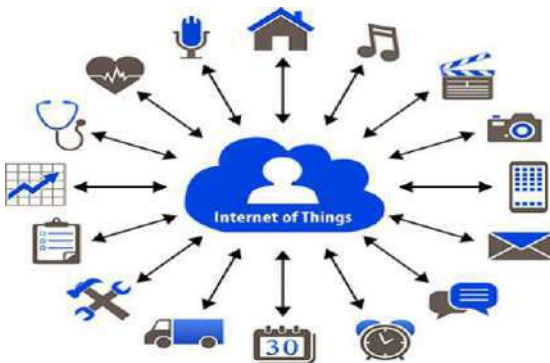
Fig. 1: IoT Application

Company and consumer lives can be smoother than ever before thanks to IoT technologies. Figure 1 shows with a help of IoT we can connect all the business applications [13].

2.2. Devices that Link with Internet of Things

Internet of things devices can be used in a diversity of areas, ranging from home automation to home functionality. This category includes smoke alarms, thermostats, smart music systems, and smart light bulbs [7]. IoT gadgets, on the other hand, can be used in the relationship with the human body, such as fitness trackers, smart body scales, and even baby monitors. IoT Gateway Devices connect the IoT Sensor Network to the Cloud Server via a communication link. IoT Gateway Devices are increasingly becoming critical components in the Internet of Things' adoption of next-generation devices (IoT) [2]. They help with networking protocol integration, data storage and edge analytics management, and data flow security between edge devices and the cloud.

III. IOT DEVELOPMENT KITS FOR INDUSTRY

Engineers and solution architects can utilize Industrial IoT Development Kits to create a complete, high-quality design environment that will accelerate the development and production of IoT applications. These kits may simply change any development/industrial area into a production-ready unit. The IoT Development Kit provides a choice of hardware platforms to meet a wide range of IoT application needs, ranging from compact, low-power ARM-based designs to powerful multi-core Intel Atom gateways of the newest generation. Advantech Co. LTD, Congatec Asia Ltd., ADLINK Technology, and ICOP technology are just a few of the companies that include IoT-related devices and products [8].

Advantech Co., Ltd offers high-end, cutting-edge products, services, and solutions. This company sells Internet of Things (IoT) products, as well as computers, gateways, and industrial IoT creation kits [9]. Embedded systems, IoT Wireless I/O Modules, automation products, and global logistical assistance are all available from Advantech. This firm specializes in the design and manufacture of high-performance computing platforms.

Congatec Asia Ltd is a leading provider of Internet of Things gateway devices. Industrial automation, telecommunications, transportation, and test and measurement are just a few of the areas and applications where this company's products might be used. The organization's products are made in accordance with current quality standards. Congatec Asia's IoT Gateway Devices are simple to configure and instal in the field. OEMs get a pre-configured, pre-certified IoT gateway that can link a variety of heterogeneous sensors, actors, and systems to cloud-based services fast and easily [3].

ADLINK Technology Inc offers Industrial Internet of Things (IoT) solutions to the automation, medical, transportation, and government/defense industries. ICOP Technology manufactures industrial embedded computers, embedded controllers, IoT Development Kits, industrial panel PCs, and other control system automation components. Industrial IoT Development Kits from this company include with sample code, minimal power usage, and a touch screen LCD, and stackable wireless networking. The Vortex86EX low-power consumption x86400MHz CPU (VEX-SOM) from DMP is combined with DIGI's XBee module in these Industrial IoT Development Kits. The VEX-IOT-DEV kit also offers balanced computing performance with 128MB DDR3

device memory and secure wireless networking for your computers.

Subsequently the tenure "Internet of Things" was devised in1999, it has generated a lot of discussion about its potential influence on our individual and professional life. The buy and transportable to the way producers control and handle portfolio towards agriculturalists maintain a record of their current stock, the Internet of Things has revolutionized our lives in many ways. It's progressed from a crazed notion to a vital truth. Many of these developments are related to development drivers such as pervasive computing, widespread procedure of the Internet Protocol (IP) / logical layer, and the continual rise of information processing, among others [4, 17]. By2020, Gartner estimates that 20.4 billion nodes will be associated to the Internet of Things. Notwithstanding the aids it offers, it is still a somewhat perplexing term.

IoT is a vast, digitally linked cosmos comprised of billions of physical devices located around the globe that gather and share information in their use and environment. These products are connected to the internet, outfitted with software, sensors, and other hardware that enables them to interact with other devices through the internet [5]. The internet of things expands the reach of the internet further than computers and mobile devices to everyday objects such as light bulbs, locks, smart microwaves, wearable fitness devices, advanced industrial equipment, and self-driving cars, enabling them to perform more analytical and computational tasks.

IV. AUTOMATION AND IOT NODES TOGETHER

While the internet of things has many applications, to link devices to the internet, it relies on key technologies and components, they are:

- o Sensors to accumulate information from the atmosphere for processing by the IoT device.

- o IP addresses are used to connect and identify devices in the Internet of Things system.

- o Actuators allow devices to react to information from their personal devices as well as link input.

- o Data from multiple devices is connected to the cloud via an IoT gateway. It also unifies the node protocols into a single customary protocol and eliminates redundant information gathered by the nodes.

- o The cloud software will collects and processes all data from IoT devices.

- o The GUI is where customers acquire information from systems so they may issue commands that

the gadgets require. All of these aspects are linked through automation, which confirms that procedures function efficiently deprived of the need for human intervention.

4.1. The Benefits of Automation in IoT

IoT-enabled automation provides several benefits to the business processes. Uptime has increased. The amount of time your company is open or operational is referred to as uptime. Employees arrive and depart at predetermined intervals, therefore the industry determination individual be exposed for a limited amount of hrs. Per day unless their shifts coincide. There are no time limits while your industry practices are automated, allowing you to operate seven days a week, 24 hours a day. Your employees would be able to focus on higher-level tasks rather than tedious, manual labor.

Automation can save time and money in factories when engineers repair defects in machinery or other equipment due to the fact that automated programming can identify the particular font of the defect and alert professionals consequently they can rapidly repair it and get everything endorsement and organization.

4.2. Sensors and Scanning Technologies

Automation and IoT add intelligence to supply chain and asset management. These aid businesses in supplementing existing technologies such as barcodes with passive radio-frequency identification (RFID) tags for cycle counting or a global positioning system (GPS) for fleet and equipment administration are also viable options.

The efficiency of agency constructions can also be improved by automating eco-friendly necessities are lighting, moisture regulation, and other elements. There is no need to configure the smart devices once the bots have learned the behaviors and interests of the employees in each part of the facility. Lights will only turn on if required, and the appropriate temperature will be determined by the setting, resulting in important electricity charge investments.

4.3. Improve Safety Enforcement

The Internet of Things (IoT) helps workplace safety in a variety of ways. If sensors are installed on several assets in the workplace, they will identify impending component flaws are detected and keep workers are notified, preventing employee harm caused by avoidable conditions. IoT and automation allow better enforcement for companies dealing with perishable goods, whether they are manufacturing or retailing, by ensuring that refrigerated food items do not surpass or fall below FDA temperature thresholds. They will assist in ensuring that consumers receive goods that are suitable for human

consumption, as well as allowing for prompt response to any issues that occur in order to avoid recalls. The Automation and Internet of Things combined solutions can provide manufacturing data to reduce the chances of equipment incidents and enhance efficiency in factories where they have already-automated machine maintenance and diagnostics.

4.4. Enhance Access Management

To power protection systems, IoT and automation will work together. An integrated solution will recognise authorised individuals and doors to high-risk places, such as bank vaults, should be opened and closed on a regular basis. The technologies may also be used to restrict or allow access to specific machinery. IoT and automation can help with enforcement, performance, protection, and other long-standing issues in this way.

4.5. Enhance Customer Insights

Sensors and beacons are ideal for retail businesses because they yield useful information about consumer behaviour and aid consumers in many ways, such as offering directions to locate items and helpful hints for looking things up.

4.6. The public Sector's Activities

Governments and service-related companies will benefit from IoT and automation in a variety of ways. In the public sector, IoT-enabled apps can assist with traffic control, city government, public safety, and resource management.

4.7. Advantages in Health Care

IoT devices could help doctors and emergency responders keep an eye on their patients from afar, particularly if they're in a risky position are showed in Figure 2 [15]. IoT systems can be implemented in medical managers maintain track of assets like hospital bed availability [25, 26].
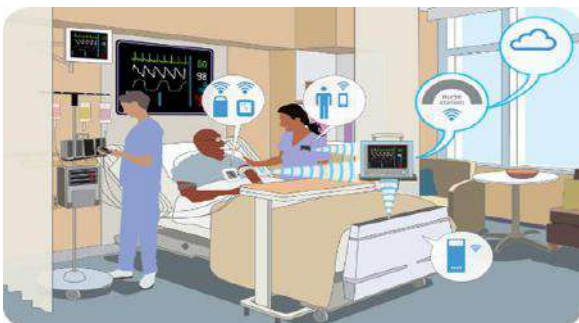
Fig. 2. IoT in Health Care

4.8. Agriculture's Advantages

Smart farming technologies may be used by farmers, particularly those with large-scale operations, to remotely monitor agricultural fields and manage irrigation systems are showed in Figure 3 [16]. Current stock holders may use apps for the Internet of Things that are wireless to get information about their cattle's health and well-being, such as when they're ill, to avoid disease spread, or when they're about to give birth, and where to look for them.

Fig. 3.IoT in Agriculture

4.9. Product Advantages

Automation and the Internet of Things have the potential to dramatically benefit consumers. Wearable are becoming more popular, ranging from smart watches and fitness trackers that help users better understand their health to smart speakers such as Google Home that make information simpler to get, set timers, and even play music. Smart refrigerators deliver low stock notifications, smart light bulbs make it seem when you're not home, smart plugs save energy and money, and smart thermostats keep the house warm till you return. These are simply iceberg tips in terms of possible IoT and automation applications.

Since the phrase "Internet of Things" was created in1999, there has been much debate about its possible influence on our personal and professional lives. From how we purchase and travel to how companies monitor and manage inventories to how farmers keep track of their animals, the Internet of Things has revolutionized our lives in many ways. It's moved from crazy concept to fundamental fact. The emergence of omnipresent computing, widespread usage of internet protocol (IP), and ongoing expansion in data analytics, among other reasons, all led to this. By 2020, Gartner expects 20.4 billion devices will link to the Internet of Things. Despite the advantages, it's still a rather baffling phrase.

4.10. IoT Effect on Automation

The Internet of Things encompasses anything from consumer electronics to factory-connected machinery to

industrial assets such as computers, robots, and staff in smart factories. It helps automation companies intensify operations and increase efficiency by bringing several improvements. For automation, IoT principles and technologies must be implemented. Its key purpose is to keep manufacturing inputs and outputs linked at all times. At the same time, the situation necessitates the interconnection of several complex and sophisticated devices. This means that supply chain monitoring and management, as well as the management of distributed teams, should be prioritized.

4.11. There is no Human Involvement

Up until recently, the primary goals of automation were to boost efficiency and lower costs. Owing to the decrease in human interaction, both goals have become achievable–machines run 24 hours a day and do not require holidays or benefits. The automation industry's emphasis has changed. It's used to improve product quality and versatility by making manufacturing processes more practical and safe for humans. Human-to-human and human-to-computer experiences can be reduced by IoT technology. This method not only lowers staffing costs, but it also eliminates potential vulnerabilities and errors. Connected devices are self-contained and use two types of hardware. The first is a sensor, and the second is a piece of equipment that converts an electrical impulse into a physical result. It's difficult to predict how the Internet of Things would affect industries and human involvement at various stages of manufacturing. Would artificial intelligence be able to fully replace humans? Now we can see that, in addition to a slew of advantages, IoT also carries with it a slew of problems that have yet to be resolved. Software Defined Networking with IoT will leads better resources management and mischievous node entry in IoT systems can be detected and moderated using SDN [6, 7, 8, 23, 24].

4.12. Prospects for Growth

IoT encompasses a wide range of innovations and services, combining them into a single, well-connected ecosystem. Blockchain, augmented reality, virtual reality, big data, cloud computing, machine learning, and more are all gathered under one roof as part of a larger image. The Internet of Things has evolved from a futuristic phenomenon to a regular part of our lives, infiltrating our cars and homes and even our clothing. By 2017, the demand for connected smart devices had grown to 7 billion people, accounting for the entire world's population. By 2020, there will be approximately 20.4 billion linked devices on the planet. In 13 years, that's more than $450 billion.

4.13. Smart Products Have a Wide Market

People are now more connected than ever before thanks to devices and data services. Owing to many fair barriers, the diffusion of technology across the world is uneven. Europe, Asia, and the United States are our flagman areas. However, even in communities with advanced technological infrastructure and a strong demand for smart services, risks such as security concerns remain, and many potential consumers are uncertain to fully adopt IoT.

V.   THE FUTURE HOME

While large companies and governments appear to be the primary users of IoT technologies, customers now have access to them as well. Smart watches, self-driving vehicles that are autonomous and smart homes are showed in Figure 4 [14]. A smart home is a grouping of wired devices that follow a set of laws. Some devices are pre-installed, while others can be added later. The most popular sensor types are optical, humidity, water quality, gas, image, noise, temperature, and motion detectors. A smartphone app can be used to connect to the network from a distance. The remote dashboard would connect devices and sensors, allowing all of the house's critical processes to be handled and monitored. For example, lighting can be changed according to the time of day and your preferences, a refrigerator can analyses its contents and submit shopping lists directly to a mobile device app, and a coffee machine can learn your schedule and prepare a latte when you wake up [11, 12].

Fig. 4. IoT in Home Appliances

Smart homes are now a reality in today's world, but they are not commonly used for a range of reasons. High costs and security risks, to name a few. Customers seem to find the expense of smart homes unjustifiable, despite the advantages of smart homes being appealing. Another source of concern among potential customers is security:

hacker attacks are still a possibility, as is the possibility of private information being stolen.

5.1. Industrial Automation and IoT Implementations

Smart innovations are also absorbed by industrial automation. As previously stated, the IoT aids in cost reduction, increased efficiency, and improved protection for both human employees and the company as a whole. However, the cost of IoT technology should not be overlooked. Adding "smartness" to a commodity always raises the price and introduces new layers of maintenance.

The standard linear product life cycle is what we're used to. It covers the stages of product development, design, and manufacturing, marketing, and aftermarket services. The issue is that when a customer buys a product, the manufacturer receives virtually no information about its use, such as whether the customer is satisfied or dissatisfied, and to what extent. Since consumer feedback is often written from extreme polar positions, there isn't much information to be gleaned from it. Furthermore, a favorable evaluation of one function yields no information about the customer's subsequent behavior, such as purchases.

5.2. IoT Five Drivers

The Internet of Things is a global phenomenon that has made its way into our homes. Let's look at the five areas that are propelling smart technology forward.

5.2.1. Safety is paramount.

The number of connected devices on the planet is now outnumbering the human population. As a result, the issue of protection becomes critical, as the potential for breaches is immense and could have disastrous consequences. It's important for IoT tech companies to pay careful attention to security issues during the early stages of product development. Since it is well understood that a chain is only as powerful as its weakest link, end-points of IoT solutions should be highly safe to reduce the risk of being hacked.

5.2.2. Intelligence in Data

A huge quantity of data is produced by billions of interconnected devices. That is why the types and quantities of data collected, as well as the methods for managing and processing it, should be established early in the product development process. Data intelligence differ from business intelligence in that it focuses on interpreting data rather than categorizing and presenting data. Analytical instruments are a critical component of any IoT solution. These are used to identify patterns, detect corrupted data, and introduce machine learning, among other things [20, 21, 22]. Smart innovations become enablers of urban living transformations, increasing quality of life to new heights. Smart technologies are now commonly used in many cities, but their full benefits are yet to be realized.

5.2.3. Collaborations in Company

IoT technology implementation provides a powerful impetus for new company partnerships. IoT tech companies encounter conventional manufacturing companies at a point of collaboration with promising results for both parties. Smart technology's widespread use and wide variety of applications allow both hardware and software to become increasingly complex and sophisticated. The critical aspect of protection should be considered by application developers; data security is a must. IoT technologies and services have rapidly and fundamentally changed human life, production, business practices, and attitudes toward everyday artefacts around the world. Professionals, officials, and the general public face difficulties in addition to the benefits.

VI.   CONCLUSION AND FUTURE SCOPE

It has been demonstrated that connecting simple appliances to the Internet of Things works adequately, and that the appliances can be controlled remotely via the internet. Not only does the developed gadget track sensor data like temperature, gas, light, and motion sensors, but it also initiates a mechanism based on the necessity. Switch on the light, for example, when it gets dark. It also saves the sensor parameters in real time to the cloud. The user will be able to examine the state of a range of criteria in the home at any time. Weather stations and energy monitoring can be added to the gadget. With the right adjustments, this type of equipment can be utilized in hospitals for disabled people, as well as in industries where human entry is impossible or dangerous, and for environmental monitoring.

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Relationship between Muscle Strength and Body Composition in Active Community Elderly

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Abstract— Demographic data, not only from Brazil, suggests a significant increase in the elderly population for the next decades. Based on this fact, interest in the body composition and strength of this population arises. This study is a quantitative cross-sectional study, originated from a primary project called "Programa Interdisciplinar de Atenção à Saúde do Idoso". Thus, data from the initial phase of this project were used for this descriptive correlational study in order to assess the relationship between muscle strength and body composition in elderly community members aged 60 years and over, participants in the "Programa Mexa-se" by Sports Department of Joinville/SC City Hall (PMJ). This research consisted of an evaluation form, containing personal identification, sociodemographic and clinical data, besides physical evaluation. The results of the analysis showed a significant correlation between the handgrip strength (HGS) and the total muscle mass index (r 0.637), strong correlation with total muscle mass (r 0.806) and a weak correlation (r 0.102) with the body mass index(BMI) and age (r -0.242). It is possible to conclude that HGS is related to the body composition, being an option for a better and more assertive assessment of the physical state and functional independence of the elderly. Finally, that is an accessible measure and could be used routinely in the physical evaluation of seniors.

I. INTRODUCTION

Worldwide, the elderly population has gained more visibility due to the decrease in the population's mortality level in relation to aging and associated pathologies. According to data presented by World Population Ageing (UNITED NATIONS, 2019) there were 703 million people aged 65 and over in the world in 2019. The projected number of elderly people will double to 1.5 billion in 2050. Globally, the participation of the population aged 65 years or older jumped from 6%, in

1990, to 9%, in 2019. The population profile willprobably change in the coming decades, as said by the UN (2019).

The Brazilian population has maintained ascension in the number of elderly individuals in recent years and has gained 4.8 million since 2012, surpassing the mark of 30.2 million in 2017, according to the "PesquisaNacionalporAmostra de Domicílios" (IBGE, 2018). In Santa Catarina, the number of elderly people, according to the "InstitutoBrasileiro de Geografia e Estatística" - IBGE (2018), reaches over a third of the population, with a considerable increase over the years, even in the midst of the COVID-19 pandemic. In the city of Joinville/SC, the elderly population aged 65 and over is close to 2% of the population and has been increasing (IBGE, 2018).

With the projection of an increase in the number of elderly people in the coming years, dated by the UN (2019), the search for quality of life has increased. Thus, conducts to prevent diseases associated with aging and improve muscle quality have been the target of studies. Therefore, it is expected some advances in the treatment of diseases that may affect the elderly, even the frailty syndrome of the elderly and the pathology that most afflicts them, the loss of muscle quality (sarcopenia).

The International Classification of Diseases ICD-10 (2019) classifies sarcopenia as an internationally recognized muscle disease with the diagnostic code M62.84. And as a disease, attention to the most affected public is needed with government assistance and more research on the topic.

Dos Santos Martins, 2012, observed that physical activities performed in the gym of the best age favor, in addition to physiological gain, increased strength and cardiopulmonary capacity, as well as improved flexibility in the elderly.

In carrying out a literature review, dos Anjos(2019) pointed out physical exercise as an ideal strategy against sarcopenia, in prevention or treatment. The studies reported in the screening showed that sarcopenic elderly people respond well to physical exercise and are able to improve mass, muscle strength and physical performance. Physical activity can prevent possible frailties improving functional and cognitive abilities (OLIVEIRA, 2020).

In view of these arguments, the aim of this study was to evaluate the relationship between muscle strength and body composition in community elderly.

II.   METHODS

TYPE OF RESEARCH

This is a prospective cross-sectional study with a one-year (12 months) segmentation. The sample was constituted in a non-probabilistic way of the intentional type.

The sample consisted of 88 elderly people aged ≥60 years old, 62women and 26 men, participants of the "ProgramaMexa-se" by Sports Department of Joinville/SC, composed of elderly people from the five main regions of the city (north, south, center, east and west). These elderly people practice the following physical activities: choreographed dance called "rhythms" and functional aerobic activities.

For its development, all ethical principles of research involving human beings were met, in accordance with the "Resolução do ConselhoNacional de Saúde" No. 466 of December 12, 2012, and the participants received the free and informed consent form in duplicate, one way to the participant and the other to the researcher.

RESEARCH AND COLLECTION INSTRUMENT

The project used as an instrument the functional assessment protocol developed by the authors, based on measurement instruments already validated and used internationally. It contemplated the most relevant aspects of the physical assessment. For this study, the following measurement data were used, detailed below.

Physical assessment; Anthropometric measurements: weight, height, Body Mass Index, Total Muscle Mass Index; for checking body composition; dynamometry for measuring HGS. Test with protocol according to the American Society of Hand Therapists (ASHT) considered simple, economical and verified, known as 'gold standard'. A portable device (dynamometer) is used for measurement (MIJNARENDS et al., 2013).

Data tabulation and analysis was performed using the GraphPad Prism 6® software, and descriptive statistics data such as means, standard deviations and confidence intervals were obtained. To test the normality of the data, the Shapiro-Wilk test was used. To verify the differences between the pre- and post-test measures over time, ANOVA for repeated measures was used, and Student's t test was used between each phase, with a significance level of 95% ($p < 0.05$). To verify the relationship between the study variables, the Pearson or Spearman Correlation Test (according to the classification of variables) was used, with a significance level of 95% ($p < 0.05$).

III.   RESULTS AND DISCUSSION

Community elderly aged ≥60 years old, who are part of a physical activity program of the PMJ, participated in 62 women and 26 men. Descriptive statistics of the variables controlled in the study are presented in tables 1 (women) and 2 (men).

Table 1. Descriptive statistics of the controlled variables in the study, women.

	AGE	BMI	MMT	IMMT	FPM
M	69.2	29.1	19.5	8.03	22.6
DP	6.0	4.8	3.3	1,2	5.1
Minimum	60.0	18.6	12.0	5.4	11.0
Maximum	90.0	44.6	27.8	11.7	32.5

Subtitle: Age years; BMI, Body Mass Index (kg/m2); MMT, Total Muscle Mass; IMMT, Total Muscle Mass Index (5.9 to 9.5 kg.m-2); FPM, handgrip strength (kgf).

Table 2. Descriptive statistics of the controlled variables in the study, men.

	AGE	BMI	MMT	IMMT	FPM
M	70.2	28.9	29.1	10.5	37.3
DP	5.3	3.7	3.8	1.0	8.8
Minimum	60.0	20.0	20.6	8.0	15.0
Maximum	80.0	35.0	39.4	12.6	57.0
Maximum	80.0	35.0	39.4	12.6	57.0

Subtitle: Age years; BMI, Body Mass Index (kg/m2); MMT, Total Muscle Mass; IMMT, Total Muscle Mass Index (5.9 to 9.5 kg.m-2); FPM, handgrip strength (kgf).

Table 3. Correlation analysis between HGS and body composition variables in the study

	AGE	BMI	MMT	IMMT
r	-0.242	0.102	0.806	0.637
P	0.023	0.343	0.000	0.000

Subtitle: Age years; BMI, Body Mass Index (kg/m2); MMT, Total Muscle Mass; IMMT, Total Muscle Mass Index (5.9 to 9.5 kg.m-2); FPM, handgrip strength (kgf).

It is observed that BMI and age do not present a strong correlation with HGS, however, even if weak, the correlation exists and points to a moderate degree on this variable. MMT and IMMT showed a strong, significant correlation with HGS. In this study thelevels in correlation of the strength of hand grip are high, when compared to total muscle mass, and index of muscular mass evidencing the importance to combine the two evaluation data to measure the profile of the elderly and indicate possibleweaknesses. According to data presented, HGS is a very relevant way of analyzing the functional profile of the elderly when combinedto the studied variables. Although, more assertive due to the high correlation profile between them, thus being an accessible measure to the body composition and functional quality of the elderly.

For the maintenance of muscle mass, studies point to strength training, as they promote an improvement in the levels of functional autonomy of active elderly people, even considering the practice of other modalities associated with the routine. (LIMA, 2020). Physical activity not only improves the physical condition but can also prevent possible weaknesses, as evidenced by Oliveira(2020).The author investigated the relationship of the duration and frequency of physical activity practice with the indicators of sarcopenia in the elderly, had as one of the main findings that with the higher level of physical activity of mild moderate intensity, there were less trends towards indicative of sarcopenia. Oliveira(2019), concludes, in his study about deficits in cognition and physical performance, thatphysically active elderly people have a greater chance of maintaining their cognitive functions during the aging process, and notably adequate levels of physical activity may be related to better cognitive function scores in elderly subjects.

Data show the benefits of HGS as a predictor of capacity functional and its importance to verify the muscle quality of the elderly when combined with other variables, as studied by Medeiros et al. (2016), evaluating the handgrip strength in community elderly, identified that there are no high significant differences in strength comparing the active and inactive groups. Concluding then that the handgrip test alone does not indicate signs of frailty in the elderly and/or lack of muscle quality.

Mendes (2016) in an investigative study on the prevalence of sarcopenia in a group of sedentary elderly and its relationship with physical strength, identified a high number of sarcopenic elderly, these being sedentary with an association of loss of muscle mass associated with loss of muscle strength in both sexes.

Pereira(2015) when evaluating the relationship between body composition and handgrip strength of 46 elderly Brazilian men, found that the levels of handgrip strength depend not only on lean mass, but also on adipose tissue, and also noticed that the correlation between lean

mass and fat percentage may indicate an improvement or worsening in performing the isometric handgrip effort.

Nascimento(2019) in an observational, analytical study with a sampling of women aged between 40 and 80 years found that changes in body composition during female aging are associated with decrease muscle mass and a drop in physical performance in middle-aged and elderly women. Given the importance of the findings on the subject and due to the beneficial impact that the practice of physical activities can have on body composition and, consequently, on the life quality of the elderly, it is important to carry out further studies in the area.

IV.   FINAL CONSIDERATIONS

The data obtained in this study showed the relationship between HGS and body composition of community elderly, which are important variables for a more assertive physical assessment of this population. As well as adequate guidance for the proposed activities taking into account the physical and functional independence. Emphasizing the importance of physical activities, even if moderate, as a factor to prevent frailties.

The main limitations of the study are the small number of participants, and the exclusion of non-physical variables, which, although they were evaluated, were only considered in the screening of participants.

The benefit of strength assessment through dynamometry associated with the IMMT is also highlighted, as both are accessible and can be used frequently by the target audience of this study. It is considered the importance of understanding the measures to better control the health of the elderly.

With the findings of this study will be possible, from the measurement of FPM, identify changes in skills, according to gender, promoting subsidies so that physical educators and other health professionals can intervene in physical exercise programs, so that the elderly improve these skills and body composition.

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Analysis of a structural masonry building system in low-income housing

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Abstract— Engineering, as well as society, has evolved side by side over the years, but the economy in our country has not entered the same axis, leaving millions of unemployed people, and with low income. Soon with high rent values, many of these people end up being evicted, or just surviving, and not living. It was there that Engineering, together with the State, aligned ideas that would bring housing accessibility to low-income people, on the one hand, Engineering creating a constructive system with very low operating costs, bringing convenience and security to future residents, and the other the State financing part of this operation. In this present work, we will analyze how this structural masonry construction system works in a popular housing in My House My Life, in our city, Manaus, showing how it positively impacted society to have a place that it can call home.

I. INTRODUCTION

Evolution, whatever the area, depends on motivations, or needs needs. In the case of Civil Engineering, it advances as society gives indications that it needs improvement.

Analyzing the problem of the housing deficit in the country, which is 7.757 million homes, according to a study released by the Getúlio Vargas Foundation

(FGV) in 2018[1], the evolution would have to come in some way, and based on this study and so many others.

As the last few years, we have read news and managed information that the state of our economy is worrying, and there has been a huge unemployment rate in our society at large. This has directly affected the way everyone lives because people work for a

living, but nowadays, this concept is another, one

works to survive.

Having this thought, engineering together with the State, organized an action plan to help such low-income people to have a decent housing, with security that is crucial in the situation that we all live today, and accessibility in obtaining it. With this was created by the Federal Government in 2009 the Program My House My Life (MCMV), where popular housing is built that allow people with low income, to have their home, to call home.

Fig. 1: Typology of a popular housing Smart Tree - Manaus.

Fig. 2: Popular housing Smart View of the Sun - Manaus.

To reach this accessibility to all, had to be planned a whole project behind, from the purchase of land by the developer, to the marketing that would be made of the enterprise, but where I want to get, is that one of the main factors of all this, comes from a base for every engineer who aims for success: a work with low production cost and a shorter execution time. And this low cost aligned with a reduction in time,vieram of minute calculations, from the concreting of the radier to the size of the concrete block that will be used. However, it is worth noting, that always considering, in this case, the NBR 15.575/2013[2] of ABNT, in relation to items such as structural safety, thermal and acoustic performance, fire resistance, watertightness, durability and maintainability and have less environmental impact, with their minimum values required.

This work will analyze the line of reasoning for the execution of a qualified and efficient project, going back a little and discovering how this whole concept of structural masonry began, which is so implemented nowadays, and which has become a formula of success and guarantee of life for many families who previously did not have adequate housing conditions. We alsocontemplate the particularities of this construction system, in which we will present it, pointing out the advantages and disadvantages of structural masonry, also addressing the positive and negative impacts, socioeconomically, caused by the construction of such popular dwellings.

II. METHODOLOGY

Brazil today and in the past has always had as a great psychosocial villain the discrepancy that are the socioeconomic classes, and as most consumers, are those of the lower classes, there is more demand for housing to this population group. The choice of the construction system to be evaluated had as its basic premise the great need that is the construction of these houses in our national territory, so that in addition to a better housing condition having low cost of acquisition, by this vast group of consumers, being able in itself to solve this saturation relative to population density

to which we are currently, with a large number of people without minimum housing conditions, and with estimates that over time, population growth will be even higher.

Thus, we will use the parameters created by SINAT (National Technical Evaluation System) of PBQP-H(Brazilian Habitat Quality and Productivity Program) to determine the technologies that will be analyzed.

SINAT [3] is also responsible for validating the DATec (Technical Evaluation Document) of construction systems, but for this research they will not be evaluated. For the analysis of the construction system, we will use as a basis a type of plan for a multifamily residence.

For this project, as I had direct experience in the subject that incorporates the theme of this article, working at Morar Mais Empreendimentos Imobiliários Ltda, where I had extreme participation, from the process of creating enterprises, through studies of feasibility of land, analysis of preliminary projects and executive projects of it, and in the monitoring of the works of the program Minha Casa Minha Vida (MCMV) for which this company I worked.

The data collected went through exploratory research, where information had been collected due to my time inserted in the company, in which I could also due to the constant field visits to analyze descriptively and qualitatively about the construction process of these popular dwellings.

 The various field visits to which he had made, helped much in the database and in the questions, I had at the time, thus being able to ask countless questions to my technical superiors. Also participating in many technical meetings, regarding the quality system, which in this case, the Performance Standard NBR 15.575, which deals with the performance of housing buildings and indispensable characteristics of a work for the consumer, with the objective of pusing comfort, accessibility, hygiene, stability, construction life, structural and fire safety. All this was the basis for the results and discussions to which I will later portray.

III. RESULTS AND DISCUSSIONS

3.1. INTRODUCTION OF RESULTS AND DISCUSSIONS The Construction System is based on how the project, whether residential, commercial, mixed, housing, or any other sector, will be carried out. There are several forms and methods of constructive models, but depending on the type of finish that will be used, for which socioeconomic sector will be destined, for what purpose it will be carried out, such types of systems are organized for a better cost-benefit, presenting their advantages and disadvantages.

As learned through the Engineering course, we had several subjects related to the construction system, and all almost always direct to a common denominator, which is cost-benefit. We know that engineering, the main focus is, to have a fast productivity, in a short interval of time, all this to generate less expense, to obtain higher revenue, but always respecting the determinations and standards that pbqp-h (Brazilian Program of Quality and Productivity of Habitat) assures the consumer who will reside such housing.

Through several studies of structural calculations, they concluded that the most well-known system today by developers throughout the country, is structural masonry, because, in addition to being more economical due to the low cost of material in function of the time that the manpower will take to lift it, it still brings security to those who reside.

In order to understand a little better how this system so old and so current at the same time, has become so popular in the midst of construction, not only for the popular housing segment, we will go back a little bit and talk about how it all began.

3.2. UNDERSTANDING ITS HISTORY Structural masonry, although the name may seem so modern and current, it is much older than we imagined, coming from and at the time of our friends men of Neanderthals, Prehistory.

The first masonry to which it was known, due to the lack of rationalization in the calculations, and the knowledge of the resistance of the materials that were used, stone or ceramic brick dry in the sun, presented great thicknesses in their works with greater magnitude, and so it was carried for many, many years.

Over time, several other types of materials were being inserted, progressing along with the evolutionary process to which it had passed, and until the beginning of our century, the constructions in stone masonry, or burnt ceramic brick, settled with clay, bitumen and later with lime mortars, pozzolan, until finally reaching portland cement.

In colonial Brazil, the use of these structural masonry was made through stones, raw clay bricks and pestle mud, a technique called ground mud was used. With the advances in the Empire, instead of raw clay bricks, the clay brick cooked from 1850 was implemented, and seeing that these materials and the new technique that was being used were being very favorable against some problems they faced, such as the lack of resistance to the action of the waters, and the spans that could not have greater lengths, eventually buried the technique of the dirt mud.

At the end of the 19th century, structural masonry saw powerful construction systems inserted in our environment, the so modern structures of iron and reinforced concrete,

which were quite modern and used in Europe, were gaining their spaces in Brazilian soils.

With the arrival of new methods, the construction system in structural masonry was forced to evolve together, as early as the 1960s, the structural masonry of hollow blocks of concrete is introduced in Brazil, for buildings on up to four floors, with technologies and procedures based on American techniques. From then on, in the State of São Paulo, where reinforced concrete structures and iron structures were commonly used, again the masonry structuring was insating, and resuming its prominent place.

The evolution was in constancy, so performance standards were created for calculation, execution and control of work, for the entire Brazilian territory, where the dissemination of this construction system was wanted to the Federation Units.

In the passing of the centuries, various forms, means of construction, which were implemented, used in civil construction. In order to reduce the great problem that had occurred in the country, which was the housing deficit, it was seen that the most practical way, which fit with the Brazilian method of building, taking into account both the labor force and the possibilities of rationing costs. The union of several factors such as speed, safety, cost savings and especially the safety to which it presented, caused structural masonry to be introduced once and for all in popular works as high standards.

Nowadays, this construction system remains efficient, but in need of technological advances, although we have groups of researchers in constant study for this, so much so that it is present in the bars of our universities today, so that someone can come and arrive with another innovative idea, to put an end, help society to have a decent housing, with accessibility and security.

3.3. BASIC CONCEPTIONS

3.3.1 - MASONRY

It is a structural system composed of rigid and congruent bricks or blocks. Possessing several constructive methods, but that is carried out from the union of blocks and mortar.

3.3.2 - STRUCTURAL MASONRY

It is the entire structure in masonry, having been previously sized with rational calculation procedures for load support in addition to

its own weight. It is confused with the construction process itself, when we verify its two functions that its basic elements perform in the buildings, that is, sealing and resistance to masonry can be dismembered in two segments, depending on the reinforcements.

3.3.2.1 – STRUCTURAL MASONRY NOT ARMED

when it does not have armor or having them for construction or mooring purposes, not taking into account the efforts and loads that will fall on it. However, this type of structure is very important, due to the fact of avoiding cracks, resulting from efforts in masonry, since they do not absorb impact, leaves the masonry in more dubious comes out, besides participating positively in the safety of loads not previously predicted.

3.2.2.2 – ARMED STRUCTURAL MASONRY that has, in this case, the intention of absorbing the previously calculated efforts, its insertion is by the leaks of the blocks or between bricks, involved by graute.

3.3 – MATERIALS are the raw material used for the manufacture of the main component to assist in the services of civil constructions, in the case of structural masonry, will be made by cement, lime, sand, clay, gravel, and compounds in the freshstate: mortar and graute. Besides steel that helps in what is important material in composition.

4 – ADVANTAGES OF STRUCTURAL MASONRY we know that time in engineering is crucial, especially in the economic part, so when building with ceramic blocks or concrete blocks, making the structural function of the building, we have a large reduction in the consumption of wood, steel and concrete shapes. Thus, a faster and cheaper work, which provides the consumer who will acquire, more accessibility as to values, because one is in function of the other.[4]

Fig. 3: Infrastructure Phase, presenting the typology of the plant, Popular Housing Smart View of the Sun - Manaus.

Fig. 4: Suprastructure Phase, Popular Housing Smart View of the Sun - Manaus.

5 – DISADVANTAGES OF STRUCTURAL MASONRY what we can analyze from cause a certain limitation in constructions that use structural masonry, is the restriction regarding changing the typology of the place, and its architecture, because, as blocks were used, whether ceramic or concrete, they do not actually function as sealing blocks, but rather as the structure itself, serving exclusively for the structural function, therefore, by NBR 15.575 and the Customer Manual that is required by PBQP-H[5], in which it presents certain orientations that future residents should be careful, such as: do not drill through the walls that have a structural function, for insertion of network points, or allocation of equipment that exerts burden on it, due to all these walls have already been previously calculated to perform exclusively structural function.

6 – SOCIOECONOMIC IMPACTS Safter reading an interview by Inês da Silva Magalhães, Former Minister of Government Cities (2016) [6], which addresses us on the socioeconomic theme of the My House My Life program, which makes us think that not only the physical intervention itself, is synonymous with that the whole problem of the housing deficit will be solved, with the experiences told by it, we can observe some important points. How could a family, who for a lifetime reside in a precarious place that has never had basic sanitation, or access to leisure and or some social activity, could simply change locations and already change their lives with it? Thus it makesus think that, not only do we need to have aphysical project, one needs to work together with these families, policies of insertion in their new life, let's say, because it will have to bear new economic aspects, such as the rates that every residence must bear, such as: electricity bills, water bills and the portions of their new residence.

Another important point regarding these impacts is that, as much as this housing policy is, sometimes some regions do not behave as expected, because the entire economy of the locality tends to change, and moreover, since more people will move to these areas, the greater the supply, thus

often increasing materials and services from such regions.

7 – The CONSTRUCTION SYSTEM AND ITS RESULTS Structural masonry, within the masonry, is an important system, which is in the technical environment, and is increasingly being inserted, still lacks much insertion of this knowledge within universities, as we have with reinforced concrete, steel, wood, insert disciplines related to structural masonry for both design and sizing. Within the scenario of Housing of Social Interest, that there was this outbreak of housing in Brazil, which was accompanied by a growth, a need for expansion of Civil Construction, so masonry became one of the most used techniques, because it manages to marry technical, technological aspects, performance issues as a whole, since designed, a project thought, elaborated, from the design of the architectural project to the roofing system, we have a constructive system, idealized, according to the premises and technical idealizations.

According to Architect Siegbert Zanettini [7] who addressed construction, who said that it is a delayed industry, which has missed many opportunities and continues to lose them. From this sentence we can imagine, that we often wonder what is the best constructive system for such building, what is there of know-how within a company that will provide, establish and meet all performance criteria, which are the broadest possible, within the conception, of durability, of safety,so there are several elements that are to be thought of withinthe composition of the project, and civil construction,often works on a level ofempiricism, that is, it is often worked with lack of design, with lack of detail, without thinking about the compatibilizations, which today, it is not feasible to elaborate a structure, or think of a structure, and then make several tears in structures and structural elements where one should not.

7.1 – STRUCTURAL MASONRY PROJECT CHARACTERISTICS In the architectural design one should consider the positioning of the gateways and the sealing walls, in the typology of the slab, in the necessary technical spaces, in the prediction of the expansion joints. In the case of popular housing, in its draft approval with the agency, we must always respect all the basic rules, thereare several, I can mention some: such as the removal of 30 meters for the Permanent Protection Areas (APP), have sewage treatment station project, but as we are talking about the construction system itself of the building itself, all material, all uneven that is allocated in determining environment, is previously calculated, because everything generates loads, and we know that what holds the building, are the walls themselves that make the structural function of the whole, so the ceramic or concrete blocks, should not be less than 9cm, this being the limit , because the

recommended is 10cm, among many others that ABNT NBR 15.575:2013 - Performance of housing buildings requests.

7.2 – FUNCTIONS AND PROPERTIES OF COMPONENTS (BLOCKS, MORTARS AND GRAUTES) have aspects that should be thought of, such as the choices of materials, such as a laying block, in which they are leaked with a double central septum, which is twice the thickness of the ceramic block plus the thickness of the joint, precisely for the second squeezing, onwards, to have where to lean, not staying in the void and not causing problems of acoustic and thermal performance. If the wall has openings the flow of forces passes through the stretches between these openings. If the wall has no openings, the flow of forces takes place along the wall.

If I have a concrete block instead of a ceramic block, I have a much smaller area of contact, that is, different from the solid brick, where there is a contact area, that is, being able to work with a slightly smaller mortar resistance range, it is not usually measured area content incorporated in the mortars, but this is fundamental because it is often replaced by lime, if using air-incorporater additive, and with it, we have bubbles, facilitating the deformation of the joint and the crushing of the joint.

A badly dosed graute, loosens from the wall, so the consistency of the mixture must have cohesion and fluidity, sufficient to fill all the holes of the blocks, its retraction should also not lead to the separation between the graute and the internal walls of the blocks and its compressive strength of the graute, the mechanical properties of the blocks and mortar , will define the characteristics to the compression of the masonry.

Fig. 5: Single-country houses My House My Life, Popular housing Vila Smart Campo Belo - Iranduba, Amazonas.

Fig. 6: Houses in structural masonry, Vila Smart Campo Belo, Iranduba, Amazonas.

Fig. 6: Details of the construction system in structural masonry, Vila Smart Campo Belo, Iranduba, Amazonas.

8 - NBR 15.575 The NBR 15575 Performance Standard has arrived to modify our concepts of design and construction of our buildings. The main point of this standard is that it is not a prescriptive standard, which fixes type and quality of materials, minimum thicknesses, among other things.

The NBR 15,575 sets the minimum parameters for the overall performance of the building, without saying how to achieve it. In general, it divides the needs to be achieved, such as: safety, habituality and sustainability. Compliance with all items of NBR 15,961 and 15,812 already guarantee structural requirements, stresses and deformations, and the minimum service life of 50 years.

Fire safety will also depend on wall coverings to meet the requirements of stability, watertightness (fireproof) and thermal insulation (fire extinguisher).

Acoustic performance must be achieved in different classes of external noise. The noisier the outside, the higher the requirement for the walls. This value also varies depending on the type of environment, being more rigorous for dormitories than for the rooms.

IV. CONCLUSION

The popular housing stems from society, and construction has shown that it is a very important presence in people's lives, because from it, we can draw up plans that are beneficial for everyone, both in the economic part for construction companies, and for the accessibility of the construction company to deliver to people who have a precarious housing condition , a comfortable home, safely, with more than minimal conditions for habituality and sustainability. We can know through analyses and experiences of our own, how the My House My Life Program works, created together with the Government to try in a certain way, to alleviate the problem of the housing deficit, which reaches to this day a large population of Brazilian soil. However, with this measure, it was noted that there was rather a considerable advance in our country.

We also saw how is the process of this construction system called structural masonry, where we can know the necessary materials that compose it, its advantages and disadvantages when deciding whether or not to really make necessary the construction in structural masonry or reinforced concrete, but as we have seen, for this type of housing of social interest , certainly the structural masonry is outperformed due to the great rationalization of activities, the less costly labor, the non-use of forms, in short, is much more economically viable, also having its execution time and smaller delivery.

I believe that if we invest more in our universities in studies, adding to the researchers we already have in our country, in the future civil construction can add much more with its technological advances, and discovering new ways to build with safety, habituality and sustainability even greater than the conditions we have today.

Science allows us to dream, it is a straight path, where the end, we can not see.

them and for their disciplines, especially my advisor Professor Walzenira Parente Miranda, to whom she has always had a patience and zeal for me, I am very grateful to have her as a mentor. Only those who know what I lived in universities, to understand the moment I am going through when writing this article, were years of struggle, study, of two faculties, of frustrations, until I reach this moment that I end a phase of my life, and i start one with joys and joys. Thank you, everyone.

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The Importance of Waterproofing Structural Parts of a Building

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Abstract— A research is presented using information from articles, books, technical manuals dealing with the importance of waterproofing on the structural parts of a building. The research seeks to understand which methods are used for its application, which are the most common problems and mainly the causes. In order to elucidate the matter, a study was first carried out on the standard that regulates waterproofing in structures, as well as its importance, and the main processes to be used to solve the problems encountered. There was a lack of waterproofing projects and plans in the work, which consequently generate more costs at the end of the work due to its misuse or even its lack, as well as the types of moisture that affect the structures and which procedures to be taken in the beams baldrames and slabs, important structures of a building. The number of pathologies related to water infiltration found in buildings is relevant and this brings great concerns for the future, as in a world that is constantly evolving in civil construction, it is absurd to have to see such an important step being relegated by responsible professionals. Its use must be precise and safe, as well as it must be accompanied by a qualified professional in the area, as the subject requires knowledge for the success of its application.

I. INTRODUCTION

The waterproofing of the structural parts of a building is of great importance for a project, because from this care, builders, architects, waterproofers, engineers and designers avoid exposing the structures to aggressive agents present in the atmosphere and weathering, providing a useful life larger [1].

It was found that the lack of attention to this process has caused pathology problems such as degradation of concrete, mortar and especially the corrosion of reinforcement, something of concern, as in addition to putting structures at risk, companies suffer from high maintenance values and recovery. It is important to point out that the damages also directly affect your credibility with the consumer, your company name and not least your image.

According to NBR 9575 of the 2010 [2], waterproofing can be considered as a set of operations and construction techniques, called services, which are composed of one or more layers, with the purpose of protecting constructions against the harmful action of fluids, vapors and moisture, that is, in addition to being important and provided for in a regulatory standard, its application in structural parts is essential, providing more safety and economy.

The purpose of the study is to show the importance of waterproofing, and to indicate that this process is not just a matter of compliance with a technical standard, but the performance of techniques that can represent improvements in project planning and execution, in addition to minimizing costs, considering the different types of waterproofing agents and the cost-benefit ratio.

II. MATERIAL AND METHODS

This work was described through an exploratory research, based on theoretical information collected in technical norms and instructions established by Brazilian legislation, as well as bibliographical reviews and articles.

The stage started by searching for information that would help in the work to be developed, using books, articles, technical manuals, magazines and materials available on the internet.

The research is classified as qualitative, considering that its meaning and process are the main focus of the approach and that, [3] write the interpretation by the researcher with his opinions on the phenomenon under study is important, is also exploratory, considering that bibliographic research was carried out on the subject, addressing its techniques, standards and applications.

An analysis of the process of waterproofing structures was considered, seeking to characterize the importance and demonstrate the benefits of this technique used in civil construction, to increase the life of the structure, reducing maintenance costs and possible pathologies, by exposing structures without this treatment.

III. RESULTS AND DISCUSSIONS

The process of waterproofing a structure aims to avoid the influence of water, responsible for triggering pathological problems. It is noteworthy that there is no "half" waterproofing or a simple waterproofing, as poor execution results in wasted money and time and, in the future, serious inconvenience with maintenance and recovery.

The purpose of waterproofing is to prevent the unwanted infiltration of water, fluids and vapors, which can drain or contain them. It was found that the waterproofing step has not received its due importance by engineers, architects, designers, waterproofers and builders, resulting in the triggering of various pathologies. The importance of waterproofing is linked to containing the processes of deterioration and degradation, since a large part of the materials that make up civil construction suffer from water and the presence of aggressive means in the atmosphere.

According to [1] water indirectly and directly is one of the biggest causes of pathologies due to the presence of moisture, where it divides them into infiltration moisture, rising damp, condensation damp, construction damp and Accidental moisture. The first one, Infiltration moisture that occurs when water mainly from rain passes from the external area to the internal area, occurring mainly in wall planes and in doors or windows. Ascending humidity is characterized by the presence of water that comes from the ground and its presence is mainly noticed on walls and floors. Humidity by condensation appears when there is great humidity in the air and with surfaces that are below the temperature corresponding to the dew point, this element does not usually reach great depths of the elements. The dampness of the work usually occurs during its execution and ends up externalizing as a result of the balance that is established between material and environment. Last but not least we have Accidental Moisture which is caused by failures in piping systems such as sewage, drinking water and rainwater. Therefore, there are clear studies that water can influence structures in various ways.

In the [2] for a good waterproofing performance there are levels of projects to be followed: Basic Design and Executive Design.

The Basic Project aims to define areas to be waterproofed, define which viable system to be used, quantitative survey, performance study and cost estimation, it is noteworthy that the project must be executed together with the construction projects, such as structural, hydraulic-sanitary, architectural and others, as well as being executed by the same designer or responsible company, and this is fundamental, because according to [4] most of the designers develop complementary projects, and when they receive the plants with waterproofing indications can verify important interferences that the sooner they are verified, the smaller the error probabilities.

The Executive project goes deeper into constructive, specific and generic details that bring a waterproofing solution, however another important process within the project is the creation of descriptive memorials of materials, execution procedures and spreadsheets with quantities of materials and services. It is important to emphasize that the project must be ready in advance of the foundation's execution, that is, the advance must be prioritized to reduce the chances of problems with infiltrations (Figure 1).
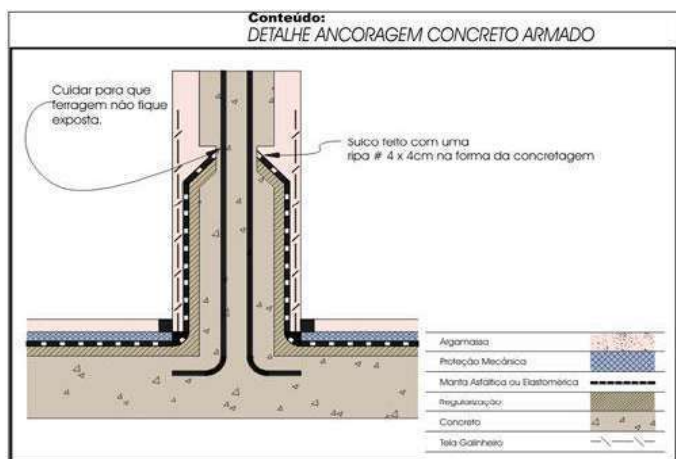
Fig.1: Detail Reinforced Concrete Anchor with waterproofing.

Source:[5]

Having a waterproofing project and planning is not just a matter of complying with a technical standard [2], but a matter of greater safety and economy, as well as a greater possibility of good execution, planning and inspection. According [4] it is not ideal to think that a single waterproofing method can have adequate functionalities for any type of work, it is understood then that each work is a different case and each different case is an adequate method, es a importance of a waterproofing project and planning (Figure 2).

Fig.2: Waterproofed Baldrame Beam.

Source: [6]

The application of a waterproofing layer on structural parts, especially on the baldrame beam, which is in direct contact with the soil (Figure 2), where it has high humidity. [7] corroborates by emphasizing that places in areas that have a humid climate with a high rate of precipitation can be harmful to the conservation of buildings, and this can be caused by the action of water that deteriorates the materials, caused by weathering,

which causes both physical and chemical wear, bringing serious problems with regard to corrosion of the hardware, putting all construction structures at risk.

Exposed slabs must be as important care as beam beams or any other structure, and because of their exposure, they need adequate treatment, such as applying an asphalt blanket, which according to [8] are uniform materials and easy to apply, becoming one of the most adopted systems in waterproofing works. However, there are cases where infiltrations still occur, explained by the lack of qualified professionals in the area, not putting into practice the correct execution. From this research, some pathological manifestations found in the buildings are highlighted, which need a better analyzed treatment, leading to discussions about possible ways to solve situations found in these places, in addition to the measures to be taken (Figure 3).

Fig.3: Waterproofing of exposed slab.

Source: [9]

There are several types of pathologies that can appear in constructions, referring to the lack of waterproofing, among them we have the manifestations caused by water infiltration, which according to [10] cause corrosion of reinforcement, concrete carbonation and efflorescence. Realizing that the biggest cause of problems in structures is water. Therefore, the importance of using waterproofing agents arises, a product so important that even so, it is often not used in construction works or even neglected by many professionals in the field of Civil Construction (Figure 4).

Fig.4: Pathologies arising from lack of waterproofing.

Source: [11]

To choose a waterproofing product, its cost-benefit must be taken into account, as there are several types of waterproofing products from different application methods and origins, and for an excellent result, the need for a preliminary study is very important. Implementing waterproofing in a building represents around 1 to 3% of the total cost of the work, as shown in Figure 5.
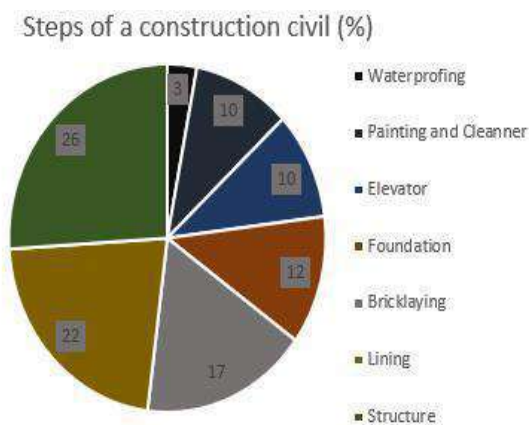
Fig.5: Description for steps a civil construction (%)

Source: Adapted [12].

[1] cited it is economical and easy to perform the waterproofing during the work, because from the moment that problems with moisture arise after the work is completed, the costs become higher, because all the complementary materials, such as ceramic floors and mortar end up being lost, that is, in addition to structural damage, there are damages with complementary materials. Costs for faults in the waterproofing system can generate re-watering costs of 5 to 10% of the total value of the work, therefore, it is cheaper to plan and design waterproofing systems.

It was observed that having planning and control, as well as monitoring by a professional specialized in the area along with the waterproofing process are essential factors and that for a successful success can never be neglected, as well as the study before the execution of the work, as This allows us to save on expenses, which can reach 15 times more than the expenses with the application of the product or waterproofing layer. Therefore, aiming at economy, comfort and safety, it is necessary to apply waterproofing to the structures.

IV. CONCLUSION

It was observed in this work that waterproofing is a critical point for the success of a construction and that the vast majority of related problems are related to the action on structures of different types of moisture.

There are many techniques, waterproofing materials and professionals, but many of these professionals are not adapted to this subject or many of them are neglecting the correct application, it is known that the cost of waterproofing is much lower, compared to the cost of re-watering, which it provides various problems in general.

Finally, waterproofing is part of the construction system of a work and for solutions to pathologies found, an in-depth study should be carried out for better results, thus providing success in the work.

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Pluviometric behavior of the city of Porto Velho –RO, Brazil

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Abstract— *Understanding the pluviometric variability of a region is necessary to analyze the existing climatological behaviors. The municipality of Porto Velho has a seasonality with high rainfall rate, which occurs at certain times of the year, but in recent years, the region has undergone climate change, which directly interfere in its hydrological cycle. This event is relate to the natural climate actions coming from the Pacific Ocean, but these events can be accelerated or modified due to anthropic actions that encompass land use and high rate of greenhouse gas emissions. Therefore, the present article aims to analyze and understand rainfall variables from 1961 to 2015, through data obtained from the National Water Agency database of the Hidrometereological station of Porto Velho – RO. When analyzing these data, it was possible to identify that the months with the highest precipitation rate are December, January, February March and April, as well as it was possible to identify that the annual average precipitation rate was 1736 mm, and that the biennium periods had influences of the El Niño and La Niña phenomena regarding their pluviometric volumes. It was also possible to observe that the region of studies present two well-defined seasons, one rainy and one dry, so the present study was able to observe the pluviometric behavior existing in the region during these 54 years.*

I. INTRODUCTION

The environmental impact caused by the numerous anomalies related to climatological variables has brought numerous disorder to regional extensions. The United Nation's DESA study about the exposure of cities to natural disaster, have found that, although cities located in developing countries have lower risk of exposure to economic losses from natural disaster, these cities have more probability of being in areas worst hit by climatological anomalies (United Nations, 2018).

One of the most important meteorological parameters for the characterization of the climate of a territory is the analysis of pluviometric precipitation (Franca, 2012).

Therefore, the study of the behaviors of the time variables of a locality becomes essential for the planning of socioeconomic activities, such as agriculture, urban planning, transportation, hydrological applications, among others (Santos Neto et al. 2014).

The pluviometric event that occurs in the state of Rondônia occurs due to the meteorological mechanisms present in the Amazon region. Such mechanisms occur due to the high rate of evapotranspiration from the forest and the convergence of humidity present in the Atlantic Ocean (Santos Neto et al. 2014). The extension of the Amazon basin has in its great part a pluviometric volume that varies from 2300 mm / year to 5000 mm / year depending on the region of the basin, this high pluviometric volume comes

from the convective rains, which are frequent in tropical regions. (Franca, 2015)

The city of Porto Velho located in the state of Rondônia has a rainy tropical climate, but has a well-defined dry period where it has a considerable water shortage. Therefore, the region has two seasons, a drought and a rainy season. The high rate of pluviometric precipitation during the rainy season contributes to the dimensioning of water projects, as shown by a study by Bezerra et al. (2010). Although the study region presented a very relevant pluviometric volume between the first and last months of the year, recently it suffered a great influence of drought between the years of 2005 to 2010, which caused numerous problems related to air quality and water supply to the population (Franca, 2012).

According to Silva et. al. (2015), the study of the climatic conditions of a geographic territory is necessary to understand the existing climatic factors, when analyzing such factors can be encountered with anomalies existing in that region, such as high rainfall, frosts, severe droughts, high-speed winds, among others. Therefore, this article presents an analysis of the rainfall variability in the municipality of Porto Velho from 1961 to 2015.

II.   METHODOLOGY

Porto Velho is a Brazilian city capital of the state of Rondônia, located in the western part of the Northern Region of Brazil (08°45'43"S and 63°54'14"O) in the area covered by the Western Amazon in the South-Amazon Plateau. Situated on the east bank of the Madeira River, the city has a territorial area of 34,082 km² with 85.2 m in relation to sea level. The climate of the region is super humid tropical, of transition between semi-humid climate of the Midwest region and the predominant equatorial in the North Region. It is characterize with high temperatures, but still provided with enough humidity, with a dry season that lasts about three months, between July and August. The average annual temperature is 25°C and September is the hottest month. For the pluviometric characterization, the data available in the database of accumulated daily precipitations was use by the National Water Agency of the hydrometeorological station of Porto Velho-RO in the periods from 1961 to 2015.

The data available in this database were group into daily, monthly, maximum, minimum and average precipitation, and as a complementary analysis, accumulated rainfall, standard error of the mean and standard deviation of total monthly precipitation were calculated.

The calculations and criteria for selecting pluviometric intervals and analyses were adopt according to the methodology described in Costa et al. (2013) and Carneiro et. al. (2013).

III.   RESULTS AND DISCUSSION

By analyzing the accumulated monthly precipitations, one can study how the behavior of rainfall from one month to the next in a given region can quantify how much is varying it. Fig. 1 demonstrates that the rainiest months during the series analyzed were January (513 mm – 1972, 549 mm - 1983, 529 mm – 2006), February (478 mm – 1973, 489 mm – 1983, 467 mm – 2009), March (450 mm – 1970, 438 mm – 1983, 426 mm – 2009), April (417 mm – 1970, 488 mm – 2006), December (471 mm – 1978) where it precipitated up 400 mm.
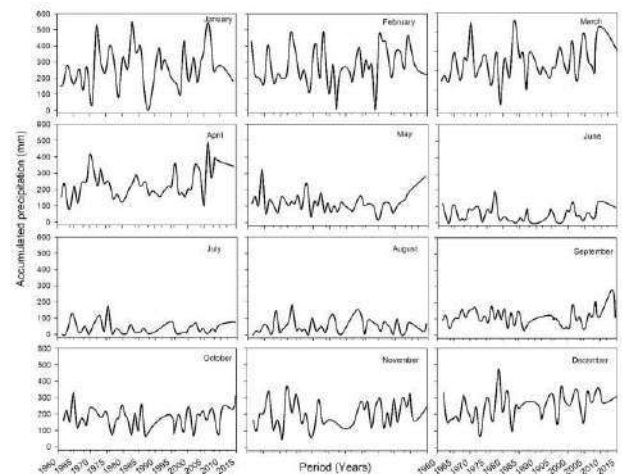
Fig. 1: Accumulated precipitation of the municipality of Porto Velho-RO, between the periods from 1961 to 2015.

The months in which the intermediate precipitations contained between 300 mm and 350 mm occurred were May (325 mm – 1964), October (333 mm – 1964, 309 mm - 2013) and November (327 mm - 1996, 339 mm - 1971, 328 mm - 2009) as shown in Fig. 1, demonstrating a variation from one month to the next. The lowest precipitation occurred in June (191 mm - 1977, 129 mm - 2009), July (178 mm - 1975, 128 mm - 1964), August (184 mm -1973, 155 mm - 1993) and September (189 mm - 2001, 207 mm - 2008, 280 mm - 2013) these months being precipitating below 300 mm and above 120 mm. It highlights only the month of September where it precipitated 280 mm in the year of 2013.

Since these precipitations are group in total accumulated precipitation for each month of every year analyzed, the graphs shown in Fig. 1 are generate, making it possible to verify the behavior of the municipality's

precipitation regime, determining a reduction or increase in accumulated precipitation.

Fig. 2 shows the mean deviation of the maximum precipitations that occurred during the months throughout the historical series studied. It can be observed that the rains of the municipality of Porto Velho are below average, being only the months of December, January, February and March where the highest precipitation is shown, and in the months of January and February the precipitation was above 370 mm, making these the highest indexes above the average. However, these also show the precipitations below average over the years, where in the other months the precipitations are close to the trend line occurring rains closer to the average in June, July and August.
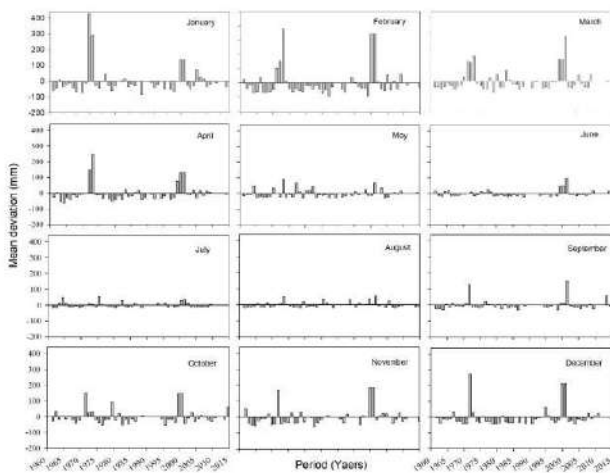
Fig. 2: Mean deviation of rainfall in the municipality of Porto Velho-RO, between the periods of 1961 to 2015.

\Fig. 3 shows the total accumulated annually precipitation for 54 years in the municipality of Porto Velho – RO.

We can observe that the years with the highest incidence of rain were 1972 (2256 mm), 1973 (2464 mm), 1974 (2373 mm), 1975 (2238), 1983 (2468 mm), 2001 (2291 mm), 2002 (2286 mm), 2006 (2711 mm), 2007 (2462 mm), 2008 (2281 mm), 2009 (2842 mm), and 2014 (2341 mm). In these years, the precipitation occurred above 2200 mm / year, with an average annual for the years studied ranging from 1860 mm / year to 1601 mm / year.
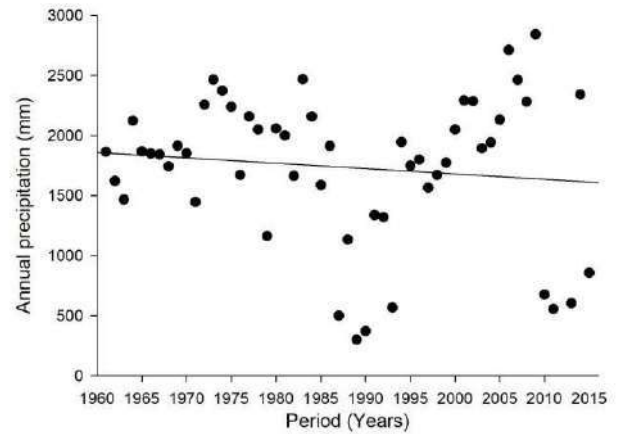
Fig. 3: Graphic dispersion of the annual precipitation of the municipality of Porto Velho-RO, between the periods of 1961 to 2015.

Intermediate occurrences of positive precipitation, with an interval of 1880 mm/year to 2190 mm/year were 1964 (2123 mm), 1969 (1914 mm), 1977 (2159 mm), 1978 (2049 mm), 1980 (2058 mm), 1981 (200 mm 0 mm), 1984 (2158 mm), 1986 (1913 mm), 1994 (1945 mm), 2000 (2049 mm), 2003 (1894 mm), 2004 (1942 mm), 2005 (2131 mm).

The years that occurred precipitations below the expected average for the year were 1963 (1467 mm), 1971 (1446 mm), 1979 (1162 mm), 1987 (500 mm), 1988 (1133 mm), 1989 (299 mm), 1990 (371 mm), 199 11 (1337 mm), 1992 (1320 mm), 1993 (567 mm), 2010 (675 mm), 2011 (555 mm), 2013 (604 mm) and 2015 (856 mm). In these periods, the incidence of rain recorded annually was lower than 1500 mm/year. The other years had a precipitation close to the trend line that various from 1860 mm/year to 1601 mm/year.

In Fig. 3, we can observe the anomalies existing in the years 1987, 1989, 1990, 1993, 2010, 2011, 2013 and 2015. In these periods, there were incidences of rain less than 1000 mm/year, where we can consider that there was a relevant drought contributing to the decrease in the hydric resources of the region. On the other hand, the years 1973, 1974, 1983, 2006, 2007, 2009 and 2015 presented precipitation above 2300 mm/year, contributing significantly to the cycle of hydro resources of the studied region.

If we look at the biennia, 1975/1976 (567 mm), 1978/1979 (887 mm), 1984/1985 (571 mm), 1986/1987 (1413 mm), 1988/1989 (834 mm mm), 1992/1993 (753 mm), 2009/2010 (2167 mm) and 2014/2015 (1485 mm), we will notice that in these periods there was a difference in pluviometric incidence between one year and another. We can conclude that in one year there was a high

incidence of rain and then a year with reduction of rainfall, which demonstrates a climatic interference existing in the region. Such interference may have occurred due to the El Niño/La Niña phenomena, originated in the Equatorial Pacific Ocean and provoked by the alterations or anomalies of the sea surface temperature approximate to the west coast of South America. These events occur with a periodicity of four or seven years and, in the periods mentioned above it is demonstrate that the high and low rainfall indices had the influence of such phenomena, according to Mendonça (2009). Paula et. al. (2010) highlights also that the pluviometric rate of the regions when affected by this phenomena it is responsible to soil and water losses from crops, occasioning in the erosive process of the soil.

The average annual pluviometric precipitation of Porto Velho during the study period from 1961 to 2015 was 1736 mm/year. In this period, the months with the highest pluviometric incidence were November (199 mm), December (250 mm), January (270 mm), February (273 mm), March (245 mm) and April (231 mm). The months with the lowest precipitation index were June (51 mm), July (39 mm) and August (51 mm). The months of May and October, that presented an indicator of precipitation around 119 mm and 110 mm, are characterize as the months of transition of season, considering that the city of study has two well-defined seasons, one of rain that runs from November to April and one of drought that goes from June to September. September points to a monthly average of 110 mm.

September it is the month with highest temperatures in the country, and as demonstrated by Silva et. al (2020) in the pluviometric characterization study of another Brazilian municipality, located this time in the regional center of the country, it also represents one of the months with lowest rainfall incidence.
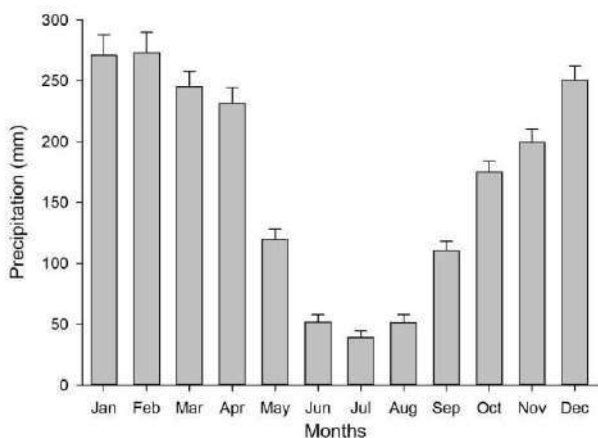
Fig. 4: Climatological Normal of the municipality of Porto Velho - RO.

IV.   CONCLUSION

The study region is characterize by two well-defined seasons, one rainy that covers the months of November to April and a drought that comprises from June to September.

The months with the highest rainfall are December, January, February with rainfall rates ranging from 250 to 273 mm.

The anomalies studied during the 54 years of analysis in the Porto Velho region showed that the biennial periods had the influence of el niño/la niña phenomena on the incidence of pluviometric precipitations.

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Solution of AePW-2 Test Cases Using Open-Source Code

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Abstract— The analyses presented in this paper are focus on the solution of cases 1 and 3A proposed by the second Aeroelastic Prediction Workshop (AePW-2), using an open-source CFD code. The reference cases presented by AePW-2 analyze the transonic flow around a Benchmark Supercritical Wing (BSCW). AePW-2 Test case 1 consists of a forced oscillation problem with Mach number of 0.7 and angle of attack of 3 deg, while AePW-2 Test case 3A analyzes a flow with Mach number of 0.85 and angle of attack of 5 deg, being that an unforced and unsteady problem. In the study, we simulated both test cases using the software SU2, being the results validated by comparison with experimental data provided by AePW-2. The results matched with accuracy with the experimental data and presented a good response for the analyses of AePW-2 test case 3A, proving the software capability of capture the physical phenomena involved in this type of flow.

I. INTRODUCTION

Computational Fluid Dynamics (CFD) evolved a lot during the past two decades. To keep the improving state art of CFD, institutions around the world are developing workshops, among them, and Aeroelastic Prediction Workshop series (AePW) stands out, [1] provides more information about AePW.

The focus of the first edition of the AePW workshop series was the solution of unsteady aerodynamics problems over three different wing geometry (the Rectangular Supercritical Wing, the Benchmark Supercritical Wing (BSCW) and High Reynolds Number Aero-Structural Dynamics (HIRENASD)). In its second version, AePW focused on the analyses of problems involving flutter over the BSCW wing.

Since 2016, all the studies that presented a complete solution of AePW-2 test cases used proprietary codes or in-house codes, as seen in [2] and [3].

More recent studies, like [4], presented the solution of the test cases and expanded these, testing the influence of parameter variation but these also using in-house codes.

However, proprietary and in-house codes present some limitations for academia. In this context, open source becomes a better option. But nowadays, the full capabilities of open-source codes to solve complex flow problems are still unrecognized, with just a few papers given an overview of this topic.

Among the possibilities of open-source CFD codes, SU2 emerges as a relevant tool for aeroelastic studies since it is focused on aeronautics applications, as presented in [5].

In [6], the developers of SU2 presented more details of the software architecture and capabilities to solve the flow problem proposed by two different full-aircraft configuration test cases. The focus of [6] was to prove the capability of the software to solve industry-sized problems. But for the current study, the principal importance of [6] was proving that SU2 was capable of solving transonic flow problems over complex geometries since one of the test cases validated was the flow over DLR-F6 Transonic Aircraft.

According to [7], the developers of SU2 focused their efforts on verifying the capabilities of the software to solve different test cases of interest in computational

aeroelasticity. The study of [7] analyzed flows over NACA 0012 airfoil, Isogai wing section, BSCW wing, and also presenting the benchmark problems solution for fluid-structure interaction (FSI). The importance of the research of [7] for the current study was the analysis of the BSCW wing test cases, which indicates the capabilities of SU2 to solve the test cases of AePW-2.

In a more recent study of SU2 capabilities of solving transonic flows, [8] uses SU2 to develop a methodology capable of providing the flow response to small-amplitude periodic deformations in a structure. This methodology was developed using NACA 64A010 airfoil in transonic flow conditions and validated by testing it in an Isogai wing section and an AGARD 445.6 wing. The results evaluated by [8] were accurate when compared with experimental data and other numerical simulation results, reinforcing SU2 capabilities.

Verified the SU2 capability of solving transonic flows. The current study aims to expand the usage of open-source software to solve complex flow problems of interest for aeroelastic analysis. The objective proposed was achieved by analyzing the SU2's ability to solve test cases 1 and 3 presented in AePW-2 and by comparing the results obtained numerically with the experimental data provided by the workshop.

II.　METHODOLOGY

AePW-2 uses the Benchmark Supercritical Wing (BSCW) for all the analysis proposed, Fig. 1:. presents the BSCW geometry view and its cross-section, a SC(2)-0414 airfoil. This rectangular wing has a chord of 0.4064 m, a span of 0.8128 m, a reference area of 0.3303 m², and a moment reference in (0.1219, 0, 0) m.

The BSCW configuration presents geometric simplicity, allowing to set the focus of AePW-2 on flow behavior.

[9] provided the experimental data of wind tunnel analysis for test cases 1 and 3A of AePW-2, being these evaluated for a cross-section of the wing, distancing 0.48768 m from the wing root. Table 1 synthesizes the information about the test cases verified in the current study, used to test SU2 capabilities.
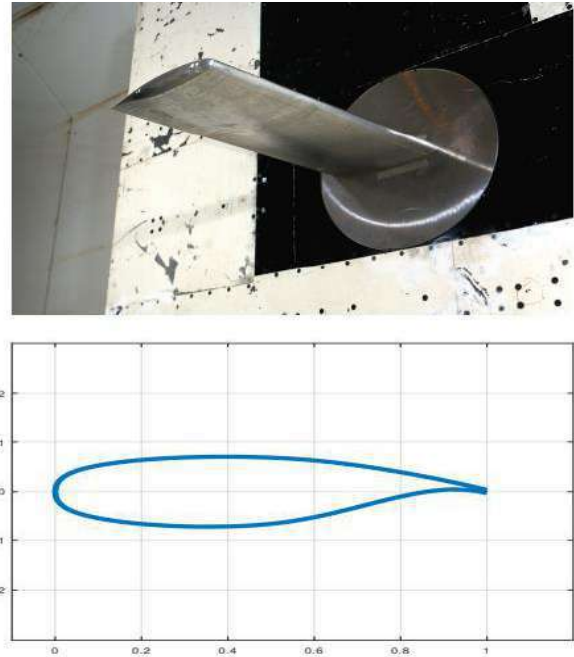
Fig. 1: Benchmark Supercritical Wing (BSCW) geometry used by AePW2 (presented in [1]).

Table. 1: Test Cases Proposed by AePW-2.

	Case 1	Case 3A
Mach Number (Ma)	0.7	0.85
Angle of Attack (AoA)	3°	5°
Fluid	R-134a	R-134a
Data type	Forced Oscillation	Unforced Unsteady
Reynolds Number (Re)	$4.560 \cdot 10^6$	$4.560 \cdot 10^6$
Freestream Velocity (V)	118.0588 m/s	118.0588 m/s
Speed of Sound (c)	168.6556 m/s	168.6556 m/s
Temperature (T)	304.2128 K	304.2128 K
Density (ρ)	1.1751 kg/m³	1.1751 kg/m³
Sutherland Constant (C)	243.3722 K	243.3722 K
Reference dynamic viscosity (μ_{ref})	$1.1165 \cdot 10^{-5}$ Ns/m²	$1.1165 \cdot 10^{-5}$ Ns/m²
Reference Temperature (T_{ref})	273 K	273 K

All the experimental data for the test cases presented in Table 1 are from NASA Langley Transonic Dynamics

Tunnel (TDT). The test case 3 points to shock-induced separated flow in the upper surface and the aft portion of the lower surface for Ma = 0.85 and AoA = 5°.

2. 1. MATHEMATICAL MODEL

Since all the analyzed test cases use R-134a is possible to consider the fluid as an ideal gas. Adopting this hypothesis is possible to create a correlation between the dynamic viscosity (μ) and the absolute temperature (T), via Sutherland's law, defined in (1).

$$\mu = \mu_{ref}\left(\frac{T}{T_{ref}}\right)^{3/2}\frac{T_{ref}+S}{T+S} \tag{1}$$

In all the AePW-2 test cases, the fluid flow is considered turbulent. To model the turbulence, we adopted the Reynolds-averaged Navier–Stokes equations (RANS). With that approach, the governing equations fall on a closure problem. To solve this, we used a turbulence model.

Based on the study of [3], was used the Spalart-Allmaras Turbulence Model for the analyses of case 1 in steady condition and case 3A. The Spalart-Allmaras model is a one equation model defined according to [10] by the equation (2).

$$\frac{\partial \tilde{v}}{\partial t} + u_j\frac{\partial \tilde{v}}{\partial x_j} = c_{b1}(1-f_{t2})\check{S}\tilde{v} - \left(c_{\omega 1}f_\omega - \frac{c_{b1}}{\kappa^2}f_{t2}\right)\left(\frac{\tilde{v}}{d}\right)^2$$
$$+ \frac{1}{\sigma}\left[\frac{\partial}{\partial x_j}\left((v+\tilde{v})\frac{\partial \tilde{v}}{\partial x_j}\right) + c_{b2}\frac{\partial \tilde{v}}{\partial x_i}\frac{\partial \tilde{v}}{\partial x_i}\right] \tag{2}$$

Being the turbulence viscosity (μt) defined as:

$$\mu_t = \rho v f_{v1} \tag{3}$$

Where f $_{v1}$ and χ are determined as:

$$f_{v1} = \frac{\chi^3}{\chi^3 + c_{v1}^3} \tag{4}$$

$$\chi = \frac{\tilde{v}}{v} \tag{5}$$

For this turbulence model, the adopted boundary conditions are:

$$\tilde{v}_{wall} = 0 \tag{6}$$

$$0.210438 \cdot v_\infty \le \tilde{v}_{farfield} \le 1.294234 \cdot v_\infty \tag{7}$$

Since the Spalart-Allmaras turbulence model is a one equation model, it is considerably faster than other models with more equations.

[10] presents the constants and auxiliary relations for the Spalart-Allmaras Turbulence Model.

For case 1 transient simulation, we considered the turbulence model proposed by [11], the shear stress transport, or k − ω SST, which is a two equations eddy-viscosity model. This formulation consists of a set of equations for turbulence kinetic energy and the specific dissipation rate equations complemented by the kinematic eddy viscosity equation, given by (8), (9), and (10).

$$\mu_T = \frac{\rho a_1 k}{max(a_1\omega; SF_2)} \tag{8}$$

$$\frac{\partial(\rho k)}{\partial t} + U_j\frac{\partial(\rho k)}{\partial x_j} = P_k - \beta^* k\omega + \frac{\partial}{\partial x_j}$$
$$\left[(\mu + \sigma_k\mu_T)\frac{\partial k}{\partial x_j}\right] \tag{9}$$

$$\frac{\partial(\rho\omega)}{\partial t} + U_j\frac{\partial(\rho\omega)}{\partial x_j} = \frac{\gamma}{v_T}P - \beta\rho\omega^2 + \frac{\partial}{\partial x_j}$$
$$\left[(\mu + \sigma_\omega\mu_T)\frac{\partial\omega}{\partial x_j}\right] + 2(1-F_1)\sigma_{\omega 2}\frac{\rho}{\omega}\frac{\partial k}{\partial x_i}\frac{\partial\omega}{\partial x_i} \tag{10}$$

[11] presents more detail about the coefficients and auxiliary relations for the k − ω SST turbulence model.

2. 2. COMPUTATIONAL ANALYSIS

2. 2. 1. Mesh

We generated the mesh using the Ansys Mesh, from Ansys academic license, software details can be found in [12], and verify the uncertainty due to discretization calculating the Grid Convergence Index (GCI), following the procedure proposed by [13].

For all the meshes developed, we centered the wing profile in a semispherical farfield, as can be seen in Fig. 2. The figure also presents the boundary conditions adopted in the analysis. Table 2 shows the parameters used in the mesh generation for cases 1 and 3.

For case 1 grid convergence analysis, we developed the coarse, intermediary, and fine meshes present respectively: 156819 elements, 426703 elements, and 1184414 elements.

The obtained refinement factor was: 1.405 between the fine and the intermediary mesh; and 1.396 between the intermediary and the coarse mesh.
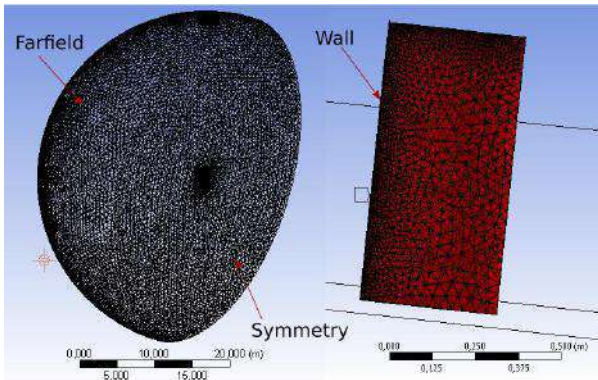
Fig. 2: Mesh developed for test case 1.

Table. 2: Test Cases Proposed by AePW-2.

Parameter	Case 1	Case 3A
y+	1	1
Aspect Ratio	1,2	1,2
Number of elements in the boundary layer	35	35
Farfield radius (m)	20	20
First element height (m)	$2,43 \cdot 10^{-6}$	$2,47 \cdot 10^{-6}$

Following the calculation procedure proposed by [13] we estimate uncertainty due to discretization using the GCI and obtained the results presented in Table 3.

Table. 3: Parameters obtained for estimate uncertainty due to the discretization of the BSCW wing.

Refinement factor r_{21}	1,405
Refinement factor r_{32}	1,396
Approximate relative error e_{a21}	0,93 %
Approximate relative error e_{a32}	13,12 %
Extrapolated relative error e_{ex21}	0,07 %
Extrapolated relative error e_{ex32}	1,03%
Convergence index GCI_{21}	0,085 %
Convergence index GCI_{32}	1,272 %

Comparing the parameters presented in Table 3 with the exhibit in [13], we saw that the convergence index allows the use of the intermediary mesh for all the calculations. Based on that result, we developed the meshes for case 3A the difference, in this case, was the use of a refinement box around the wing, as presented in Fig. 3.

With the adoption of a refinement box, we did a local refinement in the mesh to capture flow features of pressure distribution around the wing. The most dominant feature found in the flow is the shock-waves dynamics that should occur at the Mach number of 0,85. With this refinement, the mesh developed for case 3A had 1768317 elements, and the focus of this the upper region of the wing to capture the shock-wave dynamics.

2. 2. 2. Software

We used Ansys Mesh from Ansys License of Ansys 2017 for the mesh generation, [12] presents details about this software.
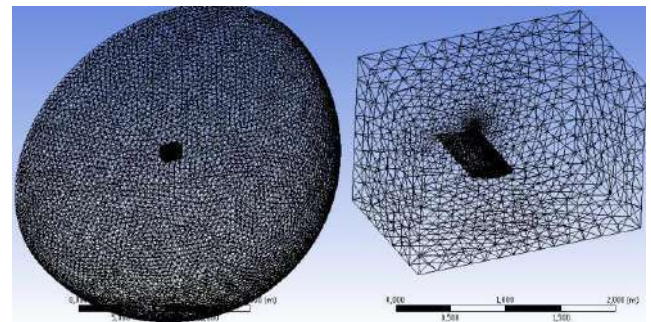
Fig. 3: Mesh developed for test case 3A.

For the numerical simulation, we used SU2 version v6.2.0 Falcon to solve the Navier-Stokes equations. [5] presents more detail about the software.

We evaluated the solution with the following settings: Green-Gauss numerical method to compute the gradient; FGMRES with ILU preconditioner to solve the linear system; JST as flow convective numerical method and Scalar Upwind as the turbulent convective numerical method.

For the post-process, we used Paraview 5.7.0. [14] provides details about Paraview.

III.   RESULTS AND DISCUSSION

3. 1. Case 1

In Fig. 4. are presented the results obtained with the numerical simulation of test case 1 for the steady flow condition. For this test condition, we sampled 76 points over the analyzed section and compared them with the 35 points found in the experimental data provided by [1].

As can be seen in Fig. 4., the numerical data almost fit with the experimental data provided by AePW-2 for the lower surface of the airfoil.

For the upper surface, numerical and experimental data present the same behavior in the Cp curve but diverges in magnitude. This divergence in the upper surface occurs

because the tetra/prism mesh generated kept some lower quality elements in the region.

Also, Fig. 4. shows that on the trailing edge of the wing, the numerical simulation diverges from the experimental data. This problem occurs because of the sharper edge used in the geometry model. Due to that fact, the software couldn't generate good quality elements, leading to an increase in numerical error.
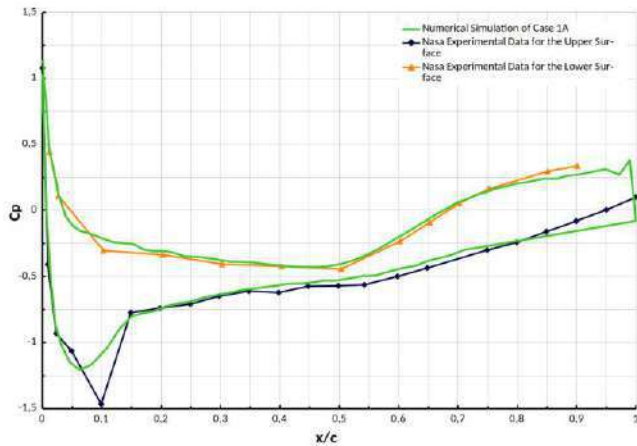
Fig. 4: Cp plot for numerical and experimental data of test case 1.

With the results, we concluded that SU2 could solve the steady transonic fluid flows with great accuracy since, in Fig. 4., we saw that most of the issues took place due to poor quality elements generate in some regions of the geometry.

The major problem found for the analysis was the mesh generation. This issue occurs due to SU2 uses meshes in SU2, CGNS, and NETCDF_ASCII formats, and just a few software develop great quality mesh in these formats.

During the study, we found that Ansys mesh was the only software capable of generating meshes for SU2. We also tested Gmsh, but at that time, it didn't generate proper meshes. For this reason, we used Ansys mesh to develop all the meshes for the studied test cases.

For case 1 transient condition, was verified the forced oscillation occurring over the BSCW wing. We simulated this condition with an oscillation frequency of 10 Hz and an angle of 1°. Fig. 5. presents the pressure coefficient evaluated with the numerical analysis, and we can compare this with the pressure coefficient found by [3] for the same test case, exposed in Fig. 6.

As can be seen in Fig. 5. and Fig 6. the results evaluated by the authors keep the same behavior as the results evaluated by [3].

The magnitude of the peak curvature is analogous to the one found in [3]. However, the curvature found by [3]

presents two peaks, while the curves obtained by the authors present a single peak. Again the pressure coefficient next to the trailing edge was poorly represented in comparison with the found by [3].
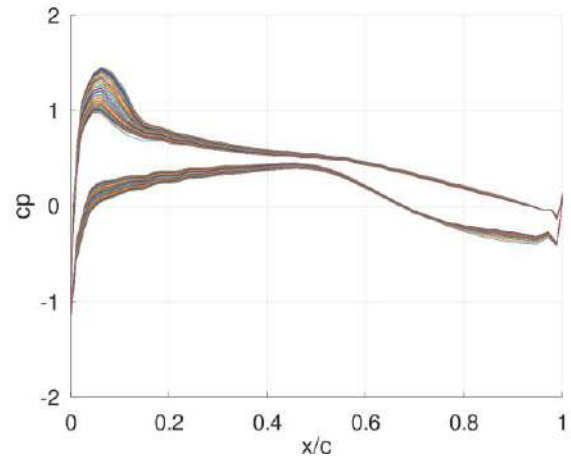
Fig. 5: Cp coefficients obtained by the authors for test case 1 transient condition.
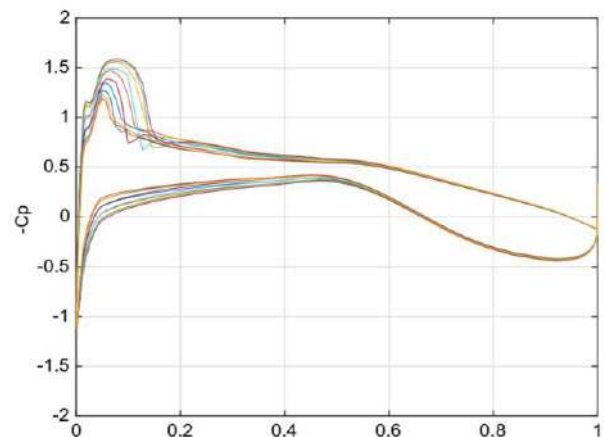
Fig. 6: Cp coefficients obtained by [3] for test case 1 transient condition.

Another way to see the behavior of SU2 is to plot the results in the frequency spectrum. AePW-2 presents the frequency response at 10 Hz for the sensors applied in the experimental tests. We can see a comparison between this response and the computational responses obtained by SU2 in Fig. 7. and Fig 8.

In Fig. 7. and Fig 8., we can see that the values obtained by SU2 are similar to the experimental evaluated by AePW-2, keeping the same shape and same peaks at upper and lower surfaces.

3. 2. Case 3A

Since case 3A consists of an unsteady problem, it was necessary to adopt a time step for developing the

interactions over time. For the analysis, we used a time step of $\Delta t = 10^{-4}$ s. Fig. 9. presents the results obtained for the SA model and Fig. 10. for the k−ω SST model.
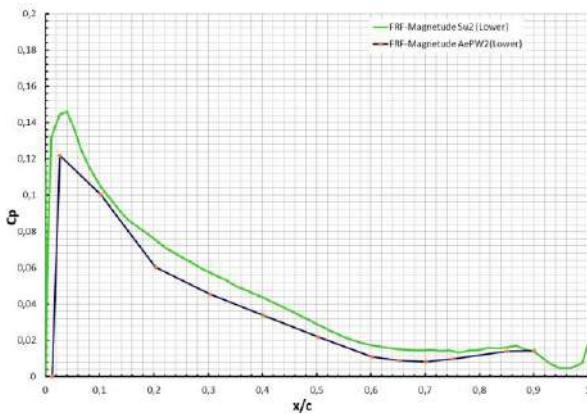
Fig. 7: Comparison between the magnitude frequency response at 10 Hz for the lower surface.
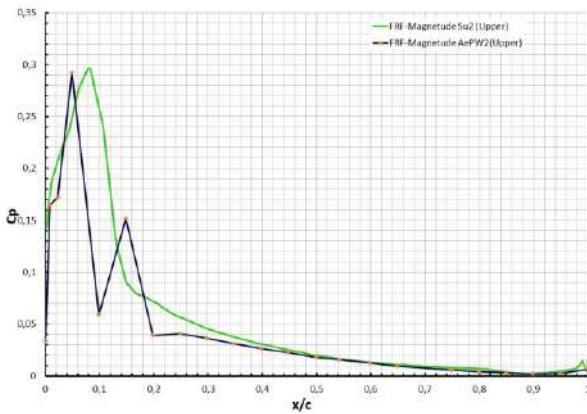
Fig. 8: Comparison between the magnitude frequency response at 10 Hz for the upper surface.

adopt local refinement techniques in the mesh generation. Due to the local refinement, we minimized the trailing edge problem found in case 1 and got a more accurate solution.
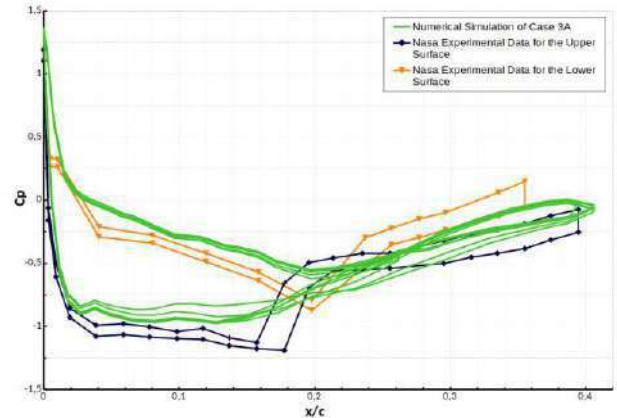
Fig 9: Comparison between Cp plot for numerical and experimental data of test case 3A using SA model.
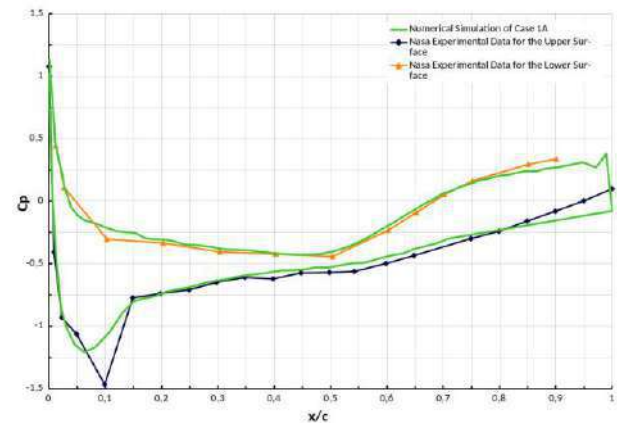
Fig 10: Comparison between Cp plot for numerical and experimental data of test case 3A using k−ω SST.

As presented in Fig. 9. and Fig. 10., the numerical results almost fit with the experimental data for this case. The difference found stays on the transition of the Cp that occurs next to x/c = 0.16, where the experiments present an abrupt fall of the Cp, while the numerical results exhibit a smooth transition.

Comparing case 3A and case 1 results, it is possible to see that the first presented more accuracy due to the mesh used.

Since case 1 consists of a flow with a low Reynolds number, and the problem occurs at a steady-state, the mesh for this case was coarser than case 3A mesh due to it doesn't use the refinement box. These simplifications into the mesh reduce the computational cost but sacrifice part of the solution's accuracy.

For case 3A, since the problem involves capture the shock wave dynamics over the wing was necessary to

Another detail noticed is the difference evaluated by the turbulence models. While the SA model captured the Cp variation over time, as seen in Fig. 9., the k − ω SST wasn't capable of that, as presented in Fig. 10.

Also, Fig. 9. and Fig. 10. presents that despite both turbulence models represent the behavior of the flow over the wing adequately, but none captured the discontinuity presented by the shock wave.

IV.   CONCLUSION

After all the analyses, we confirmed the capability of SU2 to solve transonic problems.

During the study, the principal limitation found was the generation of a proper mesh. Since SU2 native format is .su2, our first attempt was to use open-source mesh generators capable of generating meshes in this format.

None of the .su2 Open-source mesh generators tested generated meshes that provided good results for SU2.

Due to that, during the study were necessary to use another mesh format. In this case, was used the CGNS format, being the meshes generate by Ansys Mesh.

The results also present that the generated mesh impacts the accuracy of the simulation. Since a more refined mesh, like the one used for the numerical simulation of case 3A, was more accurate when compared with the coarse mesh generated for case 1, even considering that complexity of case 3A greater than case 1. This result also shows the importance of local refinement for unstructured meshes.

The analysis of case 3A presents that SU2 was capable of capture the shock wave dynamics. Also, the numerical results almost fit with the experimental data provided by the workshop AePW-2.

As observed in Fig. 9. and Fig. 10., the major problem found for the analysis was the capture of the abruptly falls off the Cp over the upper surface of the BSCW wing since the numerical simulation presents a smooth transition between the Cp curve while the experimental data shows a more abruptly fall.

ACKNOWLEDGEMENTS

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Development of an Application on Environmental Certification: Describing the experience

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Abstract—The study aims to describe the experience in developing a mobile application on environmental certification. An experience report was carried out in the development of a Mobile Application (APP) developed under the Graduate Program in Technology and Environmental Management of the Federal Institute of Education, Science and Technology of Ceará - IFCE, Fortaleza-CE, in the period from January/2020 to April 2021, with emphasis on the environmental certification of the Green Municipality Seal Program (PSMV) of the State of Ceará, more specifically on the environmental indicators of its 13th Edition. The application pilot uses standardized languages to feed the environmental certification information system database, in addition to a pleasant and easy layout. The experience was successful in developing the initial prototype of an application that could contribute to a better assessment of municipal environmental management indicators, and could encourage other cities, states, and even other countries to use digital tools (APP) for data collection, as well as the environmental indicators of environmental certification to improve environmental quality.

I. INTRODUCTION

The increasing degradation of the environment and the depletion of natural resources, caused by indiscriminate production practices, by the current and unlimited human needs and also by the mistaken ideas that natural resources are inexhaustible, make the current and future environmental situation a constant concern of world and national leaders [1].

The conservation of the environment raises questions about the role of public management and society. From the 1980s onwards, in Brazil, with the new concepts of sustainable development approached, the relations between environmental sustainability and economic development were accentuated.

According to Quental et al [2], sustainable development is understood in its three dimensions: economic, social and environmental. It seeks, the well-being of people and their prosperity, with sustained growth in harmony with the protection of the planet, so that it supports the needs of current and future generations, and in peace.

Over the years, public institutions have sought management tools for decision-making in municipalities and local communities to reduce environmental impacts and, consequently, to improve environmental quality in cities and in the countryside. With this, environmental management gains a growing space in local public policies [3].

In order to establish harmonious relationships between the development of socioeconomic activities with the maintenance of environmental quality, there are environmental management instruments that can help in this process, such as the environmental certification instrument.

Environmental certification corresponds to an advanced stage of environmental management in public and private institutions, in which the environmental variable is inserted in the organizational field. It is a voluntary commitment of the organization to adopt an environmentally correct behavior in relation to environmental management, based on standardized norms and recognized nationally or internationally [4].

With the purpose of facing these problems and qualifying cities regarding the environmental situation in the state of Ceará, the State Secretariat for the Environment - SEMA coordinates the "Green Munivipality Seal Program(PSMV)", which constitutes environmental certification [5]. PSMV is a public Environmental Certification Program, established by State Law nº. 13,304/03, amended by Law nº. 16.128, of 14 October 2016 and regulated by Decrees nº. 27.073/03 and nº. 27.074/ 03 [6].

The environmental certification of the State of Ceará, through the PSMV, is configured as a management tool that aims to verify the contribution of public policies to the environmental management of municipalities in Ceará, with the goal of promoting environmental protection, supported by the mobilization of community and public bodies, verifying the commitment of the urban environment management [7].

Information technologies have proven to be strong in various aspects of environmental management. The search for solutions requires a globalized view of causes and consequences, for that, technological innovations are adopted. Among them, information systems stand out, which allow collecting, processing, storing, transmitting and displaying information about a given topic. Considering the importance of accessibility to environmental information, national and international public policies establish Environmental Information Systems as instruments [8]. Alongside these innovations, the first portable cell phones were developed. Since then, new features have been added, a fact that has contributed to making the mobile phone one of the technologies most quickly adopted by mankind.

The experience reports the initial stage of the development of an application prototype aimed at public environmental certification in the State of Ceará. The choice for the development of the application started with our performance, in the Environmental Authority of the Municipality of Sobral-CE, in the work group of the Green Municipality Seal Program. It was through the limitations and potentialities in carrying out the data collection for certification in that municipality that the idea of the need to recognize the importance of environmental management combined with technological tools with the use of mobile devices to contribute to the process of making A conscious decision is the potential qualification of a municipality, which uses the tool, in relation to environmental indicators.

The purpose of the experience is to present how the Management Mobile Application (APP) was developed to assist the environmental certification process of the indicators of the Green Municipality Seal Program (PSMV). The APP is intended to be an accessible tool to communicate, monitor, educate and inspire a target population, offering consistent environmental management through an interactive format.

II.   MÉTHOD

This is an experience report of the development of a Mobile Application (APP) under the Graduate Program in Technology and Environmental Management of the Federal Institute of Education, Science and Technology of Ceará – IFCE, Fortaleza-CE. The experience was carried out from January of 2020 to April 2021, with an emphasis on the environmental certification of the Green Municipality Seal Program (PSMV), more specifically on the environmental indicators of its 13th Edition.

The Green Municipality Seal Program has been contributing to the effective implementation of environmental public policies at the local level, as well as to the internalization of environmental issues in programs, plans, projects and actions aimed at the cultural, social, economic, political and ecological development of Ceará's municipalities. The 13th edition of the Green Municipality Seal Program has five thematic axes that reflect the Environmental Sustainability Index (ISA) are: Municipal Environmental Policy; Environmental Sanitation and Public Health; Water resources; Sustainable Agriculture and Biodiversity and Climate Change [7].

For analysis of the experience, the 13th Edition of the Technical Manual of the Green Municipality Seal Program of the State of Ceará and other literatures that supported the experience and review of Benchmarking were used.

III.   RESULTS

The experience presents the first moments for the development of the initial prototype, with two initial

phases, which are: First phase: Bibliographic survey and Benchmarking; Second phase: development of the initial prototype.

First phase: Bibliographic survey and *Benchmarking*

We sought to describe this experience through a bibliographic survey in the scientific literature and a review of APP operating systems in virtual stores for benchmarking to later develop the prototype.

The review of virtual stores aimed to identify and analyze functional and operational aspects, which served to support the creation of the APP with ideas, innovative (radical and/or incremental) and effective characteristics; which have parameters not yet available on the market, thus ensuring maximum efficiency in the created product (performance).

To achieve the proposed objective, a survey was carried out on APP available in virtual stores of the main operating systems used in Brazil. Android - Google play store (https://play.google.com/store/apps?hl=pt), iOS - Apple store (http://www.apple.com/br/) and Windows Phone - Microsoft (https ://www.microsoft.com/en-us/windows/view-all). Google play: the APPs were located in the category, the most variable categories such as "Tools", "Lifestyle", "Climate", "Communication", "Educative" and "Social" were used as filter, using the search engine "Environmental Management", "Environmental Certification" in Portuguese and English. It is noteworthy that there were no tools, in Brazil, such as environment and environmental management, making the search difficult, as well as making the product unprecedented.

APP STORE: the most popular, free Apple APPs, arranged in the "Environment" categories; "Environmental management"; "Companies (APP and business). Installables on iPhone, iPad or any other device with some version of the iOS operating system were catalogued. The inclusion criteria adopted were: available for mobile devices (smartphone or tablet), free APP, running on selected platforms (Android and iOS), with content or tools aimed at environmental management in Portuguese or English. APPs with restrictions for use in Brazil.

To conduct the selection of APPs in virtual stores, the PRISMA checklist was used. The included APPs were downloaded and installed on a smartphone device according to its operating system. Thus, for the Android system, the Smartphone Samsung Galaxy S20 FE 128GB® was used, and for the iOS the iPhone 6 Apple 64GB®. As can be seen in the flowchart (Figure 1).
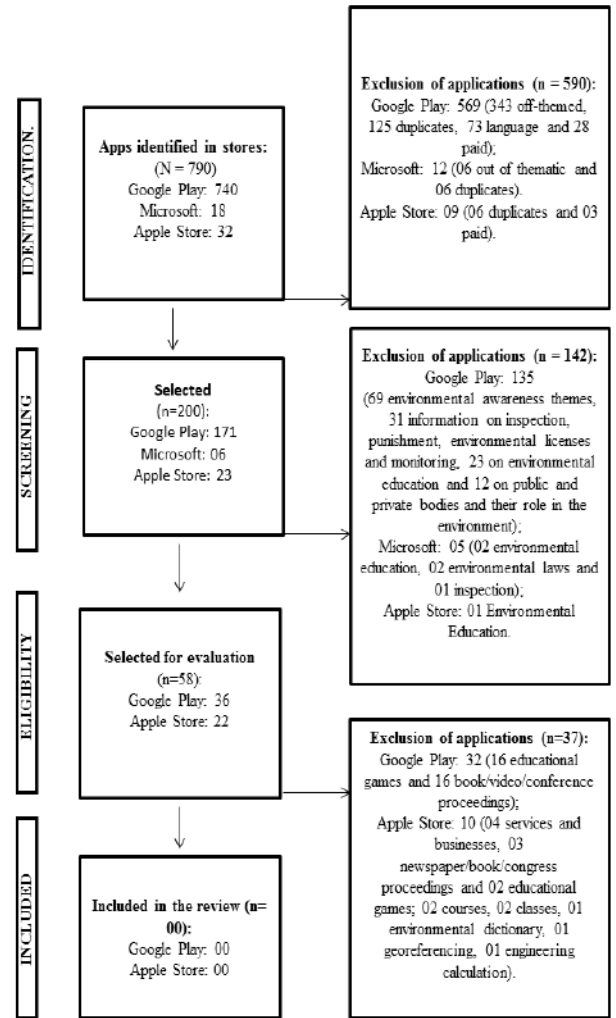
Fig. 1: Flowchart of application selection in online stores selected for review, based on PRISMA – Fortaleza-Ceará-Brasil, 2021.

Source: Authors, 2021.

APPs on environmental certification were not found, which makes the development challenge greater and the final product unprecedented. It was observed in the analysis that there are several software related to environmental issues, but with other functions, different from a certification tool with environmental indicators.

The APPs found were about awareness, environmental education, about the functions and mission of public and private bodies and the role in the environment, as well as information applications on environmental licensing with themes of inspection, punishment, environmental licenses, monitoring and environmental laws, in addition to the most varied educational games, courses, classes, as well as other tools, such as an environmental dictionary, georeferencing APP and/or environmental engineering calculations.

No applications on environmental certification were found, which reinforces the need to develop an application aimed at the Green Municipality Seal Program, as well as its innovative character.

Development phase: initial prototype

The tool aims to guide municipal managers and professionals who make up the Technical Commission and Management Committee of the Green Municipality Seal Program, in order to assist them in the task of analyzing and evaluating environmental indicators, with a view to understanding the relevance of each of the environmental variables and the municipality's competence in achieving the local territorial development agenda. The tool also proposes to show society in a transparent way how the environmental certification process takes place.

For development, the evaluation indicators of each municipality were used. The municipalities are evaluated by meeting sixteen established indicators, being distributed into five thematic axes, totaling 100 points. The Environmental Sustainability Index (ISA) is the sum of all scores on the five axes (see Table 1).

Table 1 – Thematic axes and Indicators for the evaluation of municipalities in the 13th edition of the Green Municipality Seal Program, 2019-2020

THEMATIC AXIS	Maximum Score
AXIS 1 - MUNICIPAL ENVIRONMENT POLICY	32
Indicator 1: Environment Structure	15
Indicator 2: Effectiveness of Municipal Councils for the Defense of the Environment (COMDEMA)	4
Indicator 3: Implementation of the Environmental Education Policy	12
Indicator 4: Deployment of Sustainable Technologies	1
AXIS 2 - ENVIRONMENTAL SANITATION AND PUBLIC HEALTH	36
Indicator 5: Integrated Solid Waste Management	10
Indicator 6: Final disposal of urban solid waste	4
Indicator 7: Social inclusion of recyclable material collectors	6
Indicator 8: Infestation by Aedes aegypt	5
Indicator 9: Sanitary Sewage System and Water Supply System	11
AXIS 3 - WATER RESOURCES	7
Indicator 10: Improved Water Quality	7
AXIS 4 - SUSTAINABLE AGRICULTURE	5
Indicator 11: Sustainable Management of Agricultural production	3
Indicator 12: Capacity Building in Sustainable Agriculture	2
AXIS 5 - BIODIVERSITY	20
Indicator 13: Municipal Conservation Unit (UC)	5
Indicator 14: Urban Green Areas	5
Indicator 15: Preservation and Conservation of Biodiversity	5
Indicator 16: Untying and Burning Control	5
TOTAL CERTIFICATION SCORES	100

Source: Cabral et al (2019).

A technological support tool was initially developed to map the municipalities that serve and that score best in terms of indicators. Through the tool it will be possible to improve performance and facilitate actions for environmental preservation and conservation.

The municipal environmental technicians will be responsible for supplying a mobile platform with information and proof of compliance with the indicators. The tool automatically calculates the ISA (Environmental Sustainability Index) and informs whether or not it has obtained the minimum score (cut score) that will enable the probable granting of the seal (certification), as well as informing the failures (gaps) in getting the seal. Through this tool, managers and the State Secretariat for the State Secretariat for the Environment of Ceará (SEMA) will be able to identify the municipalities with the greatest difficulties and deficiencies in sustainability, enabling a mapping of actions to be carried out from there. The focus is that all municipalities can be serving and promoting actions so that the situation in their municipality improves every day.

Requirements are the starting point for the entire definition of the system and, consequently, are decisive factors in the development of the final product. Requirements management is always a challenging activity in future software development. This is because the requirements of a system are extremely dynamic, with several factors internal and external to the project, contributing to its constant change.

Through the APP, the population will be able to see how is the performance of their municipality, news and actions that are being carried out within the state of Ceará, aiming at a better performance in the elaboration of environmental policies to serve the population more efficiently.

Mobile environment

Through the mobile APP, citizens will be able to view a map that shows the status of each municipality and whether or not it fulfills its obligations with environmental actions. Figure 2, 3.

Fig.2, 3: Mobile Vision, Fortaleza, Ceará, Brazil, 2021.

Source: Authors, 2021.

The initial screen of the APP Mobile APP Green Municipality Seal Program application aims to be very self-explanatory, through a simple interface.

It also has the space for registering the technician responsible for the municipality's information, in which he registers to send it's municipality's data.

All areas of the APP Mobile APP Green Municipality Seal Program, when clicked, will direct to where the municipal technician can send the documents and view the acceptance of a certain environmental variable, for later scoring.

The indicators of the chosen area that are touched will direct to the page where it will be possible to send the proof files.

According to the compliance with the 16 indicators and after the documental evaluation of the Technical Commission, the municipalities are sorted, according to the score achieved, being necessary a minimum of 50 scores in the Environmental Sustainability Index (ISA) to be classified in 3 different categories (A, B and C) and subsequent certification (Table 2). After the documentary evaluation, the score achieved by the municipalities with the overall classification is released. Each municipality that achieves the necessary score for classification will receive an on-site visit by technicians to verify the information identified on its form (see Box 2).

Table 2 – Environmental Sustainability Index and Categories according to the classification of municipalities for certification in the Green Municipality Seal Program

ISA Range	Category
$\geq 90 \leq 100$	A
$\geq 70 \leq 90$	B
$\geq 50 \leq 70$	C

Source: Cabral et al (2019).

The application presents the average score for the municipality (see Figure 4):
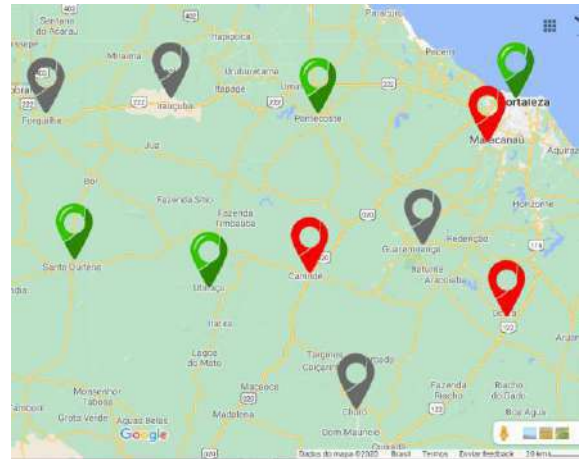
Fig.4: Average score by municipality, Fortaleza, Ceará, Brazil, 2021

Source: Authors, 2021.

The results are intuitive. Municipalities that are still in the process of analysis, as shown in Figure 4, are in the color "gray", municipalities that obey and comply with the proposed indicators will appear in "green" and those that are not following and complying with the indicators will appear in red. The cities that do not adhere to the certification process in that edition will also be in red, considering that their adhesion is voluntary. This is a simplified view for the population, but it allows important information on the current situation of commitment of municipalities in Ceará with sustainability. For SEMA, the state environmental management agency, coordinator of the PSMV, the detailing of information will be much more precise. With the help of graphics and real-time information, it will be simple to always obtain the best metrics for strategic decision-making based on statistics and results.

With an application with a cloud database, it is possible to control which municipalities have proven compliance with each of the indicators. SEMA is able to see through graphics and a geographic map each municipality that is "regular" and those that did not follow what was pre-established in each indicator and, through this, elaborates more assertive environmental policies and actions for each municipality.

On the other hand, the population acts in a participatory way, as it manages to monitor the municipalities in real time and the indicators that they are regular.

The municipal managers will always act seeking to meet what is requested so that they migrate from the "irregular" to "regular" scenario. (see Figure 5):

Fig.5: Ways of viewing and storing information, Fortaleza, Ceará, Brazil, 2021

Source: Authors, 2021.

The result of all this is a B.I (Business Intelligence), that is, a set of data referring to the situation of preservation and sustainability of each municipality and its commitment to improving results. This information can be used for immediate decision-making or preparation of future actions and projects always seeking a better framework of preservation and sustainability for each municipality in Ceará.

IV. DISCUSSION

Currently, there are several researches on application studies and development, with bibliographic research in the scientific literature and a non-e-store review of APP operating systems for benchmarking for planning the development of technologies such as applications. This type of research allows us to identify, map, respond and discuss significant contributions to the construction of knowledge from different fields of human knowledge. Thus, it constitutes a survey of what is usual about a given area, development of research analysis prototypes, assessment of the situation of knowledge production in the focused area [9].

Given the constantly growing market, the spread of this and other mobile devices, such as smartphones and tablets, around the world is undeniable. Following the same upward projection, the creation of applications (APP) for mobile devices presents itself as an innovative field considering the potential of human interaction with the environment. The increasing number of applications available in online stores represents a data source that is still little explored [10].

Accessibility levels of mobile devices have been increasing in proportion to the growing demand from managers and users of Information and Communication

Technologies. This phenomenon can be explained, among other factors, by the incorporation of new data transfer and storage technologies, as well as better information management and strategic management administration [11].

The use of technological tools such as the use of applications in the area of environmental management is in growing expansion, as this type of support can provide professionals with more precision and agility in their work. Mobile computing can be applied in several aspects within environmental management. Among these applications, remote monitoring, local diagnostic support and decision-making support can be highlighted [10].

Sustainability appears as a theme message not only in the so-called "traditional" media, such as press, television and radio; but also in corporate communication, at events, conferences, in the school environment and also on the internet. Some organizations and projects have promoted sustainability in different communication ways, some of them are even application developers [11].

The experience sought to present the initial phase of the development of a prototype on environmental certification through the Municipality Green Seal Program (PSMV) of the State of Ceará. The PSMV emerges not only as an incentive to municipalities to implement their environmental policies, but also as a channel for the effective participation of civil society, in defining their needs and establishing their priorities, considering its great merit, in addition to inserting the environment within the discussions, concerns and commitments of all instances of society, through mobilization meetings and environmental education projects [7].

Over the years, technological advances have become a key element in minimizing the negative effects of human activities on the environment. And in this experience, the relevance of using mobile applications in the environmental management process was discussed. This is because there are a number of software, application and tool innovations that have made the lives of professionals working in the environmental area easier, besides, of course, solving environmental problems [11].

In this way, the experience is justified because in addition to recognizing the importance of environmental management combined with technological tools with the use of mobile devices in order to contribute to the conscious decision-making process, there is the potential qualification of a municipality that uses the tool , in relation to the environmental indicators.

V.   CONCLUSION

The development of the initial prototype, in addition to presenting a standardized language, and a pleasant and easily accessible layout, brought a new look at environmental management, through the construction of a digital communication and information tool, which in addition to feeding the system databases of information from the State of Ceará on environmental certification, it is also essential for management, considering the realities, needs and potential of each municipality in Ceará.

Therefore, it can be concluded that the experience was successful in developing the initial prototype of an innovative, pioneering and unprecedented application, which could contribute to better municipal management of environmental indicators, through data collection, analysis, notification and recording. decision-making, encouraging the improvement of indicators in Ceará's cities, with greater sustainability, and may encourage other cities, states and even other countries to use digital tools (APP) for certification to improve environmental quality.

It is noteworthy that the initial phase of the prototype is an extremely useful and important instrument for requirements validation. This prototype serves to demonstrate the system, how will be the navigation between the interfaces, the forecast reports and so on, reproducing the behavior of the future system to be implemented.

ACKNOWLEDGEMENTS

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Literature Study on Review Emergency Generator Usage on Landing Craft Tank

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Abstract— The Landing Craft Tank (LCT) is a type of attack landing craft to vessel tanks on the waterfront. In general, LCT 415 Gross Tonnage (GT) ships are not ready to sail using emergency generators. According to Indonesia Classification Bureau or Biro Klasifikasi Indonesia (BKI) rules, only ships with more than 500 GT are required to have an emergency generator package. However, for the LCT 415 GT to gain higher level of safety, the ship is equipped with an emergency generator package installation. This generator is used as an electric power source used by the ship's compass in off condition. The purpose of this study is to learn the electrical power requirements on the LCT 415 GT to determine the required emergency generator package specifications and provide an overview of the generator's placement on the main deck. Emergency generator packages are arranged to improve ship safety, crew and cargo. In emergency condition, LCT 415 GT ships required a total power of 29,9408 kW. The basic package of emergency generator set selection is based on the total emergency power following BKI regulations as well as the generator safety engine package set when extreme weather conditions occurs.

I. INTRODUCTION

Generator is auxiliary machine used to supply all electrical need in ship. Generator set is one of the machine that can convert heat energy (combustion result) to be mechanical energy (motion). The fuel is solar (low rate oil). To burn that oil, high pressured air is used. To generate electricity, diesel machine uses diesel power motion - based on generator. In a ship, generator set is used as main source of electrical devices like lamp, navigation equipment, pump, etc.

Black out condition in ship appeared when complete failure of electrical power brings the ship into a standstill. Main source of electrical fails to be operated. If this happens, emergency generator is needed to supply electrical power to vital equipments of the ship. According to BKI regulation Vol. IV Section 3, a ship with 500 GT is required to install emergency generator for emergency condition. Actually, LCT 415 GT is not required to install emergency generator set. Yet it is allowed for safety reason. System in emergency generator has to be set automatically active to avoid long blackout to occur.

II. LITERATURE STUDY

2.1 Engine Combustion System

Based on classification, it is divided into four, they are:

a. Based on utility

The engine is categorized based on where it is used, like for ship propulsion and as assisting tool for the ship, for generator, compressor and pump in industry. On

international scale engine combustion system to generate power will be adapted for high level automotive industry producer, traction and maritime engine.

   b. Based on speed

This classification isgenerally used due to its tocranshaft axis rotation at its base that determines weight and size of engine related to the output..

   c. Based on design.

Engine can be sub classified with related to its design feature that is:

   a. Work cycle: four-strokes or two-strokes

   b. Piston: action/piston connection

   c. Cylinder: The way the air is put into cylinder (on ambientor high pressure)

   The way the air is put into cylinder (either in ambient or or high pressure)

   d. Based on size

Classification based on size is is related to many factors like cylinder dimension, cylinder number, speed and average of effective pressure.

2.2 Work cycle

The combustion can be by self igniting or by indirectly. Ignition compression and engine sparks can be arranged in one of those two cycles. In diagram. this can be explained in Figure 1 and Figure 2; along with appropriate indicator diagram depicting what is occuring in engine cylinder in every cycle. In four strokes, fuel ignition happens in every other crank shaft axis revolution engine that this cycle works from its fuel during one stroke in four strokes (Figure 2). Strokes work in once every two cycles. On the other hand two stroke engine has excellent motion in every crank shaft axis rotation (Figure 2). Yet two stroke engine generally is lighter and smaller than four stroke engine with same output.

Because two stroke engine has twice power, so four stroke engine produces twice power as well down stroke two stroke engine combines power & exhaustion of steam. During port intake and exhaust is cleaned by piston, fresh air and burnt gas is mixed. Not all gas is totally burnt, that prevent bigger fresh air to be inducted into cylinder. That's why stroke load produced has fewer pushing power.
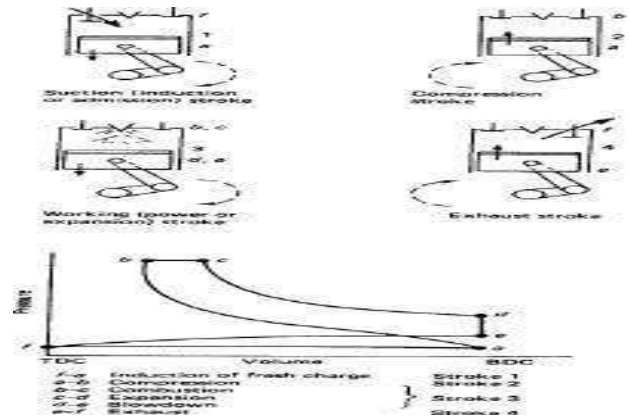
Fig.1. Four-Stroke Cycles

In four stroke engine almost all burnt gas will be forced to exit burning area by upward moving piston. This will make almost air-fuel mixture fulled to enter cylinder due to piston stoke, because piston stroke is specialized for mixture induction. Therefore, power stroke produces relatively more power than two-cycle counterpart.
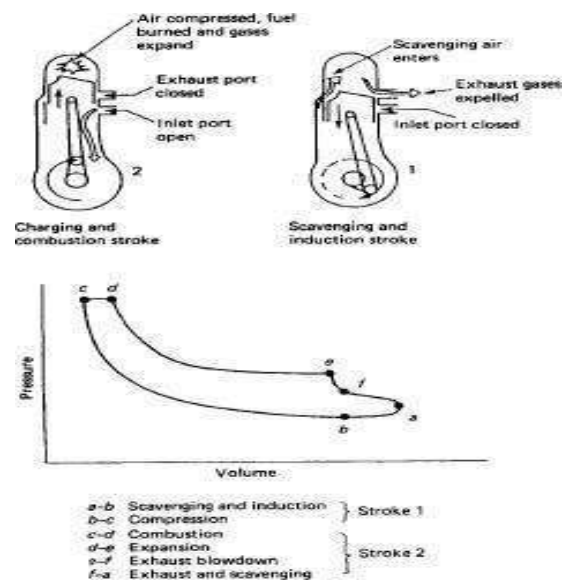
Fig.2. Two-Stroke Cycles

2.3 *Generator*

Generator is electrical device that converts motive power (mechanical energy) into electrical energy by applying magnetic induction principle. Type of generators are AC generator and DC generator.

   a. Generator AC

Magnetic induction principle is a conductor that is moved in magnetic field so that it cuts magnetic flux to create voltage. This condition generates electricity in cycle: +0 -0 (AC) or called alternator. It is a device to convert mechanical energy into electrical energy with magnetic field induction as intermediary. Basic principle of

ACgenerator is Faraday Law stating that if circuits conductor is in alternating magnetic field, electricity movement will reformed. AC Electricity is generated from electromagnetic induction, a wire close to permanent magnetic pole rotating at its axis so electrical voltage at the edge of the circuitwill appear shown by Volt meter, Volt meter indicator will moveright to left showing positive or negative polarity. This changing energy occurs due to changing magnetic field in coil (location of voltage in generator. Field coil in AC generator is at its rotor coil jacket coil is at stator. Shown in folowing picture

Fig.3. Generator AC with Rotor to produce electrical voltage

Generator of one axis with diesel motor, usually uses alternator to generate power. This Generator has high capacity, its magnetic field is rotating because it is located at rotor. Next is construction of AC generator:

1. Stator frame
2. Stator
3. Rotor
4. Sliding ring
5. Strengthening generator

Poles will generate rotating magnetic field. This Generator is called internal pole generator, shown in Figure 4.
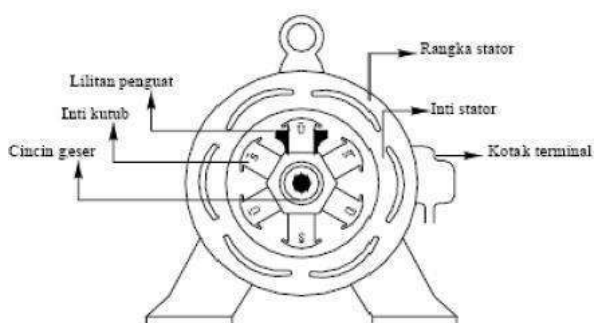
Fig.4. Construction of Magnetic pole generator

b. DC Generator

DC Generator is a mechanical energy converting device that is rotation to be direct current electrical energy. Mechanical energy is used to rotate coil in magnetic field. Usually ship using AC generator or called alternator shown in following picture:
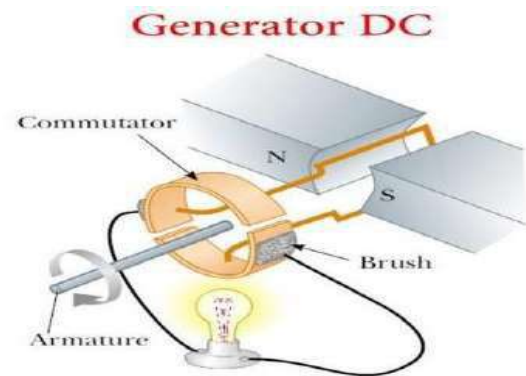
Fig.5: DC generator with Rotor to generate voltage and coil as electrical conductor

2.4 Similarities and Differences of AC and DC Generators

Both have basic construction that is conductor to produce voltage and part that produces magnetic field. Every generator has rotor and dan stator to represent both . Rotor is rotating and stator is static. In DC generator rotor generates voltage, while in AC generator AC generator both, rotor and stator generates voltage.

AC generator with rotor to generate voltage, construction is almost similar with DC generator, but produced voltage is not in direct with comutator but to slip ring and electric current is flowing to stator This type of Generator usually is used for not so big electrical supply. For AC generator to produce voltage, current is flowing to rotor until rotating field occurs in rotor. Advantage of this system is produced voltage can be combined with electrical load and also to reduce short circuit due to not using slip ring or or charcoal brush as conductor because both are difficult for isolation .

Generator Set

Generator set is to convert mechanical energy to electrical energy, therefore generator rotor needs to be rotated. Mechanical energy source can be water turbine, steam turbine motor diesel. Integration of enerator and its mechanical energy is called generator set

Black Out/Emergency condition in ship

Black Out is when electrical supply is interrupted due to oversupply, under supply or telectrical current is too high or too big, for example main genset and controlling system

a panel are damaged, short circuit happens, etc.

2.6 Regulation of Biro Klasifikasi Indonesia (BKI)/ Indonesian Classification Bureau

Biro Klasifikasi Indonesia (BKI) is national classification agent that is to make classification of commercial ship and foreign ship operating regularly in Inonesia. BKI was established to setup technical standard in ship's design and costruction and maritime survey related to floating facility including ship and off shore facility. BKI conducts classification based on engine hull construction and electrical installation in order to evaluate ship's ability to sail/operate.

III.   RESEARCH METHODOLOGY

The research use descriptive method based on:

1. Data Gathering.

   By requesting data to ship owner of Trijaya Bravo 415 GT.

2. Data analysis

Acquired Data is used as reference to conduct ship design literature study. Then data will be processed in Excel to obtain electrical load calculation for LCT 415 GT. This Data is used to choose appropriate generator package set.

Testing was conducted in Computer laboratory of Faculty of Marine Technology, Darma Persada University from March until July 2020.

IV.   RESEARCH AND DISCUSSION

4.1 Data of ship

Data for final assignment is gathered from owner of the ship :

1. Ship Name   : LCT. TRIJAYA BRAVO
2. Ship Type   : Ships for the Carriage of Craft tank
3. Length Over All   : 56,15 M
4. Length Water Line : 52,00 M
5. Length Between P. : 50,50 M
6. Breadth Moulded   : 9,40 M
7. Depth Moulded   : 2,85 M
8. Gross Tonage   : 415 Ton
9. Main Generator   : 2 Units gensets operated, AC 380V/220V, 3Ph, 50Hz 4 Wire 100 Kw, 125KVA, 190A

4.2 Result of Load Need Calculation Analysis in Emergency Condition

Table 1. Load Need in Emergency Condition

No.	Equipment	Load (kw)	Number	Total Load (kw)	Brand	Type
1	Radio equipment	0,5	1	0.500	JRC	JSS-2500
2	Giro compass and pilot	0,05	1	0.050	JRC	APLHATRON Marine
3	Echo Sounder	0,3	1	0.300	Furono	LS 6100
4	General Alarm	0,05	1	0.050	Aqua larm	
5	Integrated Communication	0,06	1	0.060	JRC	Aplha connect 48
6	**Radar**	**4**	**1**	**4.000**	**JMA**	**JMA-1032**
7	AIS and motor horn	0,05	1	0.050	JRC	JHS-183
	Navigation Devices			5.010		
1	Mast Head Light	0,04	1	0.040	WISKA	AS-760-WH-24-PB
2	Acnhor Light	0,01	1	0.010	EVAL	
3	Port Sidde Light (red)	0,0008	1	0.008	OSCULATI	

4	Stern Light	0,13	1	0.130	WISKA	DAS-760-WH-230/230-PB
5	**Star Board Side Light (green)**	**0,025**	**1**	**0.025**	**VETUS**	**SB55VN**
6	Morse Light	0,01	1	0.010	PERKO	
7	Search Light	1	1	1.000	HALOGEN	PSHR-1K
8	Emergency Lightning	0,048	20	0.960	KHJ	Ex-KSF481200
	Navigation Lightning			2.175		
9	Fire and smoke detector	0,0035	10	0.035	Squashni	
10	Fire alarm system	0,37	1	0.370	Minerva	
	Alarm & Detector			0.405		
11	Exhaust Blower Fan	1,5	2	3.000	Hi-Sea	CWL-180G
12	Supply Blower Fan	2,2	2	4.400	Hi-Sea	CWL-200G
	Ventilation Engine Room			7.400		
13	Exhaust Blower Fan	0,06	1	0.060	Hi-Sea	CWL-100D
14	Supply Blower Fan	0,09	1	0.090	Hi-Sea	CWL-100G
	Ventilation For Galley			0.150		
15	Exhaust Blower Fan	0,12	1	0.120	Hi-Sea	CWL-160D
16	Supply Blower Fan	0,37	1	0.370	Hi-Sea	CWL-180D
	Ventilation Steering Room			0.500		
17	Transfer Fuel Pump	1,5	1	1.500	Azcue	CA-80/7A
18	Oily Water Separator	0,8	1	0.800	RWP-VEOLIA	0.1
19	Public Utility & Fire Pump	4	3	12.000	Azcue	CA-50/5A
	Pump			**14.300**		
TOTAL				**29.940 kW**		

4.3 Choosing of Emergency Generator Set

Emergency generator set is assisting device to convert mechanical energy into electrical energy in emergency condition. Basic consideration to choose emergency generator set is because total voltage of ship needed during emergency based on BKI Volume IV Section is 3 29,940 kW Power Supply Installation, total voltage needed of LCT 415 GT during emergency is 29,940 kW. Perkins emergency generator set has specification voltage of 30

kW in 3-phase system. This indicates that this generator to be emergency generator package set for ship LCT 415 GT. This machine has casing to ensure safety of generator machine in extreme weather. Below is specification of Perkins generator package set.

Fig.6. Perkins Emergency Generator Set

Table 2 . Perkins Specification of Emergency Generator Set

Engine Maker		Perkins
Model		1103A-33G
Engine Speed	RPM	1800
Engine Power Output at rated rpm	kWm	36.5
	HP	48.9
Cooling		Radiator Cooled
Aspiration		Natural
Total Displacement	Liter	3.3
No. of Cylinders andBuild		3-inline
Bore and Stroke	mm x mm	105 x 127
Compression Ratio		19 : 25 : 1
Governor		Mechanical
Fuel	Full Load	8.6

Consumption(L/hr)	75% Load	6.6
	50 % Load	4.9
Fuel Tank Capacity (Non-UL)	Liter	130 Open / 180 SAE
Oil Capacity	Liter	8.3
Coolant Capacity	Liter	10.2
Radiator Cooling Air	m^3/min	70

General Arrangement

General arrangement is planning of room/space based on its function and equipment facility. For example cargo space, accomodation room, machine room, etc. Besides, this planning covers location of room and its access. Accoding to Ship Design and Construction, it is divided into four:

a. Decision of main room location

b. Decision of its boundary

c. Decision to choose exact equipment

d. Decision of its access.

Based on acquired data, LCT 415 GT has design of general arrangement shown in Figure 7. This design represents ship prior to using generator set.
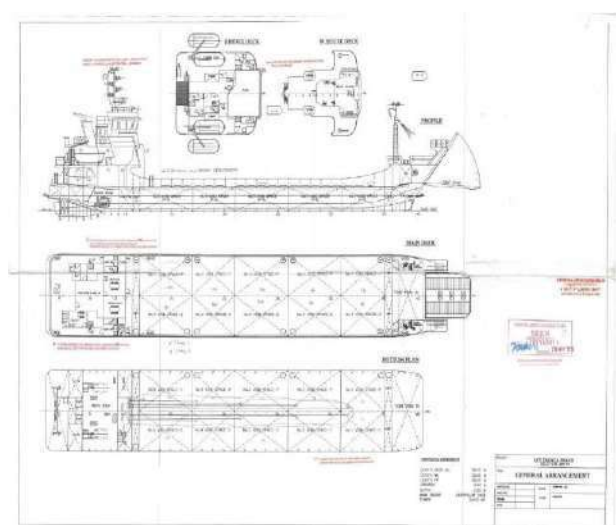
Fig.7: General Rearrangement of LCT. 415 GT

Source: P.T. Indoliziz Marine

Based on planning, generator package set will be put in main deck. Main deck is open area for easy access to operate generator in emergency condition. Below is modification of generator arrangement of LCT 415 GT after the installment of generator package set.
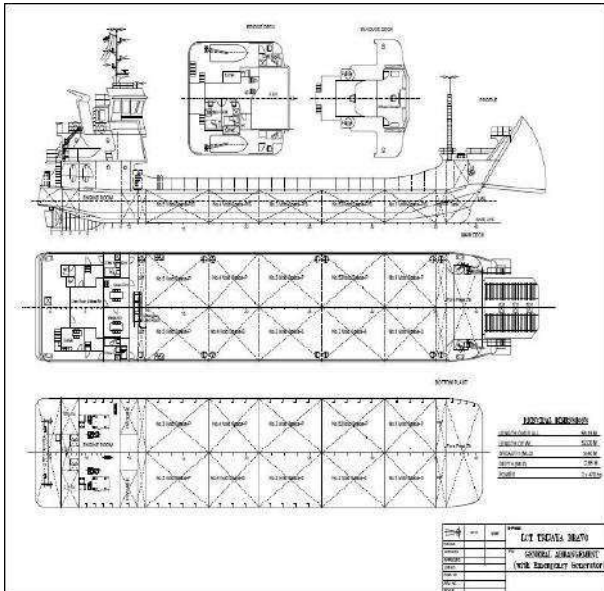
Fig.8: Modification of General Arrangement of

LCT. 415 GT

Source: PT Indoliziz Marine

V.   CONCLUSION

Ship of LCT 415 GT needs total emergency power of 29,940 kW. There is modification   ofLCT 415 one line diagram due to   emergency generator package set installment. Reason of emergency generator package set is based on total emergency power according to BKI regulation and the safety of generator engine package set in extreme weather. Emergency generator package set for tshi p LCT 415 GT is put at open deck that is in line with BKI regulation so it can be accessed if there is fire or other incident .

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Weighted Taylor Series for Water Wave Modeling

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Abstract— In this study, the Taylor series is formulated with a weighted coefficient to time step and spatial interval. With the weighted Taylor series, the weighted total acceleration is formulated on Euler's momentum equation and the Kinematic Free Surface Boundary Condition (KFSBC).

The final part is the development of a time series water wave model using the weighted momentum Euler equation and the weighted KFSBC.

I. INTRODUCTION

Hydrodynamicequationsinclude continuityequationand Euler's momentum equation formulated using the Taylor series $O(\delta^1)$ (Dean (1991). Meanwhile, KFSBC is a total velocity equation of the movement of the water surface in the direction of vertical axis that can be formulated using the Taylor series.

Analytical solutions to Laplace's equation using the separation of variables produce a sinusoidal wave equation (Dean (1991). Thus, the formulation of the equations for the water wave mechanics should be based on the nature of the sinusoidal function. Time step and spatial interval in the Taylor series for sinusoidal equations are correlated with phase speed (Courant (1928)), not with particle velocity. Hence, it is necessary to formulate a Taylor series in which time step and spatial intervals correlate with the water particle velocity. Thus, it can be used in the formulation of basic equations of hydrodynamics that are the basic equations of water wave mechanics.

The first step of this research was formulating the Taylor series for sinusoidal functions where the time step and spatial interval can be correlated with the water particle velocity. At this stage, the weighted Taylor series was produced, that is, the Taylor series in which, there is a weighted coefficient on the time step and spatial interval.

Next, with the weighted Taylor series, the basic equations of hydrodynamics were formulated. They are namely the continuity equation, the Euler's momentum equation, and KFSBC containing a weighted coefficient.

With the basic equations of hydrodynamicscontaining the weighted coefficient, the time series water wave model was formulated.

II. THE FORMULATION OF THE WEIGHTED TAYLOR SERIES

This chapter examining the meaning of $\frac{\delta x}{\delta t}$ in a sinusoidal function and the meaning of $\frac{\delta z}{\delta t}$ in the hyperbolic functions considering the solution of Laplace's equation which is the multiplication of a sinusoidal function with a hyperbolic function (Dean (1991). This chapter is a rewrite of Hutahaean (2021), considering that this section is the basis of the theory developed and at the same time is a correction of typos in Hutahaean (2021).

2.1. An Overview of the Solution of Laplace's equation

Solution of Laplace's equation (Dean (1991) is,

$$\Phi(x, z, t) = G \cosh k(h + z) \cos kx \sin \sigma t \quad .....(1)$$

Particle velocity in the direction of horizontal axis $-x$ is,

$$u = -\frac{d\Phi}{dx} = Gk \cosh k(h + z) \sin kx \sin \sigma t \quad ......(2)$$

The velocity in the direction of vertical axis-$z$is

$$w = -\frac{\mathrm{d}\Phi}{\mathrm{d}z} = -Gk\sinh k(h+z)\cos kx \sin \sigma t \dots(3)$$

k : wave number $= \frac{2\pi}{L}$ (m^{-1})

L : wavelength (m)

σ : angular frequency $= \frac{2\pi}{T}$ (sec^{-1})

T : wave period (sec.)

h : water depth (m)

From Laplace's equation, $\frac{\delta x}{\delta t}$ in the Taylor series for a sinusoidal water wave equation is not the water particle velocity, it should be the wave celerity or wave phase speed. Meanwhile $\frac{\delta z}{\delta t}$ is also a function of wave celerity that is described in the following section.

2.2. A function of a single variable

The first step was examining the characteristics of δt, δx in the sinusoidal function and δz in the hyperbolic function in the Taylor series, in a function of a single variable.The formula of the Taylor series for a function with one variable is:

$$f(x+\delta x) = f(x) + \delta x \frac{df}{dx} + \frac{\delta x^2}{2!}\frac{d^2 f}{dx^2} + \frac{\delta x^3}{3!}\frac{d^3 f}{dx^3}$$

$$+ \frac{\delta x^4}{4!}\frac{d^4 f}{dx^4} + \cdots \dots \dots + \frac{\delta x^n}{n!}\frac{d^n f}{dx^n} \quad \dots(4)$$

a. $f(t) = \cos \sigma t$

The first single-variable of sinusoidal function examinedwas f (t) = cos σt. In his function, the value of δtwas examined, in which the Taylor series can be used with only one derivative. This study was carried out using the Taylor series third order,

$$f(t+\delta t) = f(t) + \delta t \frac{df}{dt} + \frac{\delta t^2}{2!}\frac{d^2 f}{dt^2} + \frac{\delta t^3}{3!}\frac{d^3 f}{dt^3}\dots(5)$$

The second and third differential terms can be ignored if the sum of the two terms is much smaller than the first term:

$$\left|\frac{\frac{\delta t^2}{2!}\frac{d^2 f}{dt^2} + \frac{\delta t^3}{3!}\frac{d^3 f}{dt^3}}{\delta t \frac{df}{dt}}\right| \leq \varepsilon \dots(6)$$

The fourth term, fifth term, and so on can be used. However, considering that δt is a very small number, the fourth and higher differential term is a very small number that can be ignored. Equation (6) is hereinafter referred to as the optimization equation. In (6), the variable to be calculated is δt. While ε is a very small number which will determine the level of accuracy. δt in the denominator with the numerator cancel each other out,

$$\left|\frac{\frac{\delta t d^2 f}{2! dt^2} + \frac{\delta t^2}{3!}\frac{d^3 f}{dt^3}}{\frac{df}{dt}}\right| \leq \varepsilon \qquad \dots(7)$$

The derivatives of the function are

$$\frac{df}{dt} = -\sigma \sin \sigma t \; ; \; \frac{d^2 f}{dt^2} = -\sigma^2 \cos \sigma t \text{ dan } \frac{d^3 f}{dt^3} = \sigma^3 \sin \sigma t.$$

The substitution of the derivative of the function in (7),

$$\left|\frac{\frac{\delta t}{2}(-\sigma^2 \cos \sigma t) + \frac{\delta t^2}{6}(\sigma^3 \sin \sigma t)}{-\sigma \sin \sigma t}\right| \leq \varepsilon$$

This equation is valid for any value of σt as long as it is not equal to zero. It is easier to use the value of $\sigma t$where $\sin \sigma t = \cos \sigma t$.This is called the characteristic point. The final equation is:

$$\left|\sigma \frac{\delta t}{2} - \sigma^2 \frac{\delta t^2}{6}\right| \leq \varepsilon$$

For very small δt, the term in the absolute value sign will be positive. Thus, the absolute sign can be omitted,

$$\sigma \frac{\delta t}{2} - \sigma^2 \frac{\delta t^2}{6} \leq \varepsilon$$

By using an equal sign,

$$-\frac{\sigma^2}{6}\delta t^2 + \frac{\sigma}{2}\delta t - \varepsilon = 0 \qquad \dots(8)$$

Equation (8) is for calculating δt where the Taylor series can be used only with the first differential.

b. $f(x) = \cos kx$

Next, $\delta x$was calculated in the function$f(x) = \cos kx$. In the same way,the obtained formula is,

$$-\frac{k^2}{6}\delta x^2 + \frac{k}{2}\delta x - \varepsilon = 0\dots(9)$$

Equation (9) is for calculating δx where the Taylor series can be used only with the first differential.

c. $f(z) = \cosh k(h+z)$

The function of the next variable is$f(z) = \cosh k(h+z)$. In the same way,the obtained formula is,

$$\frac{k^2}{6}\delta z^2 + \frac{k}{2}\delta z - \varepsilon = 0\dots(10)$$

With (10),δz, can be calculated, where the Taylor series can be used only with the first differential.

In Table (1), it is presented the calculation result ofδt, δx, and δz, with (8), (9), and (10), in which wave number $k$calculated using the dispersion equation of the linear wave theory, at waterdepth of h =10 m.The dispersion equation of the linear wave theory (Dean (1991) is,

$$\sigma^2 = gk \tanh kh \qquad \dots(11)$$

g :gravitational force

Table.1: The calculation results of δt, δx, and δz

T (sec.)	δt (sec.)	δx (m)	δz (m)
6	0,00191	0,01542	0,0154
7	0,00223	0,01905	0,01903
8	0,00255	0,02258	0,02255
9	0,00287	0,02603	0,026
10	0,00319	0,02942	0,02938
11	0,0035	0,03277	0,03273
12	0,00382	0,03609	0,03604
13	0,00414	0,03938	0,03933
14	0,00446	0,04265	0,04259
15	0,00478	0,04591	0,04585

With δt, δx, and δz in Table (1), $\frac{\delta x}{\delta t}$ and $\frac{\delta z}{\delta t}$ was calculated and wave celerity $C = \frac{\sigma}{k}$ was calculated. The calculation results are presented in Table (2).

Tabel.2: The value of $\frac{\delta x}{\delta t}$ and $\frac{\delta z}{\delta t}$, and wave celerity $C = \frac{\sigma}{k}$

T (sec.)	$\frac{\delta x}{\delta t}$ (m/sec)	$\frac{\delta z}{\delta t}$ (m/sec)	$C = \frac{\sigma}{k}$ (m/sec)
6	8,0677	8,05695	8,0677
7	8,54589	8,5345	8,54589
8	8,86229	8,85049	8,86229
9	9,08074	9,06864	9,08074
10	9,23739	9,22508	9,23739
11	9,35337	9,34091	9,35337
12	9,44158	9,429	9,44158
13	9,51022	9,49754	9,51022
14	9,56465	9,5519	9,56465
15	9,60854	9,59574	9,60854

It is interesting that $\frac{\delta x}{\delta t} = \frac{\delta z}{\delta t} = C$. This correlation does not only occur for dispersion equations (11). If (11) is changed, it becomes:

$$\gamma^2 \sigma^2 = gk \tanh kh$$

Where γ is a positive number greater than one, wavelength resulted will be shorter and the relation of $\frac{\delta x}{\delta t} = \frac{\delta z}{\delta t} = C$ is obtained.

2.3. A function of two variables $f(x, t) = \cos kx \cos \sigma t$

The form of Taylor Serieswith two variables with variables (x, t), to ease the writing, it can be written:

$$f(t + \delta t, x + \delta x) = f(t, x) + s_1 + s_2 + s_3 \dots + s_n$$
...(12)

s_1 is the first differential term, s_2 is the second differential term, and so on

Next, the optimization equation is made:

$$\left| \frac{s_2 + s_3}{s_1} \right| \le \varepsilon \dots(13)$$

Function $f(x, t) = \cos kx \cos \sigma t$, is substituted to s_1, s_2, and s_3 to (13) and made at a characteristic point where $\cos kx = \sin kx = \cos \sigma t = \sin \sigma t$. The polynomial equation for δx is:

$$c_0 + c_1 \delta x + c_2 \delta x^2 + c_3 \delta x^3 = 0 \dots(14)$$

$$c_0 = \sigma^2 \frac{\delta t^2}{2} - \sigma^3 \frac{\delta t^3}{6} - \sigma \delta t \varepsilon$$

$$c_1 = -\left(\sigma^2 \frac{\delta t^2}{2} + \sigma \, \delta t + \varepsilon \right) k$$

$$c_2 = (1 - \sigma \delta t) \frac{k^2}{2}$$

$$c_3 = \frac{k^3}{6}$$

The equation can be written into an equation for δt, However, in this study, the equation is made with input δt to calculate δx, where δt is calculated with (8). Table (3) shows the calculation results of wave number k calculated by the dispersion equation of the linear wave theory (11), with water depth of $h = 10$ m.

Table.3 : The results for the calculation of δt and δx with (14)

T (sec.)	δt (sec.)	δx (m)
6	0,00191	0,04628
7	0,00223	0,05719
8	0,00255	0,06778
9	0,00287	0,07813
10	0,00319	0,08831
11	0,0035	0,09836
12	0,00382	0,10831
13	0,00414	0,11819
14	0,00446	0,12801
15	0,00478	0,13779

With δt and δx in Table (3), $\dfrac{\delta x/\delta t}{C}$ is calculated with the calculation in Table (4).

Table.4: The value of $\dfrac{\delta x/\delta t}{C}$

T (sec)	$\dfrac{\delta x}{\delta t}$ (m/sec)	$C = \dfrac{\sigma}{k}$ (m/sec)	$\dfrac{\delta x/\delta t}{C}$
6	24,2138	8,0677	3,00133
7	25,649	8,54589	3,00133
8	26,5987	8,86229	3,00133
9	27,2543	9,08074	3,00133
10	27,7245	9,23739	3,00133
11	28,0726	9,35337	3,00133
12	28,3373	9,44158	3,00133
13	28,5433	9,51022	3,00133
14	28,7067	9,56465	3,00133
15	28,8384	9,60854	3,00133

In contrast to the results of separate calculations, using equations derived from equations $f(x,t)$ it was obtained that $\dfrac{\delta x}{\delta t} = 3.00133\ C$, this fits the criteria of Courant (1928) that $\dfrac{\delta x}{\delta t} = 3\ C$.

1.4. A function with three variables
, $f(x,z,t) = \cos kx \cos \sigma t \cosh k(h+z)$

The Taylor series for a function with three variables up to the third derivative is $f(t+\delta t, x+\delta x, z+\delta z) = f(t,x,z) + s_1 + s_2 + s_3$

with s_1, s_2, and s_3 in Table (5)

Table.5: Element s_1, s_2 and s_3

s_1	s_2	s_3
$\delta t \dfrac{\partial f}{\partial t}$	$\dfrac{\delta t^2}{2}\dfrac{\partial^2 f}{\partial t^2}$	$\dfrac{\delta t^3}{6}\dfrac{\partial^3 f}{\partial t^3}$
$+\delta x \dfrac{\partial f}{\partial x}$	$+\delta t\delta x \dfrac{\partial^2 f}{\partial t\partial x}$	$+\dfrac{\delta t^2}{2}\delta x \dfrac{\partial^3 f}{\partial t^2\partial x}$
$+\delta z \dfrac{\partial f}{\partial z}$	$+\delta t\delta z \dfrac{\partial^2 f}{\partial t\partial z}$	$+\dfrac{\delta t^2}{2}\delta z \dfrac{\partial^2 f}{\partial t^2\partial z}$
	$+\dfrac{\delta x^2}{2}\dfrac{\partial^2 f}{\partial x^2}$	$+\delta t \dfrac{\delta x^2}{2}\dfrac{\partial^3 f}{\partial t\partial x^2}$
	$+\delta x\delta z \dfrac{\partial^2 f}{\partial x\partial z}$	$+\delta t\delta x\delta z \dfrac{\partial^3 f}{\partial t\partial x\partial z}$
	$+\dfrac{\delta z^2}{2}\dfrac{\partial^2 f}{\partial z^2}$	$+\delta t \dfrac{\delta z^2}{2}\dfrac{\partial^3 f}{\partial t\partial z^2}$
		$+\dfrac{\delta x^3}{6}\dfrac{\partial^3 f}{\partial x^3}$
		$+\dfrac{\delta x^2}{2}\delta z \dfrac{\partial^3 f}{\partial x^2\partial z}$
		$+\delta x\dfrac{\delta z^2}{2}\dfrac{\partial^3 f}{\partial x\partial z^2}$

Substitution,

$f(x,z,t) = \cos kx \cos \sigma t \cosh k(h+z)$

to s_1, s_2 and s_3 and optimization equation done at characteristic points and in conditions $\cosh k(h+z) = \sinh k(h+z)$, equations for δz was obtained, where δt and δx as input, δt was calculated using (8) while δx was calculated using (14),

$c_0 + c_1\delta z + c_2\delta z^2 + c_3\delta z^3 = 0$ ….(15)

With elements of c_0, c_1, c_2 and c_3 in Table (6)

The condition $\cosh k(h+z) = \sinh k(h+z)$ can be obtained in deep water. However, it does not mean that the obtained equation only applies to deep waters, it also applies to shallow waters. This is considering the conservation law of the wave number (Hutahaean (2020):

$\dfrac{\partial k(h+z)}{\partial x} = 0$ ……..(16)

Table.6: Elements of c_0, c_1, c_2, and c_3

c_0	c_1	c_2	c_3
$\varepsilon\sigma\delta t$	$-\varepsilon k$	$\dfrac{k^2}{2}$	$\dfrac{k^3}{6}$
$+\varepsilon k\delta x$	$-\sigma k\delta t$	$-\dfrac{\sigma k^2}{2}\delta t$	
$-\sigma^2\dfrac{\delta t^2}{2}$	$-k^2\delta x$	$-\dfrac{k^3}{2}\delta x$	
$+\sigma k\delta t\delta x$	$-\sigma^2 k\dfrac{\delta t^2}{2}$		
$-k^2\dfrac{\delta x^2}{2}$	$+\sigma k^2\delta t\delta x$		
$+\sigma^3\dfrac{\delta t^3}{6}$	$-k^3\dfrac{\delta x^2}{2}$		
$+\sigma^2 k\dfrac{\delta t^2}{2}\delta x$			
$+\sigma k^2\delta t\dfrac{\delta x^2}{2}$			
$+k^3\dfrac{\delta x^3}{6}$			

Table (7) shows the calculation results of δt, δx, and δz where k was calculated by the dispersion equation

of the linear wave theory (11), with the water depth of h =10 m.

Table.7: The calculation results of δt, δx and δz

T	δt	δx	δz
6	0,00191	0,04628	0,13914
7	0,00223	0,05719	0,17195
8	0,00255	0,06778	0,20379
9	0,00287	0,07813	0,23491
10	0,00319	0,08831	0,26551
11	0,0035	0,09836	0,29573
12	0,00382	0,10831	0,32566
13	0,00414	0,11819	0,35536
14	0,00446	0,12801	0,38489
15	0,00478	0,13779	0,41427

With δt, δx and δz in Table (7), $\frac{\delta x}{\delta t}$ and $\frac{\delta z}{\delta t}$ was calculated with the results presented in Table (8)

Table.8: The calculation results of $\frac{\delta x}{\delta t}$ and $\frac{\delta z}{\delta t}$ and C

T (sec)	$\frac{\delta x}{\delta t}$ (m/sec)	$\frac{\delta z}{\delta t}$ (m/sec)	$C = \frac{\sigma}{k}$ (m/sec)
6	24,2138	72,8026	8,0677
7	25,649	77,1177	8,54589
8	26,5987	79,9729	8,86229
9	27,2543	81,9442	9,08074
10	27,7245	83,3578	9,23739
11	28,0726	84,4044	9,35337
12	28,3373	85,2004	9,44158
13	28,5433	85,8197	9,51022
14	28,7067	86,311	9,56465
15	28,8384	86,7071	9,60854

With $\frac{\delta x}{\delta t}$ and $\frac{\delta z}{\delta t}$ dan C in Table (8) $\frac{\delta x/\delta t}{C}$, $\frac{\delta z/\delta t}{C}$ and $\frac{\delta z}{\delta x}$ was calculated with the results presented in Table (9).

Table.9: The calculation results of $\frac{\delta x/\delta t}{C}$, $\frac{\delta z/\delta t}{C}$ and $\frac{\delta z}{\delta x}$

T (sec)	$\frac{\delta x/\delta t}{C}$	$\frac{\delta z/\delta t}{C}$	$\frac{\delta z}{\delta x}$
6	3,00133	9,02395	3,00665
7	3,00133	9,02395	3,00665
8	3,00133	9,02395	3,00665
9	3,00133	9,02395	3,00665
10	3,00133	9,02395	3,00665
11	3,00133	9,02395	3,00665
12	3,00133	9,02395	3,00665
13	3,00133	9,02395	3,00665
14	3,00133	9,02395	3,00665
15	3,00133	9,02395	3,00665

Referring to the calculation results in Table (9) relations can be formulated:

$$\delta x = \frac{\sigma}{k} \gamma\, \delta t \quad …..(17)$$

$$\delta z = \frac{\sigma}{k}\gamma^2\, \delta t \quad …….(18)$$

With separate claculation as a function of single variable, $\frac{\delta x}{\delta t} = \frac{\delta z}{\delta t} = C$ was obtained, or $\gamma = 1$ whereas with the simultaneous calculation $\frac{\delta x}{\delta t} = 3C$ and $\frac{\delta z}{\delta t} = 9C$ is obtained or $\gamma = 3$, all are related to wave celerity C. Thus, to make $\frac{\delta x}{\delta t}$ closer to horizontal velocity u and $\frac{\delta z}{\delta t}$ closer to vertical velocity w, Weighted Taylor series $O(\delta^1)$ on sinusoidal function $f(x,t)$ should be in the form,

$$f(x + \delta x, t + \delta t) = f(x,t) + \gamma\delta t \frac{\partial f}{\partial t} + \delta x \frac{\partial f}{\partial x}.(19)$$

Where the total acceleration obtained,

$$\frac{Df}{dt} = \gamma \frac{\partial f}{\partial t} + u \frac{\partial f}{\partial x} \quad ……(20)$$

Meanwhile, for the function $f(x,z,t)$, the form of Taylor series $O(\delta^1)$ is,

$$f(x + \delta x, z + \delta z, t + \delta t) =$$

$$f(x,z,t) + \gamma^2 \delta t \frac{\partial f}{\partial t} + \gamma\delta x \frac{\partial f}{\partial x} + \delta z \frac{\partial f}{\partial z}…(21)$$

With total acceleration,

$$\frac{Df}{dt} = \gamma^2 \frac{\partial f}{\partial t} + \gamma u \frac{\partial f}{\partial x} + w \frac{\partial f}{\partial z} …..(22)$$

III.   WEIGHTED CONTINUITY EQUATION, EULER'S MOMENTUM EQUATION,AND KFSBC

3.1. Weighted Continuity Equation.
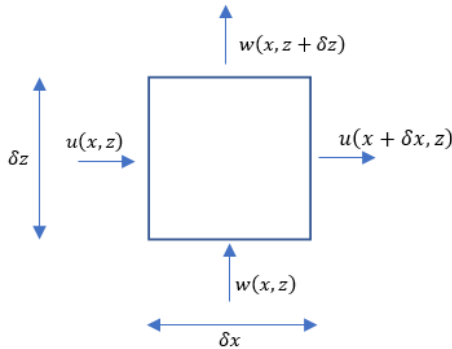
Fig.1: Control Volume for the Continuity

Equation Formulation

At $t = t$, thus (22) can be written,

a.   For constant z

$$f(x + \delta x, z, t) = f(x, z, t) + \gamma \delta x \frac{\partial f}{\partial x}....(23)$$

b.   For constant x

$$f(x, z + \delta z, t) = f(x, z, t) + \delta z \frac{\partial f}{\partial z}......(24)$$

The law of conservation of mass for the volume of a constant control volume (Fig. (1) and for incompressible flow,

$$I - O = 0$$

$$I = \rho u(x, z, t)\, \delta z + \rho w(x, z, t)\, \delta x$$

$$O = \rho \left(u(x, z, t) + \gamma \delta x \frac{\partial u}{\partial x} \right) \delta z$$

$$+ \rho \left(w(x, z, t) + \delta z \frac{\partial w}{\partial z} \right) \delta x$$

Subtraction and equation are divided by $\rho \delta x \delta z$, weighted continuity eqation is obtained,

$$\gamma \frac{\partial u}{\partial x} + \frac{\partial w}{\partial z} = 0 \quad ....(25)$$

3.2.Weighted Euler's Momentum Equation

Using (22), weighted Euler's Momentum Equation in the direction of the direction of horizontal axis-$x$and in the vertical axis-$z$are

$$\gamma^2 \frac{du}{dt} + \gamma u \frac{du}{dx} + w \frac{du}{dz} = -\frac{1}{\rho}\frac{dp}{dx} ....(26)$$

$$\gamma^2 \frac{dw}{dt} + \gamma u \frac{dw}{dx} + w \frac{dw}{dz} = -\frac{1}{\rho}\frac{dp}{dz} - g....(27)$$

3.3. Weighted KFSBC.

The known KFSBC (Dean (1991) is,

$$w_\eta = \frac{\partial \eta}{\partial t} + u_\eta \frac{\partial \eta}{\partial x}$$

$w_\eta$is the water particle velocity on the surface which is the total velocity of the water level elevation$\eta(x, t) = \cos kx \cos \sigma t$, while theweighted total acceleration of water level elevation with(20) is

$$\frac{D\eta}{dt} = \gamma \frac{\partial \eta}{\partial t} + u_\eta \frac{\partial \eta}{\partial x}$$

Thus, wigthed KFSBC is,

$$w_\eta = \gamma \frac{\partial \eta}{\partial t} + u_\eta \frac{\partial \eta}{\partial x}.....(28)$$

IV.   THE APPLICATION INTIME SERIES WATER WAVE MODELING

In this section, the governing equations for time series modeling water wavesare formulated. The governing equations consists of two equations, they are the water surface elevation equation and the particle velocity equation. The variable of particle velocity in this equation is the depth-averaged velocity.

a.   Water surface elevation equation

The Continuity equation (25)is multiplied by đzand integrated with water depth. . Integration of the first term is completed with the Leibniz integral (Protter, Murray, Morrey, Charles, 1985).KFSBC and bottom boundary condition were calculated,

$$\gamma \frac{\partial}{\partial x} \int_{-h}^{\eta} u \ dz - (\gamma - 1)u_\eta \frac{\partial \eta}{\partial x} + \gamma \frac{\partial \eta}{\partial t} = 0...(29)$$

The integration of the left-hand first term is solved by using the particle velocity equation for the solution of Laplace's equation (2). From (2), the relation of the direction of horizontal axis of particle velocity at an elevation z to the horizontal velocity at elevation η is

$$u = \frac{\cosh k\,(h + z)}{\cosh k(h + \eta)} u_\eta$$

Left hand integration (29) becomes,

$$\int_{-h}^{\eta} u \, dx = \int_{-h}^{\eta} \frac{\cosh k\,(h + z)}{\cosh k(h + \eta)} \, dz \ u_\eta$$

Integration is completed using $\eta = \frac{A}{2}$and defined by $H = h + \frac{A}{2}$ and calculated in deep water depth wheretanh $k\,(h + \eta) = 1$,

$$\int_{-h}^{\eta} u\, dx = \frac{u_\eta}{k}$$

Conservationlaw of the wave number (Hutahaean (2020) is,

$$\frac{\mathrm{d}k\left(h + \frac{A}{2}\right)}{\mathrm{d}x} = 0$$

or

$$k\left(h + \frac{A}{2}\right) = k_0\left(h_0 + \frac{A_0}{2}\right)$$

In deep water $\tanh k_0\left(h_0 + \frac{A_0}{2}\right) = 1$ where $k_0\left(h_0 + \frac{A_0}{2}\right) = \theta\pi$, a relation is obtained

$$k = \frac{\theta\pi}{\left(h + \frac{A}{2}\right)} = \frac{\theta\pi}{H}$$

The final result of integration is,

$$\int_{-h}^{\eta} u\, dx = \frac{u_\eta H}{\theta\pi}$$

Substitute to (29),

$$\frac{\partial \eta}{\partial t} = -\frac{1}{\theta\pi}\frac{\partial u_\eta H}{\partial x} + \frac{(\gamma - 1)}{\gamma} u_\eta \frac{\partial \eta}{\partial x} \dots\dots(30)$$

As mentioned earlier, the modeling uses depth-averaged velocity. The horizontal depth average velocity U is defined as the particle velocity at the leevation $z = z_0$ below the SWL, where z_0 is a negative number. From (2):

$$\frac{u_\eta}{U} = \frac{\cosh k\, H}{\cosh k(h + z_0)}$$

Is defined:

$$\alpha = \frac{\cosh kH}{\cosh k(h + z_0)} \quad \dots\dots(31)$$

Thus, the relation of horizontal surface velocity with horizontaldepth-averaged velocityis:

$$u_\eta = \alpha U \qquad\qquad \dots\dots(32)$$

Substitute to (30)

$$\frac{\partial \eta}{\partial t} = -\frac{\alpha}{\theta\pi}\frac{\partial UH}{\partial x} + \frac{(\gamma - 1)}{\gamma}\alpha U \frac{\partial \eta}{\partial x} \dots\dots(33)$$

z_0 is calculated by the following equation,

$$\frac{1}{UH}\int_{-h}^{A/2} u\, dz = 1$$

From (2) and the definition ofdepth-averaged velocity,

$$u = \frac{\cosh k\,(h + z)}{\cosh k(h + z_0)} U$$

The characteristic of z_0 is,

$$\frac{1}{UH}\int_{-h}^{A/2} \frac{\cosh k\,(h + z)}{\cosh k(h + z_0)}\, dz\, U = 1$$

From this equation the equation for z_0 is formulated:

$$kH\, \cosh k(h + z_0) - \sinh kH = 0 \dots(34)$$

The calculation of α in (31)and in the calculation of z_0 (34), in the deep water depth,requires deep water depth depth value h_0. wave number k_0 is calculated bydeep-water weighted linear wave dispersion equation,

$$k_0 = \frac{\gamma^2 \sigma^2}{g}$$

As deepwater depth:

$$h_0 = \frac{\theta\pi}{k_0} - \frac{A_0}{2}$$

Deep water depth is used to calculate α. Considering conservation law of the wave number, the value of α is constant.

b.   Horizontal velocity equation

Weighted horizontal surface momentum equation (Hutahaean (2021), is,

$$\gamma^2 \frac{\mathrm{d}u_\eta}{\mathrm{d}t} + \frac{1}{2}\frac{\mathrm{d}}{\mathrm{d}x}\left(\gamma u_\eta u_\eta + w_\eta w_\eta\right) = -g\frac{\mathrm{d}\eta}{\mathrm{d}x}$$

By substituting surface velocity with (32) andby neglecting convective acceleration,

$$\frac{\mathrm{d}U}{\mathrm{d}t} = -\frac{g}{\alpha\gamma^2}\frac{\mathrm{d}\eta}{\mathrm{d}x} \dots(35)$$

c.   Model Results

The Finite Difference Method for spatial differentials uses numerical solutions, while time differentials are solved by the predictor-corrector method for numerical integration (Hutahaean, 2019). The time step δt was determined with (8), using $\varepsilon = 0.005$, while the grid size of δx was calculated with (17).The model exectheir was made using weighting coefficient $\gamma = 3.0$, deep water coefficient $\theta = 2.0$, $\tanh\theta\pi = 0.99999$.

As the first case, the model was done on a channel with a constant depth $h = h_0 = 14$ m. In the channel there are sinusoidal waves with wave period $T = 8$ sec. and wave

amplitude $A = 1.0$ m. The model results are presented in Fig. (2). Fig (2) shows that the model can simulate well the short waves with large amplitudes.
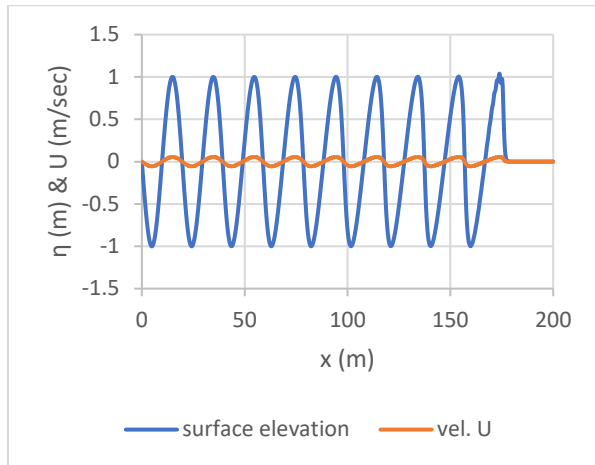
Fig.2: Model Results on Flat Bottom

In the next case, the model was made on a sloping bottom with a bottom slope $\frac{dh}{dx} = -\frac{13}{200}$. Downstream water depth is $h_0 = 14$ m, while upstream water depth is 1.0 m. The incoming wave of sinusoidal wave with the wave period of $T = 8$ sec. and wave amplitude of $A = 0.8$ m. The model results are presented in Fig.(3).
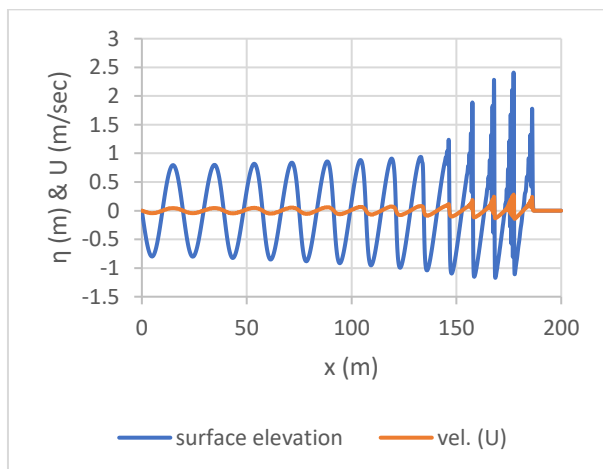
Fig.3: Model Results on Sloping Bottom.

The model results show that initially shoaling occurred, then the waves became unstable at waterdepth of 4 m and then the breaking peak occurs at a water depth of 2.60 m.

V.   CONCLUSION

Some conclusions are drawn from this study. The first is that the application of the Taylor series to the sinusoidal wave equation should use time step and spatial intervals correlated with phase speed. Thus, it can be correlated

with the water particle velocity, a weighting coefficient must be obtained. The Taylor series with the weighting coefficient is hereinafter referred to as the weighted Taylor series that only uses the first derivative.

The formulation of hydrodynamic equations with the weighted Taylor series produces equations with the weighting coefficient, including the weighted continuity equation, the weighted Euler's momentum equation, and the weighted KFSBC.

The next conclusion is that by using the weighted equations, the time series of the wave equation is obtained to simulate a shortwave where short wavelengths are produced and there is a breaking phenomenon.

The determination of the time step and gridsize in numerical modeling using the Finite difference method can use the equations formulated in this study.

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The PBL method and the performance of Teachers from the Pitágoras Medicine Faculty of Eunápolis-BA: A Case Study

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Abstract— The present study is a qualitative research of an ethnographic nature, carried out in the field of education, to raise comparative aspects through a case study. The scenario of this research occurred simultaneously with the challenges and transformations that the professors of the Faculdade Pitágoras de Medicina de Eunápolis are facing with the innovative methodology adopted by the institution, which started its activities in September 2018. In 2001, it was defined by the Ministry of Education and Culture (MEC) that Brazilian medical schools would have as their National Curriculum Guidelines (DCN) the guidance of their educational guiding matrices, the formation of a graduate with a profile to meet the needs of the country's health system. These new directions would bring great changes in the objectives and in the form of education for the new faculties recently implanted in several Brazilian states. In order to obtain new skills and competences, the courses would start using active teaching-learning methodologies with a focus on the attention to biopsychosocial aspects, employing areas of competence in the dimensions of management, education and health care. The research does not pretend to be a static or final point, it only reveals the moment when medical education passes through the new challenges of the methodological transition, and can be a tool for reflective analysis for the implementation of the next periods throughout the Medicine course inEunapolis. The research result was satisfactory and the method was well accepted by the team.

I. MEDICINE AND ITS TRANSFORMATIONS THROUGHOUT BRAZILIAN HISTORY

This chapter is dedicated to the account of the long historical path that Brazilian medicine contributed to the establishment of the first schools of medical education and the context in which it began. From the discovery of Brazil until the arrival of Dom Joao VI in 1808, the scenario of care for the sick was linked to indigenous wisdom, especially to the knowledge that the Indians had of the roots and leaves as antidotes for healing diseases, as well as the action of the missionaries who, when they arrived here, specialized in the knowledge of popular medicine, creating botanicals for this purpose. We cannot forget yet a few doctors who came from Portugal because they were working on sick care. We cannot, in the end, forgetting the popular practices of Africans and Portuguese settlers who were often used in the hope of reducing the suffering of those afflicted by diseases. Freyre (1992), in his work Casa-grande e senzala, reports the way in which medicine was practiced by Portuguese colonists and peoples of indigenous African cultures:

Since the arrival of the Portuguese crown to colonial Brazil, the medical education scene has obtained greater possibilities for progress in the face of the various

difficulties of the time for the concretization and institutionalization of an organized civilization. The forging of science discourse took many years since the 16th century, and, around the third decade after the discovery of Brazil, the first medical activists began to arrive. The art of healing was carried out with few therapeutic resources, brought from the Iberian Peninsula to a tropical country. Local diseases were treated by shamans who took advantage of the local flora to cure diseases.

In the isolation of new lands, there was only the shamanism and the work of the Jesuits in dealing with tropical diseases that are still little known. Years, decades and centuries passed and the evolution of treatment was ephemeral even in Europe, at least to face the pathologies of the time that devastated

The relationship of health as an institutional policy began with the creation of the Liga Pró-Saneamento in 1918, a project at the national level that aimed at valuing rural people. Driven by sentiment after the Spanish flu epidemic, the health defense movement was carried out on expeditions in favor of an agricultural Brazil, the main economic activity at the time. The appeal to treat rural endemic diseases denounced the conditions in which the agrarian populations that faced diseases, such as yellow fever, chagas diseases, malaria and cholera lived. and contribute to improving the economy and health of men in the field.

Politically, it was not so easy to resolve the logic of centralization of power in the State, as there was still no clear model of what the division of financial resources would be between the most productive and the poorest states. Wealthier states like São Paulo differed from the poorest states in the federation in terms of the amount of funds raised. Poor states did not have the structural and installed capacity to combat their daily problems, and in 1923, São Paulo stood out with the creation of its own department, the National Department of Public Health (DNSP). It was an autonomous body, but it allowed the federal government to inference, in cases of epidemic outbreaks, if needed. According to Fonseca (2007), in 1930 the Ministry of Education and Public Health (Mesp) was born, which was the first centralizing and

institutionalizing body created to think about policies at the national level. Only in 1937, under the dictatorial regime, was the National Health Department (DNS) born, which aimed to implement norms and standardize national activities with a view to decentralizing their execution at the state level.

The current health policy has its basic guidelines for public health and hospital services. In the 1930s, Brazil created several ministries, such as work, and organized legislation with several decrees, such as the creation of pension funds, for example, in all cases and pensions. of health. Political development around the guarantee of health rights began with increasingly greater inclusions in society. The evolution of the Ministry of Health (MS) and of education occurred in response to demands and social and political transformations. For many years,

statewide.

At the beginning of this century, the federal government's strategy to open more health facilities and increase the coverage of health care for the population, through basic health care,

II.   METHODOLOGICAL ROUTE

The qualitative research had a characteristic that allows the author to participate in the phenomena that seek to capture, during the literary survey and interviews to be carried out, the objective to achieve the content of the interpretation of the research reality. The intention was to understand, by comparing the methods, that teachers with experience in the traditional method are adapting to the PBL in view of the results. At the end of the scientific search, the selection of the sample to be researched and the interviews, I analyzed the data that brought meaning to society.

When starting the course on September 18, 2018, the group of educators was composed of professionals graduated in different backgrounds. The selection followed the criterion of experience of the least two years. Four doctors, four were selected. Of the group of biologists, only two experienced the atmosphere of the traditional classroom, a psychologist and a pharmacist, the latter with experience of higher education teachers.

Table 1 - Demonstrative table of teachers of the first year of medicine in Eunápolis-BA

Teacher	Teaching experience	University graduate
Teacher 1	06 years	Medicine
Teacher 2	06 years	Medicine
Teacher 3	Did not have	Biology
Teacher 4	Did not have	Biology

Teacher 5	08 years	psychology
Teacher 6	Did not have	Biology
Teacher 7	07 years	Biology
Teacher 8	Did not have	Biology
Teacher 9	Did not have	Medicine
Teacher 10	15 years	Pharmaceutical
Teacher 11	4 years	Medicine
Teacher 12	06 years	Medicine
Teacher 13	02 years	Biology

Source: Human Resources Sector, Faculdade Pitágoras de Medicina, Eunápolis, 2018.

After the sample selection, seven teachers were within the criterion of previous experience in the traditional methodology for more than two years, as shown in Table 2 (teachers qualified for the interviews).

Chart 2 - Teaching staff selected for the comparative study of the research at Faculdade Pitágoras de Medicina de Eunápolis

Teacher	**Teaching experience**	**University graduate**
Teacher 1	06 years	Medicine
Teacher 2	06 years	Medicine
Teacher 3	08 years	psychology
Teacher 4	07 years	Biology
Teacher 5	4 years	Medicine
Teacher 6	06 years	Medicine
Teacher 7	02 years	Biology

Source: Information provided by the Human Resources department of the Pitágoras de Medicina Faculty of Eunápolis, 2018.

This nomenclature used in the table indicating the teacher and the number refers to the ordering of the semi-structured interviews that, after having been carried out, were transcribed and thus used throughout the analysis, preserving the name of the teachers.

To facilitate the analysis of the collected data, I sequenced it in phases to facilitate the treatment of the results. In the first phase, I took care of correcting transcriptions originating from audio recordings. Then, I tried to synthesize parts of the reports in paper clippings (pamphlets), which I called nuclei of meaning.

III. PRESENTATION AND DISCUSSION OF DATA

When analyzing the data of this research, I considered it important to portray the description of each one of the five themes a little. According to chapter 3 (methodological path), each theme was called an axis. The five axes originated from the biggest challenges we faced in the first year of the medical course, when working with the innovative pedagogy adopted by the Pitágoras Faculty of Eunápolis.

In axis 1, my comparative intention was to measure the differences between the two methodologies in terms of lesson planning and I asked teachers to comment on their experience.

After the transcription of the interviews, find the difficulty of starting the sequence of filipinas due to the richness and the amount of similar phrases. I found the possibility of nuclear this item in three more significant points: the first dealt with the difficulties and facilities of the idealization of the classes; the second portrayed the teacher's change in posture, and the third consisted of the nucleation of phrases that reported the application of the method in the classroom.

Regarding the criterion of difficulty and ease between the methods to prepare the classes, at first glance three teachers stated that the difficulty in planning in the PBL was related to the exposure of the content and this was exposed in the sentence of Professor 6, who portrayed that "[.. .] in the traditional model it is easier because you are able to prepare the whole class before it happens ". Previously using the traditional method, it was enough for the teacher to master the content, to review his synthesis in a classroom for students "[...] replicating the production of his class in other classes for later classes" (PROFESSOR 2).

As a result of the interviews, questions arose, such as: "And now?" "How am I going to do when I arrive in front of the students to start classes?" "What am I going to write to pass on the knowledge?" "Should I create a step-by-step to get to the front of the students and start a class on the subject?" Doubts like that were raised by Professors 2, 4 and 5.

The making of a class in the traditional method, usually in Datashow, served as the proper planning of the content to be passed on to students.Silva (2013) says that this technology was widely disseminated in higher education in which all teachers were applying this tool with teachers.

knowledge, having the role of transmitting the content of their class schedule through slides.

The insertion of technologies in the classroom did not replace the teacher, quite the opposite, it expanded the possibilities of the educational practice of this professional. However, the presence of technological resources required a new attitude from the teacher. From the sole holder of knowledge, who will transmit it to the student (SILVA, 2013, p. 11).

The teachers' report, when they joined the PBL, shows that this technological tool is no longer the main tool. In active pedagogy, the teacher does not have complete mastery of what will happen in the classroom, for having left the role of transferring knowledge. As Professor 3 reported, "[...] the facilitator becomes the stimulator for the construction of knowledge, leading and directing the frontiers of knowledge established in the modular units of the content".

Therefore, the planning of the classroom should provide a measure of time to encourage the student to complete a cycle in which he himself is self-taught and motivated to solve the problem situations presented. Planning in the PBL includes a more proactive movement by the teacher. According to Toledo Júnior (2008), it is necessary to elaborate situations that are inclusive, so that students feel part of the problem through previous knowledge and their curiosity and he is encouraged to build knowledge alone or with his group of colleagues.

The PBL includes the structuring of knowledge within a specific context, allows the student to face concrete problems, which could enhance the development of clinical reasoning, favors the development of self-directed study skills and increased motivation for study.

The PBL method values, in addition to the content to be learned, the way learning occurs, reinforcing the student's active role in this process, allowing him to learn how to learn (TOLEDO, 2008, p. 126).

He perceived anguish of colleagues throughout the interviews, due to the new format that they should have to prepare their lesson plans under the new model.

Professor 5 said: "[...] in the traditional method we prepared the class as holders and authorities of knowledge and it was up to the student to absorb, already in this new method the student must build his knowledge". It was evident, in my analysis, that the interviewees 1, 3, 5 and 6 of this axis effectively believe that knowledge should be built instantly by the students, with the teacher being able to guide the trajectory so that his students reach the proposed objectives.

Regarding the second criterion (teacher postural change), the teachers attributed the new paradigm to the alternation of the content transmission board to a tutor or knowledge advisor. The difficulty in changing the logic of the content transmission generated discomfort that led to a strangeness in the first moment.

These second criteria for the displacement of the place of the teacher at the center of both theoretical and practical learning activity. Four of the seven teachers reported that the preparation required greater teacher discipline in studying the content and describing a lesson program with a step by step, so that the teacher would not be the main teacher of the classroom. Professor 7 also reinforced that this role places the student at the center of the learning activity, whether theoretical or practical.

Another point that demanded the educator's postural change was made clear in Professor 1's account: "[...] PBL requires a change in the teacher's place of speech [...]" and "[...] the method reverses the logic of knowledge transmission for the production of it ". These reports enriched my perception, knowing that, even with a short time in teaching practice, a large part of the teaching staff embraced the method's intentionality and dedicated themselves to changing their paradigms in relation to their own postural change. possible; teaching requires understanding that education is a form of intervention in the world; teaching does not transfer knowledge. Creating possibilities to build and produce in the perspective in which the student is autonomous, we induce him to study through his doubts and concerns as part of classes. This displacement of the listener to a more participatory, reflective and questioning role is the objective of the method in the formation of the professional of the future. When entering with the PBL strategies, the student comes into contact with the world of laboratory practice protected from the institution consortium with the real practice of SUS lived in health centers.

The same approach of attention should be given to the specific objectives of the content covered, to avoid students' daydreams during the construction of knowledge. Before, in the traditional, the teacher read the proposed objectives and went to the construction of his class. Based on innovative pedagogy, the discipline of

teacher to follow the specific objectives must be reviewed at all times, during the stimulation and construction of knowledge by students in the trajectory of what was planned.

The third criterion analyzed in this first axis (planning) was reported by six teachers of the seven interviewees who mentioned that the active method of learning requires greater teacher preparation. According to the perception of educators, reports such as Professors 1, 3, 4, 5, 6 and 7 mention that "[...] in PBL it takes much more time to plan, as it requires greater creativity, greater articulation of different types of knowledge to integrate practice with theory ". I noticed the challenge in the statements cited in the elaboration of classes that were dynamic and contemplated the general and specific objectives, so that the student triggers the construction of his knowledge, conquering the understanding of the content in significant ways.

This integration of knowledge really requires a greater teaching domain to trigger, direct and integrate the frontiers of knowledge involving practical and human skills than simply elaborating a class in the traditional method.

It was clear, in line with these six teachers, that, when executing the plan of the classes elaborated in advance of the class week, the teacher should stick to the objectives of the modular contents, and not to his scientific summary, which they used to do in the traditional method. classroom.

Not traditional, the way to plan, many times, already included the way to pass the content through the expository class, as previously mentioned by slides. The domain of the class was verticalized, that is, the teacher ministered to the student who occupied the role of listener. With this new challenge of innovative pedagogy, in addition to the domain of knowledge, the teacher must be prepared for the different situations that the student will create with his group, changing to a more horizontal way in the construction of knowledge.

The teacher awakens the student to new paths by asking questions that lead to reflection and knowledge seeking to answer a practical or theoretical problem included in the lesson plan.

Another point that was relevant for four teachers to forget the challenge of the method was the stimulation of various sources of research in the PBL method, comprising videos, scientific articles and literature, in addition to those established in the

college library and the possibility of instant Internet

searches (TEACHERS 1, 2, 5 and 7). This fact makes the active methodology more dynamic and creative, requiring a degree of study from the teacher to be aware of the boundaries of the construction of knowledge in relation to various.

Still regarding the challenges of the planning requirement criterion, four teachers reported that the PBL encourages the teacher to deepen his studies around the topic that he will constantly tutor, in order to avoid the discomfort of not knowing how to handle the doubts of more curious students. from elementary school that placed the teacher as the center of knowledge.

As it is considered a characteristic among the methods, I sought to research how the conduct of classes has been throughout this first year of the course. On this topic, only two teachers cited educational strategies used in the management of their classes.

Although the answers were convergent to the question in axis 2, which argued about the use of educational tools throughout the year, five teachers preferred to mention the importance of knowledge of PBL, to apply the best strategies according to the needs of the class, being able to change the tools according to the difficulties of the students or the size of the day.

I noticed, in the speeches of the five teachers who did not mention the names of the tools, that the choice of this strategy involved the need for each group in addition to the criteria, such as the size and difficulty of the group and the environment in which the students were. "Using the environment and the difficulties of the moment to potentiate a problematization is the best strategy to stimulate the student to reflect" (PROFESSOR 7). Teachers 3 and 6 complemented: the profile of the student's interest, the place where they are and the specific objective intended in the decision to alternate the learning tool.

In just a moment, I noticed, in the speech of a teacher, the report of his difficulties in relation to this axis, which does not mean that this teacher had little knowledge of the PBL tools, but that he had difficulty in applying them. "[...] I admit that I still can't use the PBL tools properly in many times, administering my classes to motivate students to do an active search and ask surprise questions so that I can stimulate the search for knowledge" (PROFESSOR 5).

I was able to verify, with this question, that all teachers value dynamics to stimulate the student in the search for knowledge, stimulating his own learning, to use the pedagogical tools of the active method. This demonstrates the interest of teachers in learning to learn from their own experiences and in managing the method.

All the teachers made it clear that it is important to use these tools, so that the student takes a role in self-education and is responsible for building their own knowledge.

Among the main characteristics, the innovative teaching-learning methods clearly show the migration movement from 'teaching' to 'learning', the deviation from the focus of the teacher to the student, who assumes co-responsibility for his learning (SOUZA; IGLESIAS; PAZIN , 2014, p. 284).

It was clear that, in the testimony of four participants in the case study, choosing the most appropriate educational tool to conduct the students' search for knowledge to achieve the objective of the intended content was and has been the greatest challenge for this first year of the course.

According to the reports of teachers, this "teaching to learn" (PROFESSOR 6) movement is achieved through the use of the tools mentioned by Professors 2, 3, 6 and 7, such as problematization, meetings for the discussion of clinical cases, dynamics for analysis, criticism and reflection of practice, case study, always starting from the student's prior knowledge.

Here I would also like to point out that, in general, all teachers declared it easier to teach classes by the traditional method, in which they used, in their exhibits, slide projection. I considered it important to ask teachers how they did to conduct their classes in the method they applied previously, before enter the Pythagorean Medicine intuition. The classes were unanimously prepared in Power Point, in which a deposit of knowledge was made similar to a bank deposit, where, when passing the years, the educator could revise and increase items of his complete domain of knowledge, making it much easier to teach future lessons.

The act of teaching-learning must be a set of articulated activities, in which these different actors increasingly share shares of responsibility and commitment. For this, it is essential to overcome the banking concept, in which one deposits contents, while the other is obliged to memorize them, or the licentious, unlimited, spontaneous practice of individuals given to themselves and their own luck. , in an emptiness of what they do, as opposed to, the liberating education is a political practice, reflective and capable of producing a new logic in the

understanding of the world: critical, creative, responsible and committed (MITER, 2008, p. 237).

The phase in which the teacher is the main protagonist of the classes according to his wishes and

convictions and his articulation of the practice is related by TSUJI (2010) as a review of responsibility for his role.

Regardless of the desire / need, students swallow the materials, regurgitate in the tests and try to forget them afterwards. It is believed that in this way they reach the final years prepared to learn the practice of medicine. This is how medicine has been taught for years. Knowledge evolves in a speed between 40% and 50% of what is taught today is abandoned or put into doubt in four or five years (TSUJI, 2010, p.79).

Current management requires that the teacher take on the role of tutor, be a facilitator of knowledge and program trajectories in their class time. It also requires that he be able to arouse curiosity, research motivation and be prepared for unusual questions. This will require not only a knowledge of the application of the tool or method, but a postural preparation to encourage the student to go in search of new knowledge.

I noticed, in the professed Professor4, that the name "[...] requires an active method the need for its own postural transformation, so as not to be reactive to the questions and to solve the students' doubts". Even mastering the content, he must often answer with another question, to guide the path of the search for learning to learn.

The comparisons I made for the assessment axis were centered on two questions: the first, the cognitive strengths and weaknesses between the teaching methods; and the second perception of the student's cognitive displacement. and the performance measures of the simulated scenarios of the teachers' laboratory practices, the interviews followed a path that extrapolated my intentionality, migrating to a spontaneous evaluation of colleagues.

Case studies like this extrapolate the focus of the question from the axis and even reveal a construction of knowledge beyond what was imagined. I detected through the speeches as Professor3 - "Assumed a composition with a horizontal aspect due to the possibility of formative assessment where I do not need notes and I can contribute with my professional perceptions in the formation of the student [...]" - edoProfessor4: "The method active articulates scientific knowledge with less biologicist and more biopsychosocial knowledge, relating ethical and spiritual factors to effective communication and financial and market perception ". Such statements are in line with Ludke and André (1986), who report on the unusual that may appear during scientific research. These statements revealed the teachers' postural and humanistic change, which I did not expect to find in such a short time of practice in the method.

The case studies are aimed at discovery. Even if the researcher starts from some initial theoretical assumptions, he will try to constantly keep an eye out for new elements that may emerge as important during the study. The initial theoretical framework will thus serve as a skeleton, a basic structure from which new aspects can be detected, new elements or dimensions can be presented as the study progresses (LUDKE; ANDRÉ, 1986, p. 18).

There were unanimous reports about the positive reach of the active methodology in relation to the traditional method in anchoring practice over the course of the course. The stimulation of human skills, associated with the perception of the student's attitudinal and behavioral changes prevailed in all reports. According to the seven teachers, a common nucleated phrase is that "[...] the PBL method still provides the use of other knowledge domains favoring the creation of other knowledge".

Another point unanimously addressed was the application of scientific cognition to practice. Professor 2 portrays well in his speech, when he mentions "[...] the combination of practical competence with the higher work and a critical reflection and teaches the student to act in new situations and in the doctor's daily life". The PBL method, as previously reported, inserts students into a real environment since the beginning of the course. It is noted that students are being prepared for a behavior to act on the patient instead of illness.

The articulation of scientific knowledge with other human dimensions takes and empowers the student for self-learning in addition to the articulation of practical knowledge, since this integration with the community improves reflection, critical analysis and the ability to cope with everyday problems of the future doctor.

I emphasize that Professors 1, 2 and 4 mentioned that "[...] both methodologies achieve the same cognitive result, but in PBL the psychomotor skills and attitudinals are most significant and were very different for the physician's training ".

These teachers attributed the association of a set of laboratory practices and activities in the community to theoretical knowledge built in parallel and improved skills in relation to the construction of the mature individual. According to Tsuji (2010), the transition from immaturity to maturity (personality) is a painful process that depends on experience, einsight desire.

ValeressaltarafaladoProfessor7, who pointed out "[...] when teaching in the traditional method, effective communication relationships, ethics in the work environment and the best adaptation to everyday diversities were not treated as training the student and evaluating these domains will help the professional future

to overcome new challenges ".

With regard to axis 4, I aimed to compare how the teachers proceeded with the use of active pedagogical tools in the first year of the course. About this, four of the seven teachers cited the resistance of the teacher's stance as a barrier to resort to these teaching strategies throughout the year.

Of these four teachers, Professor 2 added that, "in addition to the teacher's own resistance to adapt to the new teaching models, it is important to remember that students also came from a traditional high school" and, for this reason, face the strangest role passive of the teacher.

The task of dealing with new and different strategies is somewhat complex and requires changes in habitus and paradigms: among university professors there is a predominance of content exposure, emaulas expositivas, or lectures, a functional strategy for the transmission of information. This habitus reinforces the action of transmitting ready, finished and determined content, similar to previous experiences. Still, the current curricular configuration and the predominantly conceptual disciplinary organization (in grid), have the lecture as the main form of work, and the students themselves expect from the teacher the continuous and passive exposure of the subjects that will be learned (SOUZA; IGLESIAS; PAZIN , 2014, p.288).

This comparative question between the methods brought up an important point: the shift in the role of the teacher from the center of the educational process. The need for qualification of the teaching staff in the first year of Faculdade Pitágoras de Medicina and other periods is fundamental. I realized that it would be necessary to transform the profile of the teacher by inverting his role, in order to place students as promoters of the search for knowledge. Professor 5 speech brings the need to "[...] break dogmas, paradigms, concepts and prejudices of a generation of teachers ". It is natural that medical professionals trained in the traditional method and with a successful career show a certain lack of confidence, to come across the PBL in the first moment.

The perception of the need for teacher qualification was clear in six of the seven teachers, almost unanimously. With the change in the medical curriculum, an adaptation of the integration of practice and social integration was required, perhaps that is why so many teachers were mentioning that the most demanding PBL is not just because of the demand for greater creativity, but because of the proactivity to adapt the teaching strategies.

Understanding that the teaching model is

migrating from disciplinarity to interdisciplinarity involves the need for permanent training for teachers.

Curricular changes presuppose the transition from disciplinarity to interdisciplinarity, in addition to presenting new teaching-learning strategies, such as active methodologies, considered a new challenge for the training of teachers of the future (ARAÚJO; SASTRE, 2009, p. 6).

I considered a quote from Professor 5 to be important, in which he reports: "[...] I still lack concrete and well-grounded pillars to underpin and consolidate the method". I noticed, in the teacher's speech, the insecurity to use strategies in the classroom. In my view, they complement each other, since the path to success after the adoption by the institution of an innovative method is the investment in training and continuous training.

In this axis 5, I was able to make a perspective of the future of the interviewees, measuring how their students would be in the job market after six years of graduation and how the innovative methodology would contribute to this egress in the market.

With the exception of Professor 5, all reports showed optimism and envisioned a professional adapted to technological changes, able to learn to learn with greater speed and with resolving characteristics for coping with everyday problems. PROFESSOR 5). This revelation is linked to the sudden break from the traditional to the PBL and society may not have time to welcome these changes, especially students.

Most educators, Teachers (1,2,3,4,6, and 7) complemented that "[...] the active formation for the transformation of the individual for being in daily contact with the problem situations". Professor 3's testimony brings a vision of the future based on "[...] graduates who acquire greater capacity to learn to learn throughout their professional life will be better prepared for changes in the market".

All teachers mentioned the cycle of demands and needs of the population in relation to health, which has been changing more and more rapidly, both in the public and private systems. According to Professor 7, this training model will provide students with the opportunity to "[...] learn from the changing needs of the population since the beginning of graduation, forming an individual with the ability to relate to political, socioeconomic and cultural dimensions [...] "And prepare for the constant social changes.

Learning how to manage classes correlating these biological, psychological and social domains is an advance for a continental country that has great demographic variation.

[...] health needs, in a more comprehensive way, are originated by the way human societies live life, which implies interfaces between the demographic characteristics of populations, their culture and socioeconomic organization, in a given territory and ecosystem. The combination of biological, cultural, subjective, social, political and economic nature elements produces the set of health needs of a given society (STOTZ, 1991).

I realized, in the words of all Teachers1,2,3,4,5,6 e 7, that "[...] the method is capable of transforming attitudes and behavior in the face of the situations that the work environment imposes on the day to day [...]" health professionals. This ability has been noticed since the first graduation period by teachers.

In relation to this perspective, I analyzed in the speeches that teachers, even at the beginning of the course, recognize that the courses will form a general clinical profile, which, because they are part of the first day of school, in the context of learning, there will be no further business in order to continue their journey in order to continue their journey.

I was also able to verify, based on the statements of Professors 2, 3, 4, 6 and 7, that "[...] the conduct of the active method will enhance a more humanist professional prepared to meet the needs of the market and the health of the population ". I noticed also the relativization between traditional education and PBL on the safety of the professional who, since the beginning of his graduation, maintains direct contact with society.

The protected environment is used by laboratories and classrooms to contribute to the student's cognitive domain over six years, but this learning environment alone is not able to stimulate the student in the biopsychosocial domains, as it reduces opportunities for living with the health network.

According to the report of Professor 7, "[...] the apprentice who goes through graduation in conjunction with the field training starts to live and relate to the real social optics, realizing the health management problems, the sociopolitical coexistence, closely watches the patient's pain and live with illness ".

I realized, in the words of Professors 3, 5 and 7, that "[...] the student, living and going through the six years of graduation in an environment protected by teaching, but contemplated by the association of the theory to the practice of a real world, will be an individual more prepared for the market".

"The connivance with poverty, with the therapeutic cultural difficulties, with the communities weakened by the trafficking traffic, through the habit, will

be a professional more adapted to the conditions of the current market (PROFESSOR 7). The MEC, SUS and the DCNs promote a changed medical education with validation of the model with a focus on an emancipator, in which the student comes into contact with social transformations, a question that was previously shielded in the protected environment of the classrooms.

In the perspective of permanent education for workers in the Unified Health System - SUS, the expansion of critical capacity, aiming at the transformation of their own practices, has been the axis in the construction of educational proposals with an emancipatory approach, with the use of active teaching-learning methodologies (CADERNO DE COSO, HOSPITAL SÍRIO LIBANÊS, 2014, p.6).

Only one professor made an inference showing that he was concerned with the insertion of the graduate in the market. The transition from the ways of teaching is being implemented in the faculties that have recently emerged without the adhesion of all existing faculties. In 2014, the National Curriculum Guidelines pointed the way for methodological change, but they did not impose a schedule for all institutions to adopt or structure themselves in the active method. Large and renowned country faculties, mainly in the public, continue to traditional methodology, as well as the selective tests of medical residency and the selective notices of public tenders. "This may cause difficulties for the student who is in transition" (TEACHER 5).

Based on the research carried out, I considered the contributions of teachers to be potent in the face of the short time of experience in the methodology. The reported approaches were useful for the application in the exhibition of partial results acquired so far as a reflective strategy in the pedagogical week of 2020. Analysis of the data makes interfaces with the difficulties studied in articles and brings innovative results that will be dealt with in the next chapter.

IV. FINAL CONSIDERATIONS

When starting this research, I had no perception of how the historical evolution of medical education was accompanied by so many paradigm breaks. The fact is that, when comparing with the implantations or innovations, either of medical schools, or of new methods, one thing is common: the participation of the government and the disruption of society with the theme.

The medical training of the hygienist era struggled to be recognized in society. Scientific constructions were a target to be reached for professional

recognition, in an attempt to overlap with the practices of traditional healers. Today, in keeping with the 19th century period, it has not been easy to change the medical teaching methodology and evolve into a new curriculum matrix.

At that time, there was an effort to differentiate the medical professional from society. Today there is a need to reposition the medical profession for a more generalist environment. This effort to train professionals has had the same authorship throughout history and came from government power to meet the demands of the health needs of the population in the respective times.

I perceive significant changes, but, to be welcomed by the scientific society and recognized by the civil society, it will take years if we observe the circadian cycle of changes in medical education. We already have decades of innovative pedagogy in the world and, even knowing the existence of proven successful curriculum models, such as the Canadian and the Dutch, with regard to medical training, we are participating in this transformation in the same State in which the first school of surgery in Brazil was founded.

Historically, it seems that we are pursuing a model that, although we call it the new, was applied as a necessity to treat diseases, pests and epidemics in the imperial era. The monarchy 's proactivity supported the search for a cure and encouraged scientists to actively search for remedies to remedy the ills of the time. The proposal for an education that we call innovative and active in current medical education seems to seek this same role for the student as a center for the construction of knowledge, aiming to form an individual capable of learning to always learn as scientists of the 19th century did in the discoveries of tropical diseases .

Changing is a challenge. The question regarding this change still persists, which is why many professionals question this new format. Are we modifying the teaching model to meet the market, or has society changed and that is why we are changing the way of learning and teaching?

The fact that I was able to learn from this research is that the health needs of the population changed a lot after the implantation of SUS in 1988, which brought the right to health of the population as a duty of the State. With the political and social maturity of Brazilians, the country opened many strategies for dealing with various health system problems, but the training of human resources was out of line with the growth rate of the public health network.

In the last two decades (2000-2020), the public power has promoted promoting and encouraging governance and governmentality around the training of health professionals, in order to meet the network's singularities in their different cultures in our continental country.

Nowadays, it has become increasingly clear that only the student's cognitive domain, although fundamental in the teaching-learning process, is not enough to accommodate cultural diversity, the effects of globalization and the coexistence with new technologies has made it expand the frontiers of knowledge.

Changes on their own bring resistance and the change in the format of teaching would be no different. But did the PBL demand changes in the education of formacausal or did it emerge as a consequence? It is perceived that society has changed and the active method has only been adequate to accommodate these social changes. people. Another point was the advancement of technology, which changed a generation and increased several sources of research with the Internet.

For several moments, I came across testimonies that portrayed the teacher's resistance and mistrust towards the PBL, when argued in the interviews. Challenges such as planning, managing classes and using tools appropriate to the method raise doubts. Do these phenomena reported by teachers occur due to the new methodological paradigm or the innovation of the required teacher's posture? This natural discomfort may be related to the way we were educated in the traditional method in which we received as good listeners the transfer of the teacher and today, as teachers, we participate in the displacement of power by changing the logic of the transmission of classes. Ceasing to be the main actor in the room is what the method suggests, so that the student assumes that place. And leaving the place of power is neither easy nor comfortable for those who are unaware of the practice proposed by the PBL.

Other conclusions could be perceived, when analyzing the resistance and demand to plan, manage and apply the PBL: the co-responsibility of the teacher in these questions. In this first consideration, teachers, when getting involved in the new methodology, feel more co-responsible for teaching, as they are part of the construction of knowledge.

From another point of view, the teacher feels more committed to the more integrated and synchronous format of the provision of the weekly pedagogical modules, which point out the trajectory of the content to be worked on by the teaching group in relation to the same theme. Thus, theoretical classes are often complemented with the synergy of approaching the same subjects concomitantly with other classes, such as microscopy, general skills, medical and morphofunctional skills, in addition to field practice at SUS. Teachers know and know that their part must be done on time and with satisfaction,

so as not to compromise the construction of subsequent classes.

The syllabus of learning is arranged by the coordinates of the modules with the general objective and the specifics to be worked on during the week. With this, each teacher knows the parallelism in which their colleagues are dynamizing with their students, either in the tutorials (classrooms), in the technical and skills laboratories, or in the field of depression.

This set of theory and praxis in PBL is not just an addition of knowledge, but an intersection of knowledge domains in which content is worked in the real field of work with all the singularities and deficiencies that the reality of the health system has in its gradual evolution. The teaching-community requires more teachers and is a point for them to be attentive to the fulfillment of their own objectives and their syllabus. As for the problems faced, these are problematized providing opportunities for learning in ethics, management, communication and other areas that the traditional curriculum did not offer.

According to the comparative study, two more critical phenomena are perceived: applying tools and handling the method. From these two inferences appears a peaceful point: to improve these competencies, one must work with the constant training of the teacher.

Another interesting fact is the perceptions of the medical market with the new paradigms of the teaching model different from the one in which the teachers themselves were educated. Unaccustomed to the term, while distant from education, they compared educational models without knowing the origin or motives that led to this change. The term used, biopsychosocial, is a term that seems to conflict with traditional training. Some claim to be a term that softens the doctor's hard training, smoothing and even damaging the knowledge base necessary for good training. Studies have already shown that the point of arrival at the level of cognition does not vary from one methodology to another. Both are effective. What can be noticed from the beginning is the critical reflective performance of the student and his progress in communicability,

Still on the teacher's resistance to the method, one can infer the paradigmatic change. Changing the logic of the teacher's transmission as a center of knowledge for the student and building his own knowledge is a displacement of power. The generation that is in the current market, as well as that of their parents and grandparents, came from an educated education through the active role of the teacher and the student's passive. This role was indisputable until a few decades ago. So the doubt remains: Why change the way of teaching?

Most people who are in contact with the active subject already understand, accept and promote the method after getting to know it better. According to teachers' reports after the first year of experience in innovative pedagogy, both students and teachers who were able to compare between traditional and PBL methods preferred the liberating education of self-construction.

Another main point is how to use the method. There is still a doubt: the challenge generated by teaching classes is due to the lack of adaptation to the new tools due to the lack of training to use them.

Another perceived point was the concern to use tools to standardize and resignify learning in PBL, through which the management proposes to initiate the awakening of knowledge through the student's prior knowledge, mobilizing his previous experience to motivate new discoveries. Learn by doing, applying, studying and adapting teaching strategies at all times. As, at the end of each class, a quick assessment of activity is proposed, the teacher approaches the opportunity of improvement almost instantaneously based on the reports of his dynamic overtones. A quiet point is that, in the same way that teachers become more profitable with each period, the pupil is approved for subsequent periods and becomes more critical and reflective, in addition to a known method. Since, in each period, there is a need for new teachers, these will come up with classes already used with the method, masoprofessors will confront, for the first time, with the PBL. This fact is due to the insufficiency of teachers trained and prepared for the challenges of methodological change.

At this point, several frontiers of study open up. In relation to the student progress line and the new teachers, he realized the need for continued education or a permanent teacher and teacher. Sorting and schedule these three dimensions to garantir educação resistência e as dificuldades dos novos professores dosperíod os subsequentes? The traditional suppression of this training by the Date, much used in the last years by the institutions of higher education served as an organization instrument and planning the content to be passed on by the teacher in the classroom. Here is the restlessness of teaching, training and changing the posture, how to identify the needs of teachers?

The change in teaching methodology, even more than a training as valued as medical, could not go unnoticed or without controversy in the eyes of its representatives. However, it is worth remembering, as mentioned in the story, that the implantation of the scientific medicine in Brazil after the implementation of the first medical faculties had great opposition to the

doctors, healers and midwives, who performed, since the discovery of the country, their way to heal.

We can conjecture that the term biopsychosocial, widely used both in the citations of the referenced authors and in the interviews, seems to conflict with traditional training due to the expansion of domains that are not dealt with throughout the curriculum of traditional training. The government plan, when proposing new guidelines, saw the perception of social interests and change in the need for users' health, reaching the conclusion of what points to the formation of a generalist profile, in order to ensure the greater number of places in the workforce of the countries.

As for the future doctor, it seems, we have to leave some gaps in the field of doubt still open. In the same way that we treat PBL as an innovative pedagogy, it does not have a contingent of trained teachers and graduates, sufficient for a comparative sampling, to arbitrate that the traditional method has no success or effectiveness in the PBL.

Is teaching that we are promoting enough to meet the population's health needs?

Will this biopsychosocial training serve the market, the future doctor and the medical market?

It can be seen, at the conclusion of the work, that the professors of the Faculty of Medicine of Eunápolis are adapting to the method throughout the course, as proposed by innovative methodologies: a learning cycle similar to a constructivist spiral.

Based on the perceptions of the research work, I realized the need to separate the triad that makes up the education of the new teacher. A product of this work that I named "Sparks of the tutor" (Appendix B), in which is the compendium that guides the step by step of tutoring by the active method with the posture that the facilitator must maintain in class. The instrument will serve to guide and reduce challenges, as well as the resistance of teachers to PBL: those who have experience in traditional teaching or those who have not yet managed tutoring.

I affirm that this instrument does not have the proposal of plastering the facilitator, who must lead the moment of learning with the unusual situations that may appear in its unfolding. However, it is the product of this research reflective and pedagogical advisor to support the development from the beginning to the moment of tutoring assessment.

Finally, if the method is based on problem situations or on problematizing real situations to achieve its goal of teaching and learning, then many current questions are capable of stimulating everyone to anxiety. I realize that these controversies in relation to the teaching

method may be a sign that we are on the right path, looking for answers in future research.

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Comparative budget Analysis of Residences for Population with Housing in High-Risk Area, focusing on the Conventional and Pre-Molded Construction Method in the City of Manaus-Am

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Abstract— *This work aims to carry out a comparative analysis of conventional and precast construction systems for single-family homes for families living in high-risk areas in the city of Manaus-AM, according to the specifications and parameters of the Brazilian Association of Technical Standards – ABNT. The methodology applied was the case study, which represents a tool that serves to understand and enable the formulation of hypotheses and questioning of the work. In the analysis and discussion of the results, the differences between both construction methods were verified, through monitoring and data collection during the work and what is the best method to be used for the construction of single-family houses.*

I. INTRODUCTION

In the current dynamics of civil construction, and given the numerous challenges faced, the choice of the construction system plays an essential role for the project's success, determining the best technique to be applied is a key factor for the execution of a work. In most Brazilian constructions, there is a predominance of the conventional construction method, which has been suffering detriment as it remains obsolete to other construction techniques.

However, human capacity continues to grow and evolve, creating and implementing new forms of construction technologies, and thus leaving an important legacy for future generations. Recent studies show that, in a globalized world and in face of market changes, the cost factor represents a decisive aspect for industries and civil construction is no exception.

The objective of this scientific article is to carry out a comparative analysis of the conventional and precast constructive systems of single-family homes for families living in a high-risk area in the city of Manaus-AM. For this, the research will follow the specifications and parameters of the Brazilian Association of Technical Standards - ABNT.

This research will include the following moments: at first the concepts related to construction systems will be addressed, at the second moment the execution time in the construction of the property will be measured using both methods, through the monitoring and use of the MS-Project software; present in a comparative way listing the advantages and disadvantages, in terms of quality and performance, of the constructive methods to be studied, using tools such as AutoCAD; register and identify the services, and the quantitative ones for the conventional and precast system, in the construction of single-family homes and, not least, technically and in detail, through the technical documentation, survey the execution processes inherent to each analyzed system.

Then, the analysis and discussion of the results is presented with the differences between the constructive methods, aiming to show the best method to be used for the construction of single-family houses, aiming at the fastest system, considering the cost, to remove this population living in a high-risk area in the city of Manaus-AM. It is worth noting that both study model houses will be built in Bairro Tarumã, West Zone of the municipality.

It is noteworthy that for the development of research on the topic, the option was for the case study type, where methods such as bibliographic research were used, through data collection in books, scientific articles, as well as documents and texts in a virtual environment.

II. CIVIL CONSTRUCTION AND MAN

Man, historically, has always been able to build large buildings. It continues to grow and evolve its techniques for building monumental and grandiose works, imposing and that have proven to resist time, defying gravity, to leave a rich heritage for future generations. There was, however, a "stop" on certain techniques and the use of certain materials for civil construction, mainly for homes. It is extremely urgent to review and acquire knowledge of new construction techniques toin order to modernize this sector, offer quality and facilitate the acquisition of housing in a universal way (VASQUES and PIZZO, 2014, p. 2).

In the national territory, there is a predominance of the use of the conventional system, whether construction in ceramic or concrete bricks. Despite the low productivity and, mainly, the large waste of materials and the presence of residues when this technique is used, it is noted that one of the biggest problems faced is the issue of good single-family housing at an affordable cost. The hypothesis was raised, given this situation, that little is sought or known about alternative solutions to the conventional system ((VASQUES and PIZZO, 2014, p. 2).

The lack of information and interest in alternative construction methods and techniques in relation to the conventional one ends up generating an insecurity in the choice, as it is a situation that involves high values, making it difficult for the majority of the population to acquire their own home.

2.1 SINGLE FAMILY RESIDENCE

Single Family Housing is a building designed to house only one family. Unlike an apartment building, where each apartment will house a family. Hence it is called Multifamily.

According to the Decree of Law No. 5,281 of August 23, 1985, in its art. 1st states that for the purposes of this decree, a residential unit of a single-family building is considered to be one consisting of at least 1 (one) habitable compartment, 1 (one) bathroom and 1 (one) kitchen, with the requirement of an area waived minimal useful.

Still in art. 3° establishes the following: Single-family residential buildings will have a minimum frontal distance of 3.00m (three meters) in relation to the street alignment. To better illustrate the composition of a standard single-family home, Figure 1 shows a floor plan of that home.
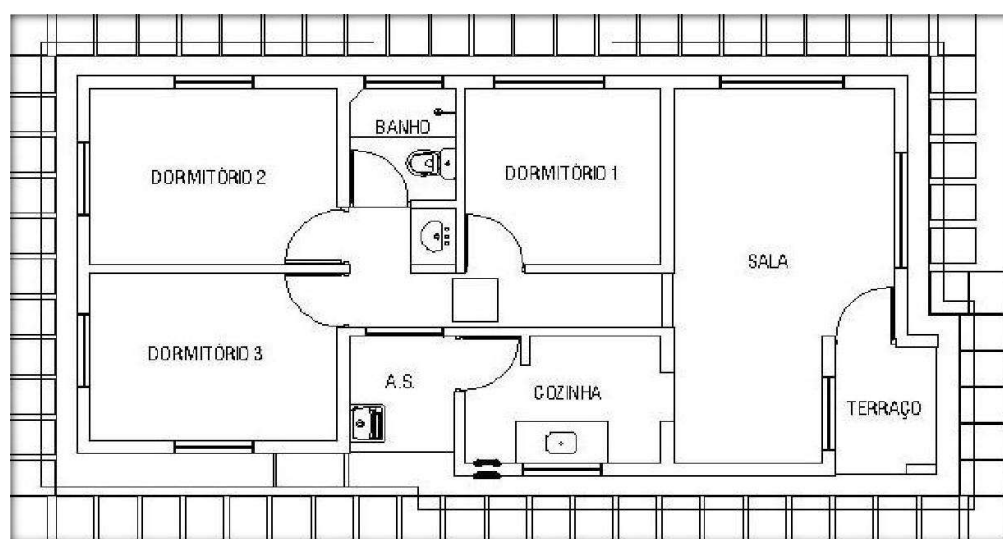
Fig.1: Planta baixa residência unifamiliar

Fonte: Campos, 2012

2.2 SOCIAL HOUSING AND REAL ESTATE FINANCING PROGRAMS IN BRAZIL

Before 1930, when the economy was based on the agrarian export sector, housing precariousness already affected the poorest population. In big cities, there were unhealthy tenements located in the central neighborhoods.

Later, according to Sampaio and Pereira. (2003), with the appearance of epidemics and pests, the government authorities recommended the demolition of these houses and the construction of new ones, outside the urban perimeter, and, to stimulate housing production, the government offered incentives to the private sector.

Thus, the public administration not only delegated to the private sector the measures related to the occupation of urban space, but also expressed the intention to segregate the working population in areas far from the central core of the cities, which allowed real estate entrepreneurs at that time to act freely according to your interests.

The Minha Casa, Minha Vida Program (PMCMV), launched by the Federal Government and executed by Caixa Econômica Federal, is a set of measures provided for in Law 11,977 of 2009 (BRASIL, 2009) and subsequent amendments.

Law 12,424, of June 16, 2011, which amended Law 11,977/2009, defined that the purpose of the PMCMV is to create mechanisms to encourage the production and acquisition of new housing units or upgrading of urban properties and production or renovation of rural housing.

Article 82-B defines that the PMCMV aims to promote the production, acquisition, refurbishment and renovation of two million housing units, from December 1, 2010 until December 31, 2014.

2.3 HOUSING IN HIGH RISK AREA IN MANAUS-AM (CIVIL DEFENSE)

In Manaus, 28,668 housing units are located in areas considered to be vulnerable, according to the municipal Civil Defense. A survey carried out by the Geological Service of Brazil (CPRM) Mineral Resources Research Company, points out that the North and East Zones lead the number of geological risk areas in the municipality.

On December 27, 2016, the defense agency dealt with approximately 130 occurrences related to the storm that fell in the city, the majority of which were slope slides and flooding. The most serious case occurred in the Nova Vitória neighborhood, East Zone, where a mother, 42 years old, and three daughters, aged 8, 10 and 14, were buried dead.

However, even though these facts were reported by the media and with the maximum warning of the danger by the local authorities, they were not enough, as people were not aware of the danger of building houses in high-risk areas, as shown in the house in Figure 2 :

Fig.2: House located in the Japiim neighborhood in Manaus-AM

Source: G1 Amazonas, 2016

According to a survey by the Civil Defense of Manaus, which classifies the risk areas into four levels, according to the degree of insecurity of the locations, 23.37% of the buildings in the capital are located in areas

considered to be of high risk (R3), with 6,732 properties. (G1 - AMAZON, 2016)

Most of the buildings - a total of 12,396, which represents 40.89% - are in medium risk areas (R2). The number of buildings at risk considered very high reaches 1,451, equivalent to 6.14%. The Civil Defense also mapped the buildings that are in flood areas, which total 21.32%, with 5,626 constructions.

The Civil Defense survey takes into account risk areas that have losses due to rain. The CPRM, in turn, has mapped the vulnerable locations taking into account the places that register damage due to the flood of rivers. Based on this, the latest survey by the Geological Survey of Brazil identified 35,620 buildings, including homes, commercial establishments, industries, public buildings and others, in risky locations.

Also the G1 – Amazonas (2016), highlights that in all, the CPRM identified 735 risk sectors in the capital. Of the buildings in locations of geological vulnerability, 8,180 units are categorized into high or very high risk areas. The study estimates that 90% of the buildings are residential and occupied, on average, by four residents, totaling more than 128.2 thousand people living in risk areas in the city. The estimate is based on a survey by the Brazilian Institute of Geography and Statistics (IBGE) carried out in 2010.

III.   BUDGET IN CIVIL CONSTRUCTION

In construction companies, when intending to carry out projects, one of the aspects to be taken care of is budgets. Its main focus is the construction of homes at a lower cost, using the most suitable construction system. Be it Conventional or Precast.

Steppan (2005, p. 20) states that the civil construction sector is experiencing a moment marked by the constant search for productive efficiency, the quality of its products and quick responses to the changes that occur in this segment. The need of companies in the sector, as well as strategic realignments, caused organizational and technological changes.

There are numerous possibilities for strategies to build a project, to obtain the best efficiency in budgeting, however, it is important to use new materials and residential construction technologies at a lower cost.

The budget stands out for being a valuable tool in conducting the activities of organizations, as well as in the process of identifying coordination problems. (STEPPAN, 2006, p. 51).

No project, regardless of its size and duration,

will be carried out without a prior budget structure, which allows knowing the costs of this work to be carried out. However, it is an item that needs continuous review during the construction work.

For Limmer (1997, p.86) a budget can be defined as the determination of the expenses necessary to carry out a project, according to a previously established execution plan, these expenses, translated in quantitative terms. For a project budget, the following objectives must be followed:

a) Define the execution cost for each activity and service;

b) Become a contractual document;

c) Serve as references in the analysis of the income obtained from the resources used in the execution of the project;

d) Provide, as an instrument to control project execution, information for the development of reliable technical coefficients.

Therefore, the budget is of paramount importance in preparing a project to be executed. However, one must look at these fundamental criteria in relation to the budget of any project.

IV.   CONSTRUCTIVE SYSTEMS

In Brazil, most constructions are characterized, particularly, by the lack of knowledge of other construction technologies, there is a predominance of the use of the conventional system, losing market by not investing in new construction alternatives.

For a country like Brazil, where there is a high deficit rate of low-cost homes, having access to good single-family housing, at an affordable cost, is a major challenge. Therefore, the hypothesis was raised that little is sought and/or is known about alternative solutions to the conventional system (VASQUES and PIZZO, 2014, p.4)

Bortolon (2004, p. 27) states that the adequacy of a building system is directly linked to the quality of the performance of the building in which it is used, whose

performance, in turn, is related to the specific conditions of the context, also specific, of the place where it is intended to be built.

As analyzed above, it is not enough just to choose a construction system, it must be adapted to the specific conditions of what is intended to be built, considering all the variables that determine the construction. In this context, we will approach two types of construction systems, precast and conventional.

4.1 PRECAST CONSTRUCTIVE SYSTEM

The constructive system of precast concrete houses or buildings has been seeking innovations that tend to be better modulated and more standardized than the concrete structures executed on site, so the techniques can produce more economic benefits due to production in scale.

Precast elements are an option to improve and increase rationalization in the construction process. They are associated, particularly with the speed of execution, strict quality control, modular coordination and high organizational level, typical of the construction process.

According to the Brazilian Association of Technical Standards – ABNT – NBR 9062, it defines a precast element as one that is executed outside the final place of use in the structure, with quality control specified in the aforementioned standard.

4.2 CONVENTIONAL CONSTRUCTION SYSTEM

According to Darini (2006, p. 12), open systems are still called conventional when their main elements (walls, slabs and roofs) are executed at the construction site and use of conventional construction techniques and materials, such as bricks, concrete, wood, ceramic tiles or fiber cement tiles. In this constructive system, as stated by the author, it is the basic elements that compose it and that are used in the various constructions. Being them from the walls to the slab.

Still in the context of the conventional system, Bortolon (2004, p. 29) states: In the conventional system, the forms of wood, reinforcement and concreting of the structure are performed, after this step, the masonry and installations are carried out, which can often generate waste materials . The amount of labor is also high and rework may occur in some stages, increasing the final cost of the work.

In the application of this system, one of the most representative costs refers to labor, not to mention the cost arising from the waste of materials, which, once accounted for, represents a relevant value.

According to Vasques (2014, p. 3), the conventional system is formed by reinforced concrete columns, beams and slabs, and the spans are filled with ceramic bricks for sealing. The weight of the construction, in this case, is distributed over the columns, beams, slabs and foundations and, therefore, the walls are known as non-supporting.

During construction elements such as beams and columns are used. It is important to consider that to embed the electrical and hydraulic parts, the construction of the walls must be completed. Immediately afterwards, the coating step must be started, when the so-called thick mass or roughcast is applied.

After the construction of the walls, it is necessary to tear them apart to embed the hydraulic and electrical installations. The coating step, characterized by the application of roughcast, thick mass (plaster), thin mass (plaster) and painting, must be started next (VASQUES and PIZZO, 2014, p. 3).

V.   THE CONVENTIONAL STRUCTURE IN BRAZIL

In the view of Vasques and Pizzo (2014, p. 3), in Brazil, the conventional structure, due to its enormous popularity, is still the most used, hence the familiarity with which civil construction workers have with the system. .

In Brazilian civil construction, the conventional system characterized by low productivity and mainly by great waste is still predominant, but the country already shows signs of mastering the technology of industrialized works, both in the industrial and residential areas, enabling the execution of constructions quickly and quality (VASQUES and PIZZO, 2014, p. 3).

This construction system uses steel bars, such as reinforcement, which are inserted into the cast concrete "in loco", in wooden forms, enabling the construction of structures that resist any type of load (GISAH and THOMPSON, 2013).

As a main highlight, these structures are commonly used in the construction process of homes in Brazil and with a certain predominance: when the main objective is quality and speed in construction.

5.1 REINFORCED CONCRETE

Reinforced concrete is, according to Martins (2009), the constructive system of walls and walls, or similar works, executed with natural stones, bricks or blocks joined together with or without mortar connection, in horizontal rows that are repeated overlapping each other over the others, or in similar layers, forming a rigid set.

5.2 DIFFERENCE   BETWEEN   CONVENTIONAL SYSTEM AND PREFABRICATED SYSTEM

According to the ABCIC (Brazilian Association of Industrialized Concrete Construction) manual, each material or construction system has its own characteristics, which, to a greater or lesser extent, influence the typology,

span length, building height, bracing systems , etc.

Once the work to be executed has been planned, the characteristics of each material involved must be in accordance with its specifications. Therefore, it does not negatively influence the development of the construction system.

Along the same lines, Lordsleem (2001, p.17) explains that traditional masonry (conventional system) is characterized by high waste, adoption of constructive solutions at the construction site itself (at the time the service is performed) by the mason or at the most by the master, lack of inspection of services, deficiency in standardizing the production process and lack of planning prior to execution. However Roman (2002) lists the following advantages obtained with prefabrication processes for ceramic panels:

a) Lower construction cost, both for structural panels and for fence panels;

b) Financial benefits from early construction, occupancy and sales

c) Increased quality control associated with greater construction speed and effective production of elements simultaneously;

d) Possibility of construction without climatic restrictions;

e) Cost and waste reduction due to process repeatability and transparency;

f) Greater effectiveness in monitoring the product with elimination of waste;

g) Possibility of using standardized fastening systems for masonry panels;

h) Possibility of manufacturing panels with all finishes incorporated;

i) Shorter execution time on site.

5.3 OTHER CONSTRUCTIVE SYSTEMS

Thus, we will use the parameters created by the SINAT (National Technical Assessment System) of the PBQP-H (Brazilian Habitat Quality and Productivity Program) to determine the technologies that will be analyzed.

5.3.1 Industrialized Building Systems

According to Ferreira (2014, p. 22), industrialized elements are understood as ranging from the simplest parts such as small elements of hydraulic installations to larger elements such as panels, floor slabs, etc. The qualitative derivation from the concept of element to component suggests the individualization of parts of a building into subsystems, such as roofing, fences, foundations and structures.

The constructive system is a set of essential parts in the process as a whole and that guide the most efficient method of execution. It also encompasses the systems and subsystems involved throughout construction as a whole.

In the view of Greven and Baldauf (2007), industrialized building systems have become increasingly necessary for modern civil construction, due to the need to have greater productivity within less time.

Thus, construction sites have actually been transformed into systems for assembling systems, also bringing as advantages a greater organization of the construction site and a reduction in material waste, impacting both in terms of expenses and the environment.

5.3.2 Traditional Building Systems

According to Campos and Lara (2012), these are the systems that have already been standardized by the country and have already passed the tests established in standards, having been "accredited" by the technical evaluation institutions.

5.3.3 Concrete Wall Construction System

The concrete wall construction method is a system that refers to the use of formwork that is assembled at the construction site, to then be filled with concrete, already with the

built-in hydraulic and electrical installations. The main characteristic of the system is that the fence and structure constitute a single element (MISURELLI and MASSUDA, 2009).

This system is recommended for projects that have high repeatability and can be used in small, medium and high standard projects, due to its great versatility. According to ABCP (2007), what defines the choice is a careful cost analysis, which takes into account all factors such as labor and construction time with their charges. They can be used in buildings of one-story houses, townhouses, buildings up to six floors, buildings up to nine floors with only compression efforts, and even having examples of use in buildings up to 30 floors.

5.3.4 Taipa or Pau a Pique

According to Campos and Lara (2012), Pau a pique, also known as hand rammed earth, rammed earth or hedge rammed earth, is an ancient construction technique that consisted of interweaving vertical woods fixed to the ground, with horizontal beams, usually bamboo tied together by vines, giving rise to a large perforated panel that, after having the openings filled with clay, was transformed into a wall.

Although it appears to be in disuse, many houses are built using this system, particularly in rural areas and further away from urban centers. In it, the living conditions do not offer any comfort, starting with the ground, which is actually made of dirt. It could receive a smooth finish or not, remaining rustic, or even receive whitewash paint. Figure 3 presents an example of this type of construction system.

Fig.3: House built with Taipa or Pau a Pique

Source: Campos, 2012

5.3.5   Wood Frame

Wooden construction has always been very present in Anglo-Saxon countries and, with the colonization of America, these people brought with them their knowledge and traditions in joinery and carpentry (CAMPOS and LARA, 2012, p 11-12).

The Wood Framing constructive system is composed of sections of wood and closing plates (OSB, cement or plasterboard) that work as bracing of the structure. As it is a relatively light building, we find the radiator and running shoes as foundations. After the structure is assembled and before the execution of the internal closures, the hydraulic and electrical installations are placed in the "shafts" of the structure.

Fig.4: Wood frame construction

Source: (Fields, 2012)

5.3.6　Steel Frame

The Steel Framing system, also known as Light Steel Framing, is an evolution of the "Wood Framing", a self-supporting constructive system used mainly in North America (Canada and the United States). Its prototype was launched at the Chicago World's Fair in 1933. Basically, the structural design is the same as the system with wood, which was replaced by steel.

"Process by which a structural steel skeleton is made up formed by several individual elements linked together, these working together to resist the loads that demand the building and giving shape to it" (FREITAS, 2006. p. 12) .

In that decade of the 1930s, particularly in New York City, many of the structures were made using this method. Even because of the durability and practicality. It has a resistance to building loads like no other material as shown in figure 5:

Fig.5: Steel Frame Construction

Source: Campos, 2012

VI.　STUDY SCENARIO

At this stage, the results acquired following the study methodology are presented. Following the presentation of the results in the same way as the methodology used to analyze the information.

Comparisons between the two construction methods, both conventional and precast, the respective calculations and measurements were carried out. In addition to the budgets, which were organized in tables and charts for better understanding.

Given this assumption, the analysis and discussion of the results was based on the problem that exists for many families who are living in high-risk situations. In all, according to a survey carried out by the Civil Defense in Manaus, 28,668 housing units are located in areas considered to be vulnerable.

According to the Civil Defense of Manaus - which classifies risk areas into four levels, according to the degree of insecurity in the locations - 23.37% of the buildings in the capital are located in areas considered to be high risk (R3), with 6,732 properties (G1 - AMAZON, 2016). The data can be seen in table 1:

Table 1: Preliminary services in the Precast system

RISK AREA CLASSIFICATION	Total Buildings	Total in (%)
VERY HIGH RISK (R4)	1.451	6,14
HIGH RISK (R3)	6.732	23,37
MEDIUM RISK (R2)	12.396	40,89

LOW RISK (R1)	5.626	21,32
Others	2.486	8,28
Total	**28.688**	**100%**

<center>Source: G1 - AMAZON, 2016</center>

According to the previous table, a total of 12,396, which represents 40.89%, are in medium risk areas (R2). The number of buildings at risk considered very high reaches 1,451, equivalent to 6.14%. The Civil Defense also mapped the buildings that are in flood areas, which total 21.32%, with 5,626 constructions.

6.1 COMPARISON BETWEEN THE TWO METHODS

6.1.1 Comparison of the Steps Involving the Construction of Systems

This work seeks to establish the cost-benefit ratios between the construction systems discussed, that is, taking into account the aspects that involve the shortest duration and execution cost.

For this purpose, budget spreadsheets and construction statements are being presented, as can be seen in Appendix B, with a particular focus on the cost and execution time variable of each of the construction methods under study.

Graphs 2 and 3 show the emphasis of each stage of the construction methods, thus showing the duration of each construction system through the Gantt chart, being able to visually demonstrate the most efficient system that presents a shorter execution time.

Graph 1 shows the comparison of cost and time it would take to use each building system to remove families from high-risk housing.
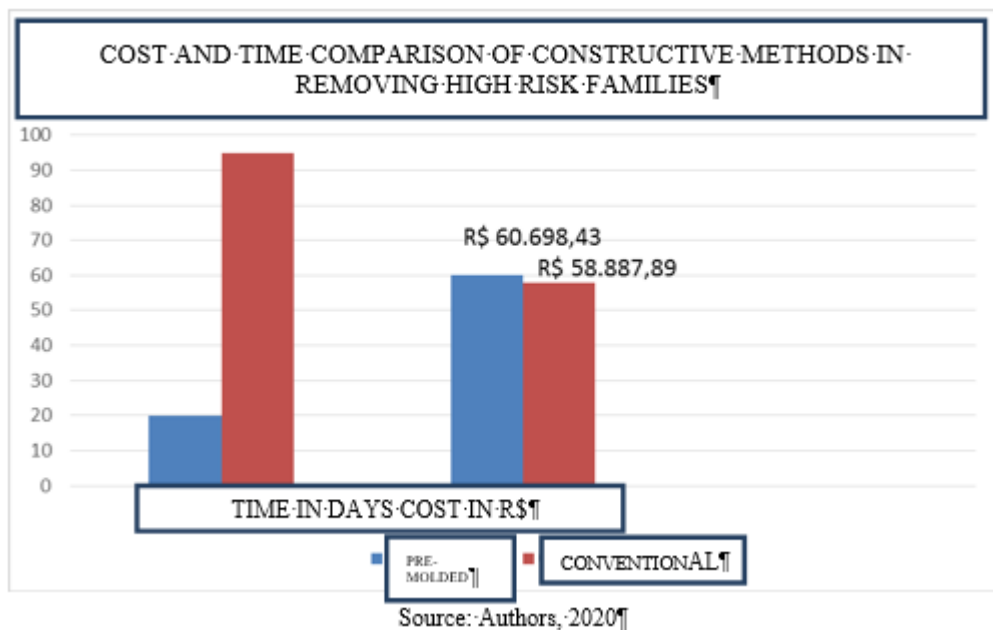
Graph 1: Comparison of costs and time between the two construction systems

<center>Source: Authors, 2020</center>

According to Graph 1, it can be seen that, despite the precast system becoming more costly, in terms of time it is more advantageous for the removal of families who are living in high-risk situations.

6.2 PREFABRICATED SYSTEM - WORK EXECUTION TIME

In order to carry out the schedule, the MS Project 2013 software was used, in it, the services and their respective dependencies were launched, that is, which service needs the other to finish to start being carried out.

For this purpose, it was defined (based on the data obtained in the dimensioning of teams) how many days each service would take, thus obtaining the schedule of the works.

According to the schedule for the execution of a

work corresponding to a housing unit, consisting of 2 bedrooms and a corresponding area of 38 to 41 m². Throughout this work, it was found that the precast construction system was able to complete the delivery of the work within 20 days.

Graph 2: Construction Execution Schedule for a Prefabricated Housing Unit
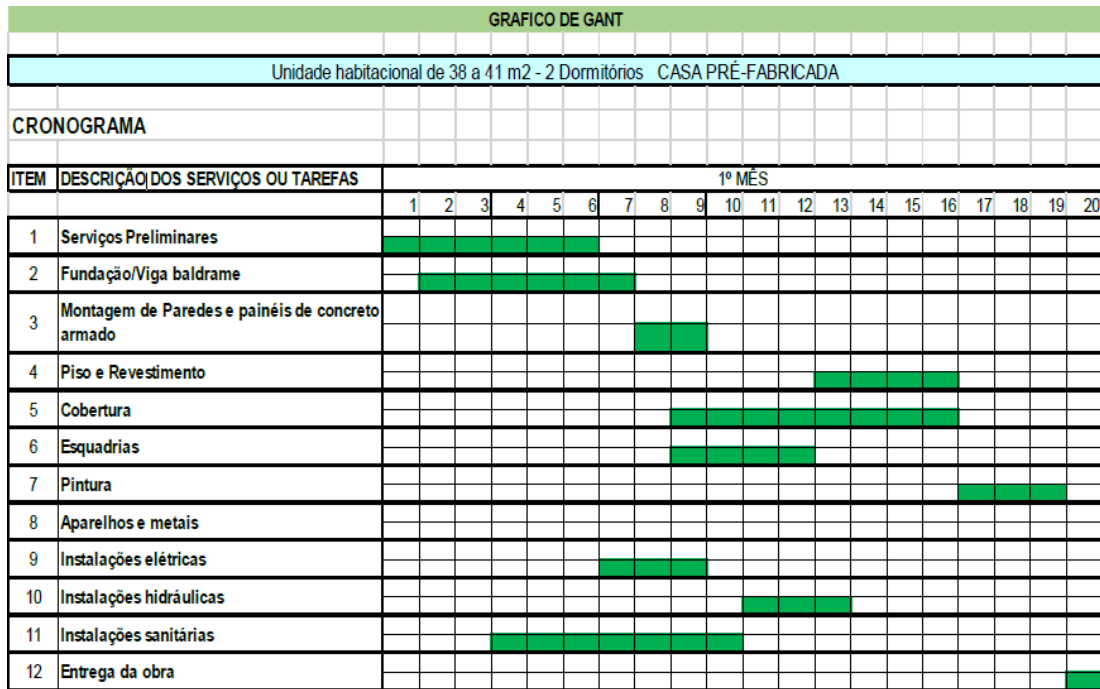
Source: Authors, 2020

As illustrated in Graph 2, the precast system presented a reduction in the time of execution of the work, it was carried out in a period of 20 (twenty) days.

As highlighted by Melo (2004, p. 11), prefabricated materials have facilitated the construction process, minimizing concerns about the execution time and focusing more on the aesthetics of the work.

6.3 WORK PERFORMANCE TIME - CONVENTIONAL SYSTEM

Regarding the execution schedule for the conventional construction system, the delivery time for the work was much longer than that presented in the

prefabricated construction system. The present work found that, in the conventional constructive system, the time for the execution and delivery of the work, constituted of 2 bedrooms and a corresponding area between 38 to 41 m². The same, extended for a period of 95 days approximately - 3 months and 1 week.

As expressed by Lordsleem (2001, p.17), mentions that traditional masonry (conventional system) is characterized by longer time in the execution of the work, due to the factors presented. See Graph 3 below, which highlights the duration schedule for the execution of the construction work in a housing unit using the conventional method.
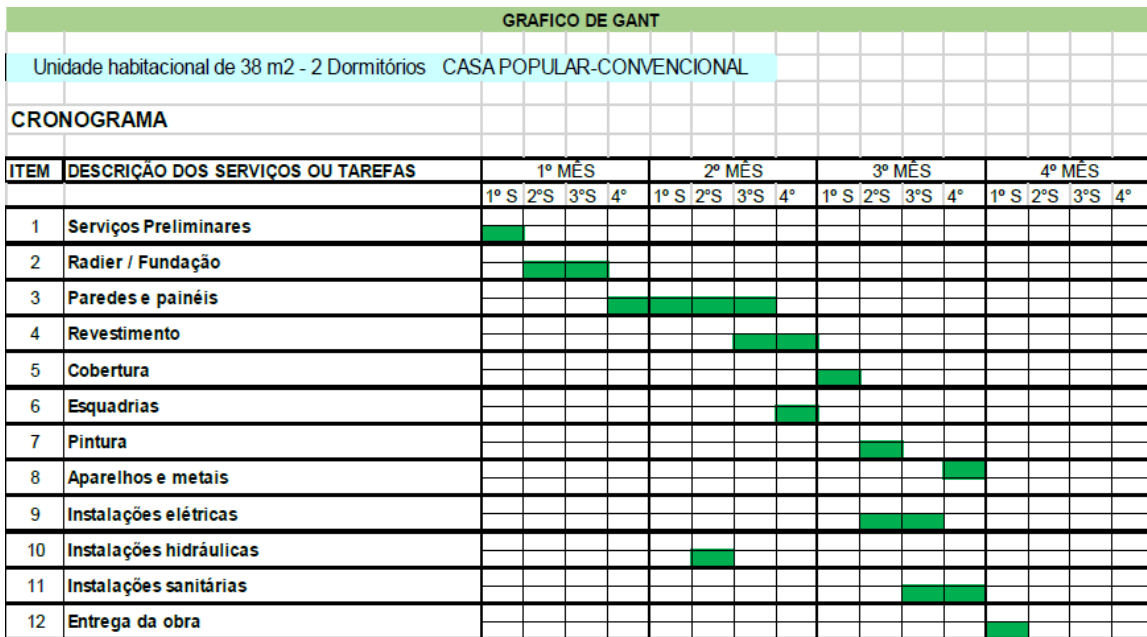
Construction Execution Schedule of a Housing Unit Using the Conventional Method

Source: Authors, 2020

6.4 PRELIMINARY SERVICES

For the survey of the Preliminary Services variables, they were carried out through information collected during the empirical research at the construction site and through the budget spreadsheets for the comparison between the constructive methods under study – conventional and precast method. See Table 2 and Table 3 respectively.

Table 2: Preliminary services in the Precast system

	Quantity	Items.	Unit Cost MDO.	Unit Cost MATERIAL	
Preliminary Services					**R$ 1.756,60**
Construction shed, provisional installations	0,00	m²	R$ 286,00	R$ 398,00	R$ 0,00
Land clearing, construction site	100,00	m²	R$ 3,66	R$ 0,00	R$ 366,00
Location of work, land demarcation	70,00	m²	R$ 12,88	R$ 6,70	R$ 1.370,60
work plate	0,05	m²	R$ 0,00	R$ 400,00	R$ 20,00

Source: Authors, 2020

Preliminary services, in the Precast system, and foundations indicate 15% of the total cost

Table 3: Preliminary Services in the Conventional System

	quantity	Items.	Unit Cost MDO.	Unit Cost MATERIAL	
Preliminary Services					**R$ 7.912,00**
Construction shed, provisional installations	9,00	m²	R$ 286,00	R$ 398,00	R$ 6.156,00

Land clearing, construction site	100,00	m²	R$ 3,66	R$ 0,00	R$ 366,00
Location of work, land demarcation	70,00	m²	R$ 12,88	R$ 6,70	R$ 1.370,60
work plate	0,05	m²	R$ 0,00	R$ 400,00	R$ 20,00

Source: Authors, 2020

This emphasis on budget costs or to assess the best construction system is in line with what is intended to be achieved. The cost and time category is the most representative when choosing a construction method.

According to Steppan (2005, p. 20), the civil construction sector is going through a moment marked by the constant search for productive efficiency, the quality of its products and quick responses to the changes that occur in this segment.

6.5 DIRECT COST ANALYSIS

From the surveys, it is possible to compare the total prices of each service. The foundation service also has a difference in values between the three systems, shown in Graph 4.

Graph 4: Comparison of Foundations Costs

Source: Authors, 2020

In the previous graph, taking into account the foundation in prefabricated baldrame beams - reinforced concrete (worked) fck = 25 MPa, since the procedure has a certain similarity between both construction systems.

Thus, there is a difference of R$ 621.06 between the baldrame beams of precast masonry and the conventional system, being the most expensive first option. Therefore, one aspect that differs significantly for the mentioned price difference is the way in which they are not performed for the beams in the conventional system.

As shown in Graph 5, it shows the prices between the sealing structures of the two systems of studies, they are composed of the structure's services – masonry and panels in homes.

Graph 5: Comparison of Masonry Costs
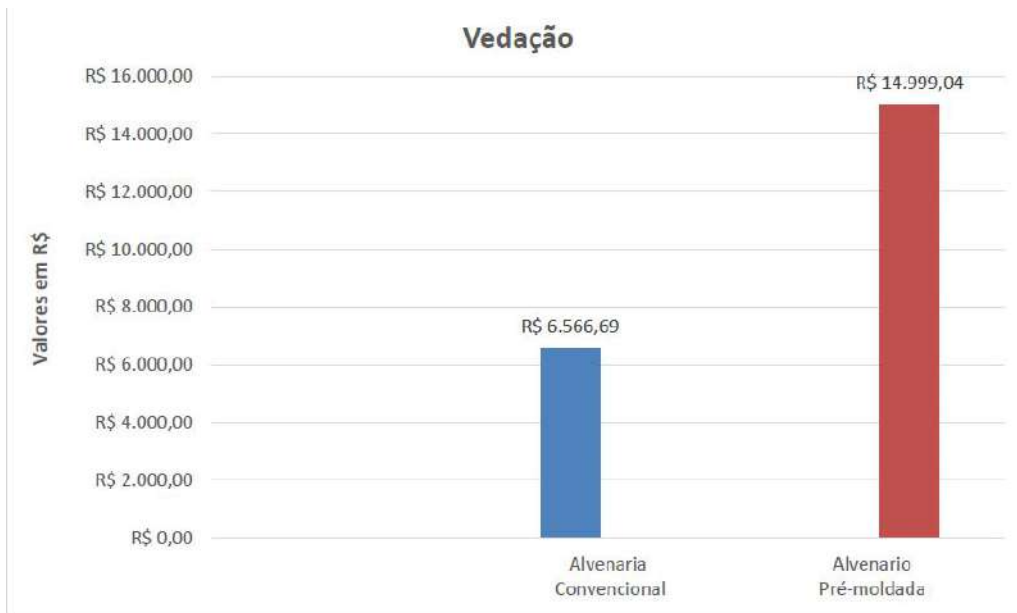
Source: Authors, 2020

Analyzing Graph 5, we can see the difference of R$ 8,432.35 between Conventional Sealing and Precast Sealing, the latter being more costly than the conventional method, when it comes to masonry structure.

This higher value is due to the high price of precast bases, joining this value with precast forms, cement slabs and plasterboard, which is also a higher price, thus having a more structure. costly than the traditional ones made of bricks and plaster.

It was found that when dealing with superstructure, the most affordable system, when analyzing only its direct costs, is that of conventional masonry. Next, in Graph 6, we can compare prices for internal coating, external coating and painting services.

Graph 6: Comparison of Internal and External Coating

Source: Authors, 2020

It is noticed that, in the comparison of the internal and external coating, a legitimate price advantage in the two construction methods, for the precast, it was R$ 1,428.87 cheaper than the conventional one.

The total for the external and internal coating for the conventional system is R$ 4,480.87, resulting in more costly than the precast system, which totaled R$ 3,052.00.

This large price difference in coatings can be explained by the fact that roughcast, plastering and plastering services in the Conventional System are not performed.

The advantage of the Precast over the Conventional system was evident when it came to coverings, the reason is simple, the roughcast service is not performed on precast masonry. Therefore, in the external and internal coating, the precast system represented the best cost ratio, being less expensive than the conventional system.

Graph 7 is presented below with comparisons of costs in relation to painting in the two methods under study.

Graph 7: Comparison of Painting Costs
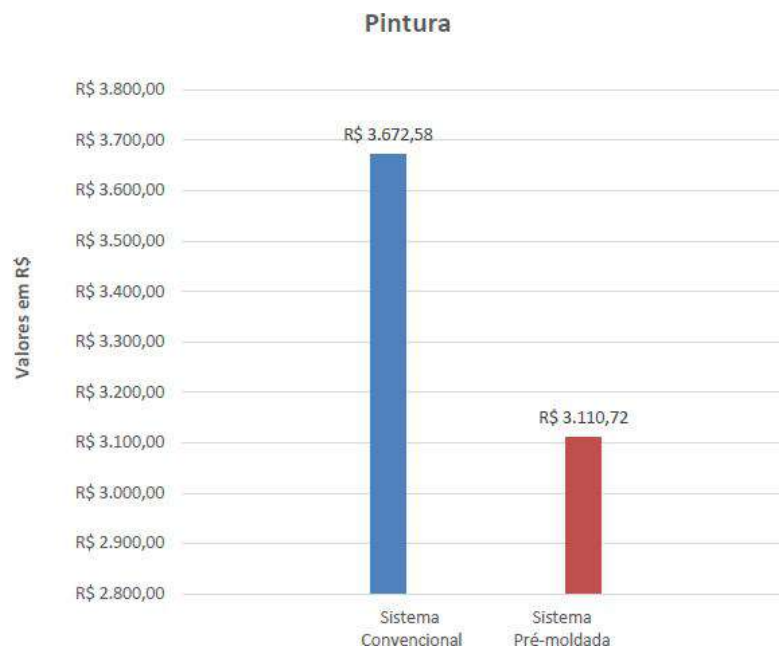
Source: Authors, 2020

In painting, we have an advantage of the Precast System compared to the Conventional System with similar values, the fact is due to the fact that it is not necessary to use mortar on cement slabs and plasterboard to apply the paint.

Therefore, painting in the Precast System was less costly, with a difference of R$ 561.86 in relation to the Conventional System.

Next, we present the coverage assembly, which is another system that has price disparity when this comparison of so-called direct costs occurs. Below is graph 8 referring to this analysis.

Graph 8: Coverage cost comparison
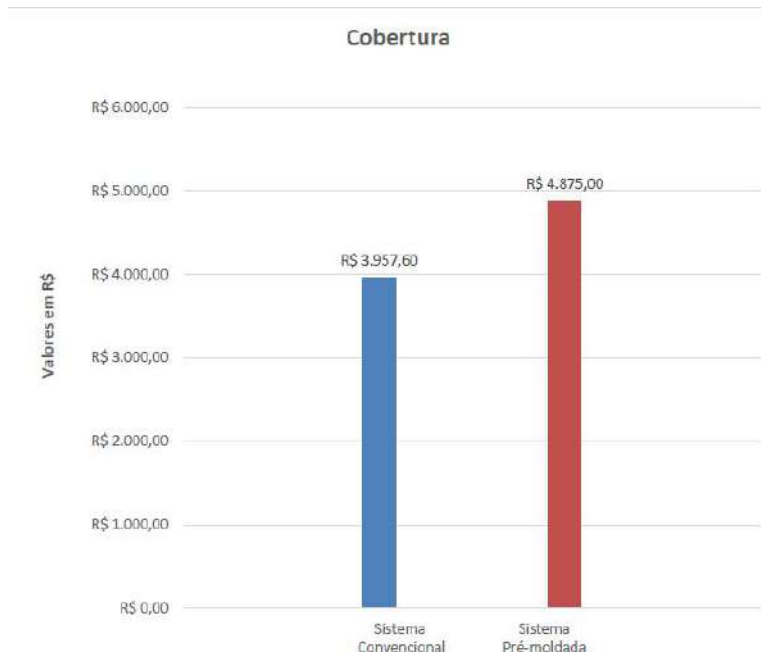
Source: Authors, 2020

When analyzing the data, it was observed that the coverage in the precast system was more expensive than the conventional one. That is, with a total of R$ 4,875, and in the conventional it was R4 3,957.60, with a difference of R$ 917.40 between both systems.

Note, then, that the precast system is R$ 917.40 more expensive than the conventional system. This difference is due to the cost of the transverse metallic structure on the roof, with roofing in trapezoidal galvanized tile.

6.6 COSTS PER SQUARE METER BETWEEN THE CONVENTIONAL SYSTEM AND THE PRECAST SYSTEM (R$/M²)

The budget was prepared based on the SINAPI Table (National Cost and Index Research System) and with TCPO cost composition budget spreadsheets (Price Composition Table).

Analyzing the results obtained by the work carried out and the field research, it was observed that for the Conventional Construction System, the total cost per m² without BDI (Indirect Benefits and Expenses), for the execution of a work on a 2-bedroom housing unit and an area between 38 and 41 m² was R$1,152.72, whereas with BDI it was R$1,436.29.

In the Precast Construction System, the total cost per m², without BDI, for the execution of the aforementioned 2-bedroom housing unit, and an area between 38 and 41 m² was R$ 1,188, 17 and with BDI it was R$ 1,480, 45. These values are well detailed in table 4.

Table 4: Budget of total costs per square meter, for both construction systems

CONVENTIONAL SYSTEM	Total (R$)	R$/M²
TOTAL WITHOUT BDI (BRL)	47.261,55	1.152,72
TOTAL WITH BDI 24.6% (BRL)	58.887,89	1.436,29
PRE-MOLDED SYSTEM	Total (R$)	R$/M²
TOTAL WITHOUT BDI (BRL)	48.714,63	1.188,17
TOTAL WITH BDI 24.6% (BRL)	60.698,43	1.480,45

Source: Authors, 2020

It is noticed that there is a difference between the conventional system and the precast system of R$ 35.45. Making the latter less expensive per square meter (m²), without the BDI. In this case, with the BDI included 24.6 % Indices given by the press, the difference between both systems was R$ 44.16. Representing a relatively low margin in quantitative aspects.

In this aspect, reinforces Limmer (1997, p.86), a budget can be defined as the determination of the expenses necessary to carry out a project, according to a previously established execution plan, these expenses, translated in quantitative terms.

VII. CONCLUSION

Given the facts presented, constructive systems have numerous advantages and disadvantages when compared to each other. Both in terms of costs and time of execution of a given work. Just like with regard to productivity.

Although, even with the numerous advantages presented over industrialized construction systems, the conventional construction system is still used on a larger scale in Brazil.

In the comparison presented in the work, it was noticed that one of the aspects that deserve to be highlighted was the time factor, as one of the work priorities, the displacement of the population living in high-risk areas. Based on MS-Project software, the Gantt chart was created, which shows the execution time of each system, visually explaining the execution time for each stage of the work, in this way the work pointed out the best constructive system to be used for the execution of these single-family houses, in relation to the time factor.

As in any constructive system, both the techniques and the materials have advantages and disadvantages, not only with regard to cost, but also related to the availability of materials, workability and execution, the performance of the workforce. All these factors influenced the choice of a constructive method.

The two construction systems were evaluated from a standard project with equal symmetry, it is noteworthy that the above-mentioned graph had an essential basis for the delineation of this work, it dealt with the physical and financial physical schedule, in addition to the difference between two methods. became spare in relation to the runtime.

As more "ad eternum" constructions are no longer admitted, with exorbitant prices, the precast system proved to be efficient with the results obtained, in the following parameters: shorter execution time, reducing the cost of project implementation due to the number of units to be built; increased quality control associated with greater construction speed and effective production of elements simultaneously; greater effectiveness in product monitoring, reducing waste; repeatability and transparency of the process; financial benefits from the speed of construction, and without climatic restrictions, having standardized fastening systems for the fence panels; in addition to the manufacture of panels with the finishes all incorporated.

Therefore, with this work it was determined that the best option when building a housing unit; with the best performance and the most cost-effectiveness in economic terms, it is undoubtedly the precast method. Due to the numerous advantages presented during this work.

Thus, as the term of execution of the work, as this work has shown to be carried out in 20 days, it definitely becomes the most effective system to be able to remove people who are in a high-risk area as soon as possible, also protecting the life of this population.

On the contrary, in the conventional construction system, this time would take an average of three months and a week, which would make it impossible to evacuate people, who are at high risk of housing in the city of Manaus. For future work, research in the areas of budget planning is suggested, which would add extensive technical knowledge in terms of projecting and building a work in Civil Construction.

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APPENDIX A - Popular House Project - Floor Plan
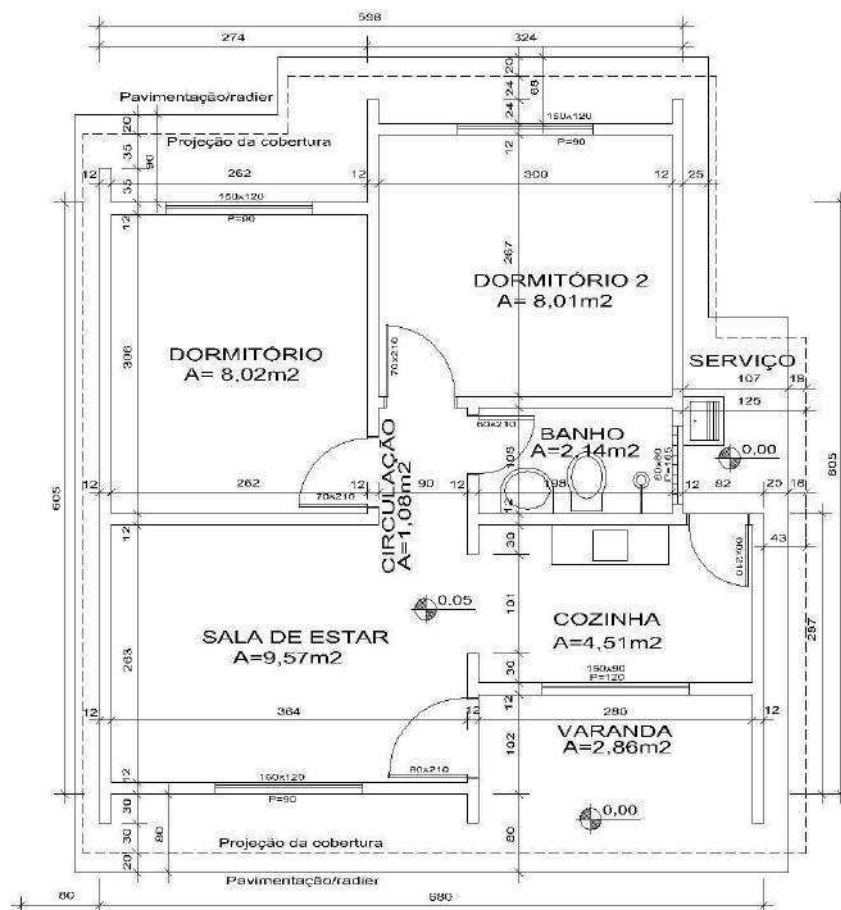
Bairro da Penha: The occupation process, the stigma of violence and social marginality

Jania Aranda Corrêa Raimondi, José Adilson Vieira de Jesus, Priscilla de Albuquerque Rodrigues Casagrande, Rosanny Machado da Costa, Daniel Rodrigues Silva

Abstract— The determinants of territorial occupation and crime in the Penha neighborhood, located in the metropolitan region of the city of Vitoria, begun in the 50's of the last century with the industrialization process in the State of Espírito Santo. The first name of the neighborhood was Stubborn, in reference to the constant return of the inhabitants removed from the area of risk. Currently the neighborhood is an area of environmental risk associated with high crime rate.

I. FOUNDATION AND OCCUPATION

The foundation of Bairro da Penha occurred around 1950 through an occupation, the area was part of the Maruípe farm. The first inhabited site was the lower part, initially covered by vegetation consisting of medium tree species, low grasses and forages.In the 1970s, with the impulse of industrialization, the occupation extended to the high parts and the site was donated to the Federal University of Espírito Santo (UFES) where the Cassiano Antônio de Moraes University Hospital (HUCAM) was installed, and later, the region came under the control of the Municipality of Vitória.

The origin of the name of Penha is based on the devotion of the residents of Nossa Senhora da Penha; the formation of the neighborhood took place in a peaceful manner commanded by a Military Police Sergeant known as Sargento Carioca[1]. Carioca stood out as a local leader, he was a reference for the residents in indicating the areas to be occupied, guiding the demarcation of the lots. Considered authoritarian, Carioca encouraged other invasions in the neighboring areas of the Penha district, such as Bonfim, Itararé and São Benedito.

The community's profile was one of poverty, initially formed by local population without their own homes, followed in the 60's and 70's by migrants from the interior of the State, North Minas Gerais, North of Rio de Janeiro and South of Bahia. The houses were mostly of wood or stucco, in the lower part were located the few masonry works belonging to the neighborhood's first inhabitants, the natives of the capital.

The maximum limit of occupation established by the city of Vitória was Rua Ariobaldo Bandeira, which gradually fell apart due to the volume of residents attracted to the region. From the 90's onwards, the population agglomeration was called by the public authorities as the Penha complex.

The 1960s-70s are considered the peak of the migration cycle in Brazil, the impacts of the interregional migratory wave were concentrated until the end of the 1980s. When reflecting on the migratory flow in Espírito Santo, we must consider the national scenario and understand the different socioeconomic moments of the southeast region. Human mobility has high rates located in the states of São Paulo

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[1] http://legado.vitoria.es.gov.br/regionalais/geral/publicacoes/Vitoria_bairro_bairrodapenha.

and Rio de Janeiro due to their social, cultural and industrial development.

Map 1 – Current boundaries of Bairro da Penha.
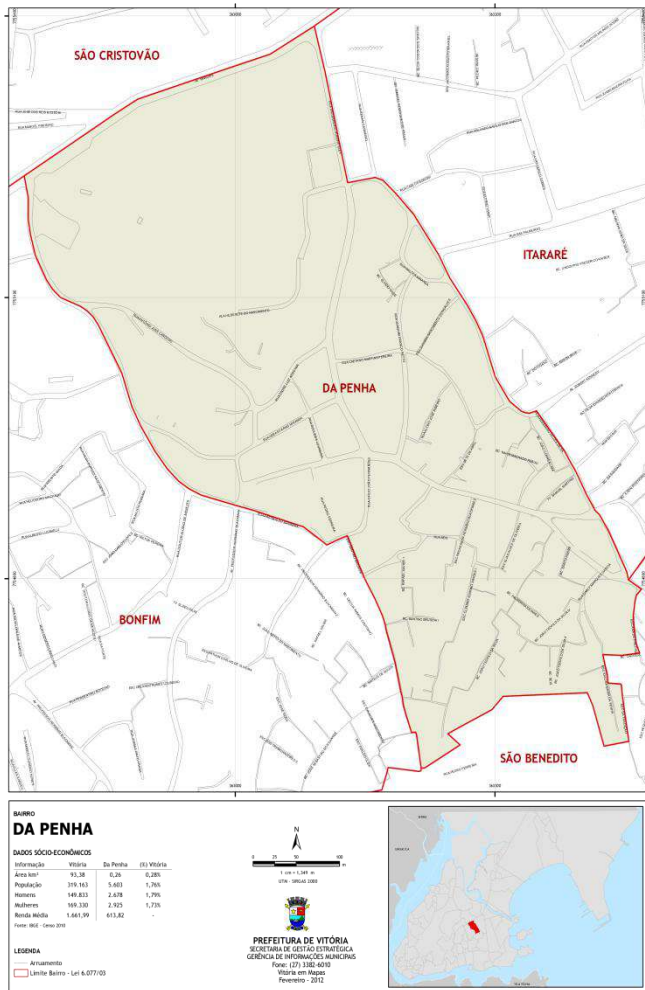
Source: Victory on maps. PMV, 2010.

Espírito Santo, in a more timid way, also receives migratory flows following the national process, on a smaller scale, as it had a high rate of inequality in terms of population, socio-spatial and industrial development compared to other states in the Southeast region. In this historical economic period, our main economic activity was coffee.

In the decades following 1970, there was a higher rate of disorderly occupation, not respecting the areas of environmental risk[2]. The occupation reaches the top of the complex Penha hill. The flow of residents changed its initial demarcation, which ceased to exist and the densification of the area was the causative factor for local

misunderstandings and the emergence of criminal organizations, referred to by residents as factions.

Thus, the stigma begins to form from the non-acceptance of the other in the geographical space of those established in the first decades of occupation. In this regard, for Bauman (p.47, 2010):

> The city is the privileged stage for the experience of transcultural understanding through the sharing of territory — an experience as important (to avoid the humanitarian tragedies that marked the twentieth century) as fragile (in light of the persistent trends towards xenophobia, racism and closure Social). It is therefore important to clarify the necessary conditions for the city to effectively perform this function.

Natives carry their culture and have their living space, while foreigners have a marginal impact, that is, those who do not behave like natives. There are also economic variables, as this one that arrives has nothing as material possessions, and will use the public power to insert itself in the social context as citizens.

The public power, in turn, cannot immediately meet the needs of that population that occupies the territory in an irregular and disorderly manner. They become excluded from the urbanization process and lacking basic public services. Translated to economic aspects, it becomes a social problem, on the fringes of civility.

II.   THE INDUSTRIALIZATION PROCESS AND THE EXPANSION OF THE PENHA COMPLEX

The second Vargas government 1950-54[3] with its developmental policy, Espírito Santo was launched on the national industrialization scene, during which time it was awarded the ¨Economic Valorization Plan for the State of Espírito Santo. The first state plan adopted in Brazil aimed to implement works that would allow industrial growth and the asphalt connection of Espírito Santo with other neighboring states.

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[2] https://ape.es.gov.br/Media/ape/PDF/Livros/Livro_Historia_ES.pdf .

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[3] _____. Vitória, February 17 2000. Special Supplement "The SAGA of Espírito Santo: from the caravels to the 21st century".

The industrialization process in the state took a leap from the 60s onwards, in parallel with the generalized crisis of overproduction of coffee. The Federal Government adopted measures to combat the crisis through the eradication of uneconomical coffee plantations. The economy, then dependent on coffee, is hit by mass unemployment. As a result of this policy, we have the rural exodus that led the migratory flow from the countryside to settle in urban centers.

At the same time, the Federal government indemnities to farmers moved the Espírito Santo economy through a shift of resources from coffee indemnities to industrialization. In this period, the expansion of the Penha complex was highlighted, with the arrival of residents from the interior of the state, settling in the region.

According to Bitencourt and Neto (2002), industrialization gained prominence with the creation of the Buaiz Group in the 50s, from the 60s onwards, the foundation of Realcafé Solúvel SA, Frigorífico Rio Doce SA, in the public sphere and the expansion of the Port of Vitória, the implementation of the "State Electrification Plan" and the construction of the Rio Bonito and Switzerland hydroelectric plants, the construction of the port of Tubarão, and the iron ore pelletizing plant of Companhia Vale do Rio Doce CVRD.

Through this, some industrial enterprises were able to be implanted, such as fabric, sand-lime material, for the use of textile fibers, production of cement, sugar, vegetable oils, paper, industrialized wood and an assembly plant of agricultural machinery. 70 advances were already visible and there are a variety of state and private enterprises opening space for international investments.

Henri Lefebvre (1974) emphasizes the dialectical aspect of urban formation and the production of space and highlights the 20th century city,some more common examples of urban segregation are the formation of slums, housing in irregular areas, tenements and squatters. In relation to natural resources, he emphasizes that goods that were once rare have become abundant and goods that were once abundant, such as light, air, water and space itself, have become rare.

Urban growth in different socioeconomic and political moments in the country and state, created designs ordered by the migratory flow. Helena M. M. Balassiano (1993) highlights that the expansion of urban space in large slums takes place in a short space of time, as the only way to house the migrant population. Workers move from rural areas due to economic factors and unfavorable conditions for landless producers to settle down, as for workers from urban contexts, the possibility of insertion in the labor market is restricted due to lack of qualification.

Urban or socio-spatial segregation refers to the marginalization of certain people or groups due to cultural, economic, historical and racial factors in the composition of spaces in cities. It can be said that spatial or geographic reproduction is related to the dynamics of urban formation, as a consequence urban segregation is the representation of social segregation, in which the poorest population tends to reside in areas that are more distant or less accessible to large economic centers .

Segregated spaces usually have a low availability of infrastructure, such as paving, basic sanitation, leisure spaces, hillside areas and environmental risk. For Balassiano (p.45, 1994):

> ...Brazilian favelas do not have government support and practically none of them are served by sewage pipes, a general water network, causing sanitary crises capable of affecting not only the working class that resides in them, but also the income classes. higher, which reside outside them, as both raw sewage and garbage are also drained to the neighboring prime areas, causing the invasion of insects and other animals that are harmful to human health.

The industrialization process boosted the occupation of the Penha district, initially consolidated in the lower part, from the 70s onwards, differentiated occupations are evident,the place is densely populated in all its boundaries and presents a disorganized agglomeration of streets and houses that express its environmental situation.

The neighborhood began to grow disorganized and visibly in the 1980s with the expansion of industrial activity in the state. The peripheral areas of the hillsides receive an influx of unassisted people, unemployed in conditions of poverty, generating serious social problems. The public received in the occupations of the neighborhood during the first three decades of the 20th century, mostly aims to transfer labor from the countryside to the industrial sector, commerce and service provision.

The 2010 census of the Brazilian Institute of Geography and Statistics (IBGE) outlines the socioeconomic profile of the community of Bairro da Penha shown in table 1:

Table 1 - Socioeconomic data of Bairro da Penha according to 2010 IBGE census

Information	Victory	Penha district	(%) Victory
Area km²	93.38	0.26	0.28%
Population	319,163	5,603	1.76%
Men	149,833	2,678	1.79%
Women	169,330	2,925	1.73%
Average income	1,661.99	613.82	_

Source: IBGE Socioeconomic Census of Bairro da Penha (2010)[4].

The articulation of the housing problem with the socioeconomic issue of employment and modernization in the city shows that nature, social and economic aspects should not be treated in isolation by the public authorities.

III. VIOLENCE, CRIMINALITY AND SOCIAL INVISIBILITY

The Brazilian metropolises, as they evolve in their offer of services and qualification for the world of work, present serious social problems, the most evident in post-modernity is the disorderly occupation of the land and urban violence. With the advent of the globalization of the economy at the end of the 20th century, we started to live on the move. According to BAUMAN (p. 99, 2010):

> Globalization has made it possible for people to get to know different regions of the world, physically leaving home or not, but it has also made them lose their roots. The type of culture in which he participates is not the culture of a particular place, but that of a time. It is the culture of the absolute present.

The presence of migrants in the natives' social imaginary is seen in an ambiguous way, because at the same time, the fact that their presence is necessary for local development will burden the public authorities, will de-characterize the region, imposing new formations on the locality. The socio-spatial segregation is due to this accelerated and concentrated growth of the industrialization process and the need for labor.

Through the tragic perspective of the social, we can understand from the work of Koltai (2000) that forces us to understand that others exist not as possible objects of our satisfaction, but as subjects of their desires and actions. This feeling reverberates in an interior disturbance, the result of the impossibility of welcoming, which causes estrangement of contact, which is produced and reproduced permanently.

Guided by Freud's formulations[5] in "Civilization and its Discontents", Koltai points out the paradox of accepting the other, since the very movement of identification implies a segregation, a division between similars, excluding non-similars, that is, the other. "There is no love between brothers without rejection of foreigners" (p. 107).

Therefore, the migrants who formed the outskirts of cities figure at the heart of violence and crime established by a policy of socio-spatial segregation and state abandonment. Youth, according to studies produced by Koltai; represent the party most affected by social exclusion. They are the most indicated through statistical data that appear as victims or perpetrators of violence.

In the 80s there was an increase in crime in the Penha neighborhood. Among the most common crimes, drug trafficking and the formation of factions by young people fighting for control of the area stand out. In the following decades, the neighborhood became a constant headline in newspapers and other means of communication due to violence and criminality.Public security controls violence, but changing this scenario is the responsibility of social inclusion and opportunity policies.

to Freire[6], violence is a destructive action that bears the mark of a desire. And these young people, desirous of social visibility, do not recognize their collective identities, which are denied or considered invisible by society and

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[4] https://cidades.ibge.gov.br/brasil/es/vitoria/bairrodapenha

[5] Freud, Sigmund. Civilization's malaise.
[6] Freire, Jurandir da Costa. Violence and Psychoanalysis.

public authorities, find in criminality a way of social ascension. this same society

Within this context, young people who are not wanted even by their family or community, are carriers of various absences, whether economic, social, affective and referential; it ends up identifying itself with the one who accepts it: criminality. The social appearance, visibility is given by the imposition of fear through violent action.

The violated subject is the one who comes a posteriori, namely, who has been subjected to coercion and unnecessary displeasure for his well-being and psychic development. For this reason, the image of the other, the unknown, causes so much repulsion and violence can only exist through human interactions and relationships.

In 2010 the Municipal Public Security Plan was implemented by the Municipality of Vitória (PMV). The Federal Government, in articulation with the municipalities, must assume control and prevention of violence and crime. One of the guidelines of the security plan is the division of the city of Vitória into Regional areas to facilitate the implementation of urban and social public policies. The neighborhood of Penha is part of Regional 4 and public safety is highlighted as the main demand for problems to be solved according to dataof Graph 1.[7]

Graph 1 – Types of occurrences in Regional 4 – Maruípe that encompasses Bairro da Penha between 2010 and 2014.
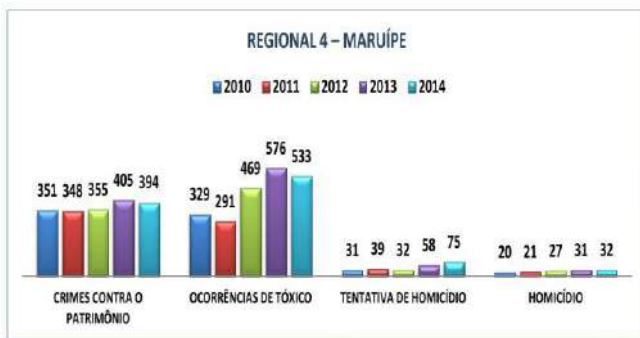
Source: Citizen Security Plan, PMV (2010, p.23).

The areas of social occupation are those that concentrate the highest historical rate of crime and violence, with high rates of homicides, school dropouts and low-income families. They are classified as areas of social vulnerability with juvenile violence as a highlight, and approximately

50% of homicide victims are young people aged between 15 and 24 years.

The main objective of the social projects is to reduce homicide rates in this age group, reduce school evasion, increase the percentage of young people in the labor market. Through the research carried out by the company Enquet and presented in the study of the administration of the city of Vitória between the years 2013 to 2016, it demonstrates the most relevant projects implemented by the Municipal Plan for Public Citizen Security in Regional 4 as shown in table 2[8].

Table 2 – Classification of the most relevant projects in the prevention of violence.

Source: Citizen Security Plan, PMV (2010, p.14).

For Bauman (2010), The movement of discussion and elaboration of public policies must move towards deconstructing, from the point of view of public security, the Hobbesian paradigm of security as a matter of military police force, surveillance, punishment, of distancing from the Other, in short, of permanent fear. It must also act in a long-term perspective, in relation to crime and urban violence. It is necessary to remember in Todorov's (2010) works that beyond conflicts, there is dialogue, beyond fear, there is trust. In this sense, table 3 shows, according to the regional community, the bodies with the greatest responsibility for public security in the region.

Table 3 – Classification of authorities/bodies with greater responsibility for public security in the region.

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[7]Source: Citizen Security Plan. Available in http://www.vitoria.es.gov.br/arquivos/20150811_planodeseguranca cidada.pdf

[8]Source: Citizen Security Plan. Available inhttp://www.vitoria.es.gov.br/arquivos/20150811_planodeseguran cacidada.pdf

Região Administrativa 4 – Maruípe

Classificação das autoridades/órgãos con... maior responsabilidade sobre a segurança pública na Região, conforme opinião d... comunidade regional.	
Governador do Estado	1º
Secretário de Estado de Segurança Pública	2º
Polícia Militar	3º
Prefeito Municipal	4º
Secretário Municipal De Segurança Urbana	5º
Polícia Civil	6º
Guarda Civil Municipal	7º

Source: Citizen Security Plan, PMV (2010, p.14).

In 2017, Bairro da Penha becomes the 26th community in Greater Vitória to be served by the Social Occupation project[9], government program of the State of Espírito Santo coordinated by theSecretariat for Human Rights (SEDH). The target audience is children, teenagers and young people aged 10 to 24 years old who represent a social risk and account for 40% of homicide victims in Espírito Santo.

In short, the actions are aimed at reducing social vulnerability, increasing and improving the conditions of social inclusion for young people living in the project's regions, aiming to offer opportunities for professional training. The program highlights three main objectives to be achieved through activities that prioritize youth involvement, dialogue and the collective construction of youth leadership.

With a special focus on education, the priority is to combat dropping out of school with the return to school, public-private partnerships that generate employment and income, work aimed at developing the socio-emotional skills of young people with workshops in the areas of culture, sport leisure and entrepreneurship.

IV.   FINAL CONSIDERATIONS

Public policies must bring with them the mark of affection towards the other, in addition to having an integrative character. They must also take into account the long-term historical perspective of the plots of violence and urban crime, in which historical subjects are found, without relying solely on an analysis of the continuum of the present.

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[9]Source: State Secretariat for Human Rights. Available inhttps://sedh.es.gov.br/ Ocupacao-social-3.

...it is not possible to promote freedom through obligation, nor equality through submission. (Todorov, 2010, p. 223).

The relations between society and state become more complex as power relations alternate, the clash is evidenced by those excluded from the social fabric. The change promoted through public policies is the transformation for the performance of democracy and citizenship. Given the historical evolution and the speed of social, political and economic changes, there is a need for a specific look at those who are on the sidelines of the process, providing an adequate environment for its development.

Finally, it is also necessary to remember with Koltai (2000), the need to find ways to transform borders - cultural, economic, social, psychological, scientific and environmental limits - into areas of passages, of approximation. The other is also socially important, because with it there is the possibility of creating bonds of solidarity to support the real, material existence and changes in the evolution process of societies.

The neighborhood of Penha is located in Regional 4, the most populous administrative area, being the third in demographic density in the city of Vitória[10]. Since its foundation until the present moment, it needs the performance of the public authorities in partnership with the community to reduce violence, to improve social and environmental conditions and to build a culture of peace.

The public power when it is presenting the ability to reduce urban crime. The problem of violence and urban crime is present in the daily lives of all residents of a city because many have been direct or indirect victims of the same or because everyone, to a greater or lesser degree, suffers from its effects.

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[10]Citizen Security Plan. PMV, (2010, p. 7).

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The importance of risk management in civil engineering

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Abstract— The civil construction industry needs of a proper project management inside of companies, the risks must be dimensioned in order to avoid any negative impacts to the success of the project. The present article consists of a bibliographic description that starts from understanding the relevant importance of risk management applied to projects in the construction industry. This study consists of a comparative bibliographic analysis, between the guide to the best practices of project management, and the study of authors on the importance of risk management in the construction industry. Projects in civil engineering are based on the success of their done objectives, which are linked to compliance with the schedule, cost, deadline and quality. Thus, risk management is essential for the project success, enabling the monitoring of these parameters. Risk management creates a wide vision of the project, and turns possible to identify risk situations to prepare control plans for the most impacts. Through these plans, it is possible to mitigate expenses, avoiding rework, waste and delays in activities, in addition to contributing to the improvement of quality management system for the services performed.

I. INTRODUCTION

The civil construction industry needs of a proper project management inside of companies, the risks must be dimensioned in order to avoid any negative impacts to the success of the project.

According to [1], project management is considered one of the main concern inside of organizations, is essential to use the standards procedures in the initial phases of the construction stage, to ensure the monitoring and control of risks in the development of the project. Still for the authors, risk management aims to prevent in order to minimize or stop possible risks from the identification, analysis, monitoring and control.

As stated in [2], the effects that the risks offer to civil construction companies have error margins that are considered harmful for the execution of planned activities,

which can lead to the interruption or even the ruin of the project.

Therefore, it is possible to understand the importance of risk management in projects, since it covers fundamental elements such as scope, time, cost and quality, which can suffer significant impacts, according to the Project Management

Institute - PMI [3].

Considering the description of risks as an uncertain event or condition, which, when it occurs, causes positive and negative effects on the project objectives, [4] recommends an adequate planning in risk management, aiming to prevent events that change the results, and consequently, the organizational success of the project.

The present study consists of a bibliographical description, that starts from understanding the importance

of risk management applied to projects in the civil engineering construction sector.

II. METODOLOGY

This study is a comparative bibliographic analysis between the best practices guide for project management PMBOK (Project Management Body of Knowledge), prepared by the Project Management Institute, the current international standard NBR ISO 31000: 2009 [5] and the study of authors on the importance of risk management in the construction industry.

After the literature analysis, a comparison was made between the concepts related to risk and its management, described by the PMBOK and ISO 31000 literature, and the analysis presented by authors who have created studies about the relevance and the importance of risk management in projects, And later the transcription of this analysis, with the highlight most relevant items.

III. RESULTS AND DISCUSSIONS

Risks

According to [3] risks are described as an uncertain event or condition, which, when occurring, can cause positive or negative effects on the project objectives, such as scope, time, cost and quality), which may have one or more causes, one or more impacts . In the ISO 31000 standard, risks are defined as the effect of uncertainties on project objectives, where uncertainty is considered a partial or non-partial state of an event, where there is a lack of information and knowledge, enabling the occurrence and existence of consequences.

Both literatures can characterize the uncertain nature of risks and the effects on projects. However, [6] consider the definition of risks described by the PMI as an optimistic view, because, presents the possibility of positive impacts, while in ISO 31000, a traditional view, is based on the possibility of failures from lack of knowledge. The authors [7] confirm the traditional view of ISO 31000 when they describe that in the initial stages of civil construction projects, where risks are identified, there is a few of data and information available, which can lead to failures.

After bibliographic studies together with practice, [8] highlight that the perception of negative risk is greater, because the possible failures are associated with an exaggerated condition of consequences, almost always disregarding the probability of occurrence. In view of this reality, [9] argues that there must be a broad vision, considering the positive and negative risks, they would enable greater benefits for the business, since not only

would the failures be mitigated and eliminated, but the opportunities could be used and converted into better results.

Risk management

Risk management is defined by PMI as a systematic process to identify, analyze and respond to risks in projects, aiming to increase the probability, and impact of positive events, and reduce the probability and impact of negative events that may interfere with the purpose of the project. In ISO 31000, this management must be based on coordinated activities, to direct and control the company in relation to the projects risks.

The authors [6] states that by performing the management properly, make benefits for the enterprise more viable, and, to encourage a proactive approach to risks, in order to improve the organization's learning and resilience. The correct application of risk management as a competitive advantage for the organization, will increase the productivity and competitiveness, besides of improve the quality of processes, it will ensure the preservation of company resources.

Civil construction risks are generally linked to engineering, execution and supply processes, as described by [11].

The authors [12] states that plan and manage the projects correctly has become a necessity for the survival of a company in this market. As reinforced by [13] where it states that in the Civil Construction market, the profit is inversely proportional to the cost of construction and, cut out extra expenses generated by unforeseen events is a necessary factor for construction companies to achieve the planned profit with the execution of the project.

To [14] manage risks is a practice that can guarantee the perpetuity of the company, as it becomes able to present solutions with lower costs, the events that generate extra expenses for the work. As described by [12], by proving that the implementation of a risk management process, the occurrence of reworks that generated expenses in the execution of the foundation and the reinforced concrete floor of an industrial shed has decreased. In addition, due to the identification of risks, there was a great reduction in the number of unforeseen events during the work.

After studies on risk management in high-end buildings, [6] concluded that delays in their correction affected not only expected profits, but also added negative values to the company's image in relation to the market. The authors also claim that risk management contributes to the improvement of the company's management processes. [12] achieved similar results, by proving that

meeting deadlines and saving on an industrial project contributed to the company's image to the customer. Another important point identified by the authors was the documental improvement in the control of the work, due to the creation of conference spreadsheets and mobilization schedules, with the implementation of risk management.

IV.   CONCLUSIONS

The success of projects in the civil construction sector is based on enforcement its objectives, which are linked to the fulfillment of the scope, cost, deadline and quality. Therefore, risk management is essential for this success, because it enables the monitoring of these parameters.

Risk management creates a wide vision of the project, and turns possible to identify risk situations to prepare control plans for the most impacts. Through these plans, it is possible to mitigate expenses, avoiding rework, waste and delays in activities, in addition to contributing to the improvement of quality management system for the services performed.

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Influence of Dual Core Type Shear Wall Used Around Lift Area with Opening in Different Percentages in Multistoried Structures

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Abstract— The Multistoried Building will consume lesser area of construction, on the other hand, it occupies more living space considering vertical approach. The reduction of the overall budget of the project leads to the cost effective one and there should be such criteria of reduction of the cost in different manner. Without losing the stiffness criteria, the work has been performed by using dual core type shear wall used around lift. The area of shear wall of the core has reduced to certain limit and the aim has decided and fixed to find a suitable reducible area upto the failure of the structure. Total 6 buildings that are modeled with different openings percentages in dual core type shear wall and then analysis procedures of the same has performed. Building with 50% opening area in dual core type shear wall performs well to reduce the overall cost of the project. Complete combined results drawn in the conclusion part.

I. INTRODUCTION

Firm and Stiff thin wall member in a structure used generally around the lift areas to resist the lateral effects is known as shear wall. Shear wall has constructed from foundation base to the top of the structure. These walls have the ability to resist the lateral forces along with the uplift forces due to the pull of wind. It has to resist the force that aim to push the walls over. The shear walls do not need extra finishing or plastering when construction is going on. The shear walls are connected with column components; thereby transfer the entire horizontal and vertical loads throughout it.

II. AIM OF THE CURRENT STUDY

The Aim of the current study has decided by selection of the optimum building case to counteract the seismic effects and analysis has done using analysis software. So for this, different loads applied and parametric values obtained are considered and the point of comparison on different building models is as follows:

1. To take 6 different buildings, comparing them among each heads by using Response Spectrum Method of dynamic analysis.

2. To calculate Maximum Displacement and Base Shear in X and Z direction and then comparing all the 6 dual core cases.

3. To evaluate maximum Torsional Moments in beams along X and Z directions and then comparison have performed on all the 6 dual core cases.

4. To explore the possibilities of overall structural resistance by minimal use of shear wall area in with and without opening dual configuration multistoried structure.

5. To determine maximum Axial Forces in column and then comparison have performed on all the 6 dual core cases.

To obtain the best building with opening threshold criteria, all buildings are thoroughly observed and compared their parametric values.

III.   3D MODELING OF THE STRUCTURE AND PROCEDURE OF ANALYSIS:

As per criteria for earthquake resistance design of structures, a (G+19) commercial building with plinth area 750 sq. m. for dual core has taken for analysis. A total six different cases have been chosen for parametric analysis for dual core type shear wall, its description shown below. Considering medium soil in seismic zone III, M 30 grade of concrete used with Fe 500 grade of steel is used in the entire analysis approach.

Dead loads (as per IS 875 part 1), Live loads (as per IS 875 part 1) and Response spectrum loads (as per IS 1893: 2016), are applied on the structure with various load combinations considering building has to be rested over medium soil. The equation of Fundamental natural period of vibration (Ta) has taken as $0.09*h/(d)0.5$.

After then dual shear core building cases are selected with its own abbreviations. Figure 1 and figure 2 shows typical floor plan and the subsequent figure shows the entire sectional 3D views of the Dual Core building. After then, the comparative result of various parameters has shown with graphical representation of each core case.

Table 1: General Data used for analysis of research work

Constraint	Assumed data for all buildings
Structure Type	Commercial Building
Height of building	78.5 m
Building configuration	G + 19
Floor to floor height	3.5 m (for all floors)
Height of ground floor	4 m
Depth of foundation	4 m
Beam sizes	450 mm X 600 mm
Column sizes	550 mm X 650 mm
Slab thickness	160 mm (0.16 m)
Shear wall thickness	280 mm (0.28 m)

Table 2: Seismic Data used for analysis of research work (as per IS 1893:2016)

Seismic Constraint	Assumed data for all buildings
Shear wall type	Ordinary Shear wall with Special moment resisting frames
Response Reduction factor	4
Damping Ratio	5 %
Importance Factor	1.2

Different building model cases selected for analysis using Staad Pro software

When Dual Core is used:-

- **Dual Core Case A**: Building with 100 % shear wall area used
- **Dual Core Case B**: Building with 90 % shear wall area used
- **Dual Core Case C**: Building with 87.5 % shear wall area used
- **Dual Core Case D**: Building with 83.33% shear wall area used
- **Dual Core Case E**: Building with 75 % shear wall area used
- **Dual Core Case F**: Building with 50 % shear wall area used
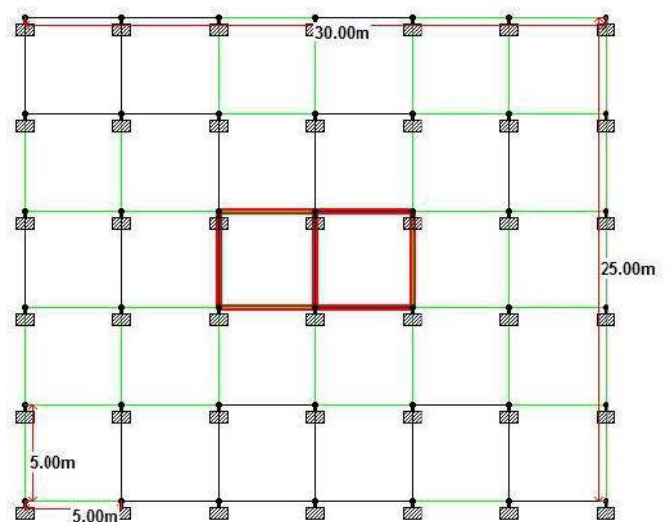
Fig 1: Typical floor plan of Dual Core
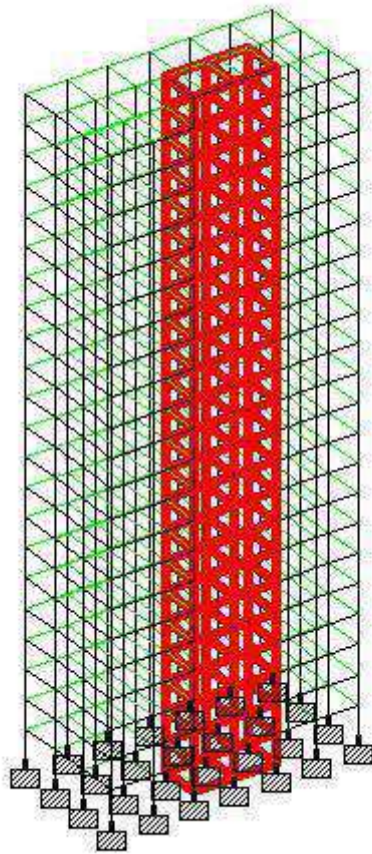
Fig 2: Sectional 3D view of Dual Core

Graph 1: Maximum Displacement in X direction for Dual Core Case A to F
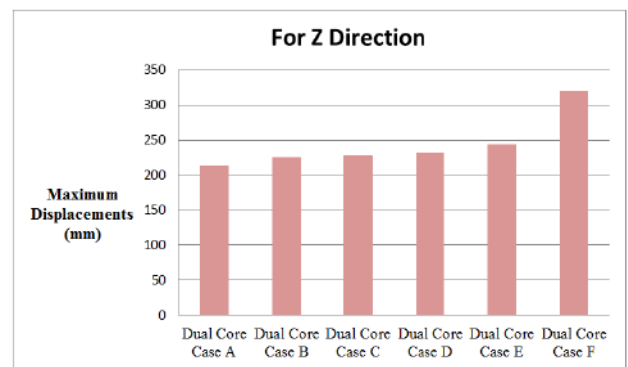
Graph 2: Maximum Displacement in Z direction for Dual Core Case A to F

IV.   RESULT ANALYSIS

To reduce the overall cost and to reduce the weight of the structure, Dual Core type Shear Wall used around lift area with opening in different percentages is used. For the stability criteria, percentage change in the shear wall opening is used. at different locations. Parameters such as the nodal displacement in X and Z direction, base shear in X and Z direction, column axial forces, column shear and moment values, beam shear and moment values and last but not the least beam torsion values in X and Z direction.

The above parameters obtained by the application of loads and their combinations on various cases of the multistory building as per Indian Standard 1893: 2016 code of practice.

Result of each parameter for all Dual Core cases has discussed by graphical form below:-

Graph 3: Base Shear in X direction for Dual Core Case A to F
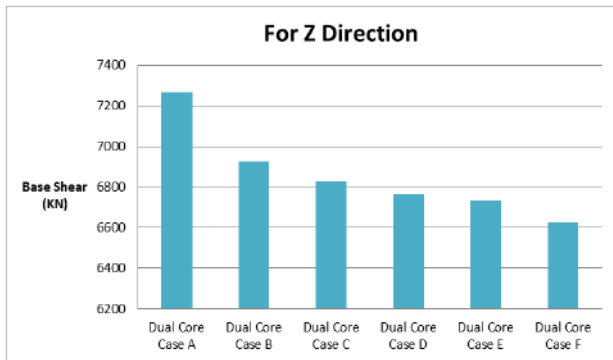
Graph 4: Base Shear in Z direction for Dual Core Case A to F
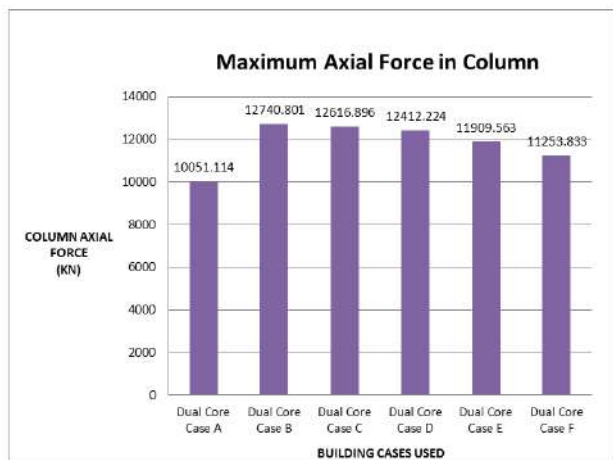
Graph 5: Maximum Axial Forces in Column for Dual Core Case A to F
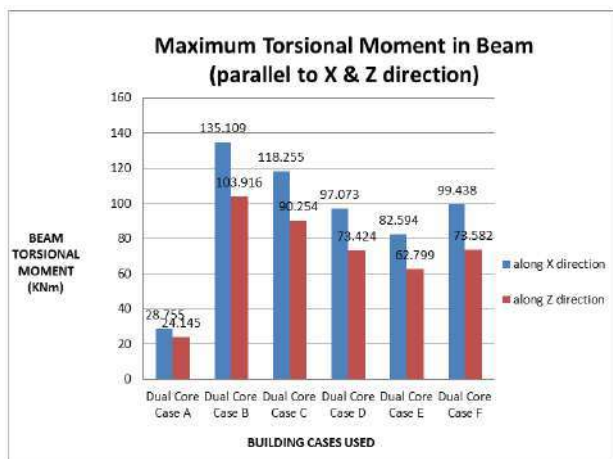
Graph 6: Maximum Torsional Moment in beams along X and Z direction for Dual Core Case A to F

V.   CONCLUSION

By analyzing different model cases and comparing their results, it is estimated that certain parameters will definitely be used for the conclusive part of this research and for that only that result values were taken are as follows:-The systems minimize hindered space compared to the traditional method. The floor space does not contain any columns and remains among the core and the external columns; as a consequence, increment in the functional efficiency of the building occurs.

1. Maximum displacement in X direction and Z direction increases due to reduction in Shear Wall and when the opening crosses 10%, there is an increase in displacements for dual core cases.

2. Base shear values decreases as the weight of the structure decreases since there is an increase in opening area percentage. For this, in both X and Z directions, Building Core Case F shows the best parametric values at 50 % shear wall opening.

3. Values of Maximum Axial forces in column first increases from 0% to 10 % opening area and then the values constantly decreases and hence building core case F is economical among all with 50% opening area.

4. Torsion in beam shows limiting parametric values under Dual Core Case B when there will be deduction in shear wall area.

Due to Seismic effects, for Dual Core structures, Building Core Case F shows best parametric values among all.

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Environmental sustainability and biodynamic cultivation of Vitis viniferas grapes in the Serra Gaúcha region, Brazil

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Abstract— Wine has shown a synergistic effect in a holistic context, being referenced in recent years by several areas, such as medicine, which considers it a natural antioxidant, economics, tourism, design and agribusiness, among other areas of study that perceive qualitative and quantitative characteristics of wine. In this sense, the wine sector is constantly looking for new practices for the Vitis vinifera grape, such as the use of biodynamic agriculture, which presents positive results for the sustainability of the ecosystem and the quality of the soil, thus ensuring a better terroir. The study here proposes to know: what interferes in the winegrower's decision to choose environmentally sustainable practices in vineyard management? The general objective is to characterize the environmental profile of the biodynamic vineyard. The adopted methodology is a descriptive case study of qualitative analysis. The factor that interferes, in the choice of sustainable practices for the management of vineyards, to the necessity of the maintenance, the fertility and productivity, the vineyards and in this case the biodynamic practice can be an option for the production of grapes with low impact environmental and that can result in the production of good quality wines.

I.   INTRODUCTION

Viticulture is shown to be a constant concern with vine production systems, seeking more sustainable management of land use and with more satisfactory results for the environment and for social actors. For, the history of the planting of grapes goes back to the history of mankind as well as the consumption of wine. According to Souza [1] the vine grape belongs to the Vitaceae family, whose fruit is the grape. The evolution of varietal production is indicated by the authors: Gobbato and Martins [2]; Days [3]; Sousa [1], as permanently. The production of grapes in Brazil is concentrated in the southern region. EMBRAPA Uva e Vinho is one of the references in the development of technical studies for the production processes of wine grapes, with the purpose of contributing significantly to the improvement of the quality of the raw material (wine grapes), and the competitiveness of the fine wines [4].

Since the wine sector is concerned with production techniques and with the quality and productive capacity of the soils of vineyards, in this perspective, the sectors related to viticulture start to assume an important role in the development of studies and techniques that contribute to the conservation and environmental sustainability of vineyards. In this sense, the behavior of international institutions and organizations in the wine sector, such as the International Organization of the Vine - OIV, is verified, which have promoted debates in congresses and meetings, on the development of new techniques, practices and tools that can provide the producer with ability to assess sustainable wine production systems and processes. Resolution OIV-ECO 460-2012, which establishes criteria for the production of vines in an organic system [5], is increasingly gaining strength in the design of environmentally sustainable vines.

As a result, the search for a more sustainable agriculture must be understood as a combination of economically viable, environmentally healthy and socially acceptable practices with the objective of creating a system that is capable of preserving the ecosystem's own characteristics. In this sense, sustainability is one of the factors that integrates a set of elements responsible for the formation of the "Terroir" of wine, as it results from the interaction between soil, topography, climate, biodiversity, customs and habits of a people, among others characteristics of each region [6].

In the case of Brazil, especially in the Rio Grande do Sul, wine producers are implementing programs such as good practices in agriculture and safe food, programs that are accompanied by SEBRAE (Brazilian Support Service for Micro and Small Businesses) and entities such as IBRAVIN (Institute Brasileiro do Vinho), FECOVINHO (Federation of Wine Cooperatives of Rio Grande do Sul) and others. As well as, the organic practice in vineyards since 2005 has shown growth in hectares produced in this system, according to data from the Technical Assistance and Rural Extension Company [7], which monitors the production of organic grapes. But as well, many properties have been advancing in the innovation of practices in vineyard management, as pointed out by Villanueva-Rey et al [8], the use of biodynamic practice considered an attractive and environmentally sustainable agricultural technique.

However, the biodynamic system adopts a holistic approach, in relation to the exploitation of natural resources, considering the sustainability of different elements, such as: cultural issues, the preservation of animal life, or the maintenance of a soil, how to recover, how to preserve or improve ecological harmony in order to obtain a high quality of the system as a whole. But for this, the use of practice requires: each farm is an integrated individuality; soil conservation practices; no use of chemical fertilizers and synthetic pesticides-only natural control products; nature conservation practices; social quality of work; application of homeopathic biodynamic preparations that increase the vitality of the environment, plants and the final product; non-use of transgenic products [9].

On the issue of environmental sustainability, it is noted that in biodynamic vineyards it is possible to use less intense machinery and, consequently, fuel, implementing artisanal exploration strategies. White [10]; Hassall et al [11]; Badgley et al [12]; Seufert et al [13] note that, despite the attractive gains in the marketing of wines and the reduction of inputs, there is a significant reduction in the volume of the harvest of the vines. However, the wines obtained are of exceptional quality with regard to the highest concentration of polyphenols. However, the advantages of adopting the biodynamic practice are in the balance of the entire ecosystem of the vineyard and its surroundings, allowing for the development of biodiversity.

For Villanueva-Rey et al [8], the wines obtained with biodynamic practice have peculiar characteristics, which are the result of the vineyard management system, such as the low concentration of sulphites and the excellent organoleptic quality. Even in the face of such benefits from the use of the practice, the same authors warn that the environmental benefits of applying these techniques, with regard to climate change or levels of toxicity, are still uncertain.

In this sense, the question is: What characterizes the environmental profile of the biodynamic vineyard?

II. VITIS VINIFERA L PRODUCTION SYSTEMS

The choice of the production system leads to a set of techniques and operations for the cultivation of vines, which is associated with the management and quality of agricultural soil. The use and management of the soil can lead to changes that can positively or negatively influence its quality. Therefore, changes in soil nutrients over time are essential components to assess the dynamics of soil quality and the sustainability of agricultural systems [14].

The vine is a crop that adapts well to various types of soils, and its productive performance is better in those with good nutrient supply capacity. In Brazil, the vine is cultivated in a wide diversity of soils, as it is cultivated even in highly weathered soils (soils with low content of primary minerals) [15]. According to Mello [15], most vines in Brazil are grown in soils that have some nutritional limitation, with phosphorus and boron, respectively, being the most limiting macro and micronutrients. For this, corrections are necessary, so that the plants are able to express their maximum productive potential.

The wine sector in Rio Grande do Sul - Brazil was structured based on the production of table wines, produced from American and hybrid cultivars, which, according to Melo [15], represent 80% of the total volume of wines produced in the country. In such a way, that from the 1980s onwards, there was a need for investments in the modernization of study processes for the adaptation of new cultivars, having as a driver the competitiveness with the international wine market and the domestic market with potential for the consumption of fine wines yet to be explored.

However, according to data from the Instituto de Economia Agrícola, the area of vineyards shows continuous decreases, accumulating in the period 2007-2011 the value of -2.33% in the global planted area. This deficit in the global area of vineyards results from area losses in some regions and some expansion of areas in other new producing regions such as China, Iran and Turkey, and some countries in the Southern Hemisphere (Argentina, Chile, South Africa, Australia and New Zealand) and also the United States. In the case of Brazil, the area occupied by vineyards decreased in 2015, following a trend started in 2013, with a reduction of 1.83% in the planted área. The states of Rio Grande do Sul and Santa Catarina presented area reduction of 0.51% and 0.98%, respectively. The state of São Paulo, which already presented a reduction of 12.79% in planted area in 2014, in 2015 suffered a further reduction of 5.86%. The state of Minas Gerais, however, showed an increase of 10.91% in the area planted with vineyards. According to Mello [15],

the area reduction occurred in some places due to real estate speculation. The vineyards are replaced by the construction of residential condominiums in rural areas, thus reducing the wine-growing area. In other territories, the problems are: climate, lack of labor, economic crises that have discouraged growth, as well as the development of viticulture.

However, the global scenario has new wine consumers and the new consumption habits associated with it beckon with an invitation to enter a new scenario, such as the Asian market [16]. In view of the new markets for fine wines, in Brazil and in the world, the vineyard manager and other actors in the wine chain need to be efficient in their decisions for the proper use of natural resources and in an environmentally correct manner.

For this, investments in the sector must go beyond technological modernization. Technically based strategies are needed to serve as a reference for the systematic and rational modernization of the production processes of Vitis vinifera grapes, having as a reference point the human-nature alignment. A systemic look is needed so that a better convergence of the balance of biodiversity can occur. As a result of this, in many planting areas there may be a better nutritive performance of the soil, and therefore, a better quality of production and the environment.

Given the concern with issues of environmental improvement, Normative Instruction No. 42 of November 9, 2016, published in the Official Gazette on 11/14/2016, presents Specific Technical Standards (NTE) (BRASIL, 2016) for more than 13 agricultural crops, including grapes for processing. From the Normative Instruction, farmers must adopt a cultivation focused on sustainability. In order to maintain these benefits, the Technical Commission for Integrated Production of Grapes for Processing, established by MAPA in June 2013 [17], has an important mission to update the system annually, especially regarding the agrochemicals grid, to the adoption of new practices to the system and the harmonization of these norms with those adopted by the main importing countries, activities that depend heavily on the monitoring of research bodies.

According to Mello et al [15], viticulture, as a productive activity in the primary sector, has been experiencing new regions in the state of Rio Grande do Sul. In other regions of Brazil, vineyards were planted with the aim of reassessing and redefining planting projects and management systems, among other innovations. The viticultural sector has shown itself able to establish conditioning factors of ecological, economic and social sustainability for small family farms.

The manager's concern with reassessing the Vitis vinifera production system makes him evaluate new alternatives and make new choices, which will lead to economic, social and environmental results that may determine the direction of the vineyard's environmental sustainability.

2.1 Vineyard Environmental Sustainability

According to Iyer-Raniga and Treloar [18] and Steurer et al [19], the best known definition of the term sustainable development was presented in the Brundtland Report, prepared by the World Commission on Environmental Development (WCED). According to WCED [20], sustainable development is what meets the needs of the present generation, without compromising the possibility of future generations meeting their own needs. As well, it is a process of change in which the exploitation of resources, the direction of investments, technology and institutional changes are in harmony to guarantee current needs and guarantee the future of living conditions on the planet [20].

It is noted that environmental issues have been systematically gaining projection due to legal, social, economic requirements and new consumption habits. This, too, becomes a concern of the wine sector. Because that doesn't just mean taking care of the land, the vineyards, the wine terroir. To produce sustainably, one must be aware of other requirements such as: a) the intelligent use of technology to reduce water, energy and fuel consumption; b) the relationship with the land, which makes the wine sustainable; c) professionals working in the cultivation of vines, harvesting and processing the grapes.

In this sense, Elkington [21] points out that companies that do not consider environmental aspects in the scope of their strategic planning may lose the chance to position themselves with competitive advantages over the competition. Consequently, activities that have their environmental impacts reduced represent gains for companies, whether in relation to market requirements, or by complying with environmental legislation, or by saving resources or reducing waste, among other factors.

This makes some of the small wineries choose to use safe food standards, according to the NBR 15635 standard [22], which deals with the control of food production, contains guidelines to be followed by companies in the food sector of all sizes, especially micro and small companies that want to grow and succeed [22]. The "safe food" and "good practices" programs receive guidance from consultants from the Brazilian Micro and Small Business Support Service (SEBRAE), who act as drivers for property planning in a more environmentally sustainable manner.

As a result, managers need to establish methodologies that allow them to assess and decide, in a dynamic scenario, that uncertainties need to be managed and risks calculated. Managers need to know how to assess and measure results in terms of climate change, soil nutrients, rainfall and carbon rates, in order to manage agricultural production.

An agricultural production process is considered sustainable, according to Fernández-Zamudio et al [23], when there is a correct management of its natural resources, especially the most limiting ones, and it is economically viable for the society that manages it, and that conducts it for the continuity of the agricultural activity. Another aspect to be considered is that, for an agricultural property to be considered sustainable, it must produce with high quality, be profitable, protect the environment, conserve resources and be socially responsible in the long run [24].

Sustainability refers to three pillars according to Hayati et al [25], namely: a) combating the degradation of agroecosystems caused by the modernization process of the 20th century; b) the establishment of new rules for the agrifood system; and c) the promotion of practices that are more adequate to the preservation of natural resources and production of healthier foods. There is, however, a duality between the choices of alternatives for the sustainable use of natural resources and the objective of industrial production to obtain the greatest quantity of fruit of the best possible quality at the lowest price.

In this case, an intensive conventional production system is considered, which according to Cerutti et al [24], which in the long term, can cause environmental damage to the ecosystem, particularly caused by pest and disease control, irrigation, fertilization, exploratory soil management, damage generated by climate imbalance. For this, Fernández-Zamudio et al [23], explain that the production of grapes can be a specialty that is associated with the efficient use of water and admits water endowments that are much lower than other cultures, such as citrus and vegetables. However, the conventional production system optimizes profitability and increased production, which can result in economic and financial gain.

On the other hand, the organic system, on the other hand, adopts the management with techniques and soil treatments with a vision of environmental sustainability. In the organic system, in accordance with LAW No. 10.831 of 2003, it establishes in Art. 1 that: "the organic system of agricultural production is one in which specific techniques are adopted, through the optimization of the use of available natural and socio-economic resources and respect for the cultural integrity of rural communities, aiming at economic and ecological sustainability, maximizing social

benefits, minimizing the dependence on non-renewable energies, employing, whenever possible, cultural, biological and mechanical methods, as opposed to the use of synthetic materials, eliminating the use of genetically modified organisms and ionizing radiation, at any stage of the production, processing, storage, distribution and commercialization and protection of the environment [26] ".

In turn, Meirelles and Rupp [27], clarify the various types of grapes that are being produced in the Serra Gaucha in the organic system are mainly the American varieties (Isabel, Concord, Ives and Niagara), Vitis vinifera (Cabernet Sauvignon and Gamay) and table (Italy, Rubi and Perlona). In the classification of production systems, Titi et al [28] present the integrated as an agrarian exploitation system that produces food and other high quality products through the use of natural resources and regulatory mechanisms to minimize the use of inputs and contaminants and to ensure sustainable agricultural production. This system is regulated and established by the IOBC (International Organization for Biological Control).

Grape growers have also been introducing biodynamic farming practices into the vineyard. This means transforming the property into an agricultural organism, in a place where each component has its activities enhanced by culture, livestock, forests, water sources, wildlife corridors, windbreaks and many others [29]. These are some of the practices that have been considered in decision making for environmentally sustainable vineyard management systems according to studies by Villanueva-Rey et al [8]; Zaher et al [30]; Chiusano et al [31].

However, Cerutti et al [24]), draw attention, which still does not have a consensus among producers about which system to choose and which is the most environmentally correct. What is observed as a unanimous point among producers, regulatory bodies and research agencies in the wine sector is the need to minimize and/or reduce the use of chemical and synthetic treatments in viticulture.

Therefore, the manager becomes concerned with the relevance of the results of the environmental conditions and the productivity of the vineyard. This is also in line with Food and Agriculture Organization of the United Nations (FAO - resolution 2025), cleaner production system program, with OIV [5], reduction of pesticides in viticulture, forcing the farmer to make decisions based on issues of environmental sustainability, and the agricultural manager, who does not have the capacity to assess the alternatives according to the market, may run the risk of a management with uncertainties in the sustainability of the vineyard.

In this way, there is also an appeal from the wine market to the need to rethink and reassess the vine production systems, through practices that allow for the recovery, reduction of actions that impact the use of land and natural resources on rural properties.

2.1.1 Ecodesign of Vineyards

The term design can be considered as a set of activities that includes from the territorial project, also the graphic design, passing through the architectural project to consumer goods [32].

As Niemeyer [33] emphasizes, design has been understood in three distinct groups of practice and knowledge: a) as an artistic activity, in which the professional's commitment as an artisan to the fruition of use is valued; b) as an invention, a plan in which the designer has a priority commitment to the productivity of the manufacturing process and technological updating; and c) as coordination, where the designer has the function of integrating the contributions of different specialists, from the specification of raw material, through production to the final use and destination of the product. In this last understanding of Niemayer [33], it can be seen that the development of a product design also needs to be thought of from the production of its raw material. In the case of wine, the vineyard is the place for this production, so the elaboration of its design can represent a lot in the manufacture of wine and/or its derivatives throughout its life cycle.

As well as Mansini [34] and Vezzoli [32], they understand that design for sustainability means promoting the capacity of the productive system to respond to the social demand for well-being using an amount of environmental resources drastically lower than the levels currently practiced. In addition, establishing the alignment between technique and what is possible is ecologically necessary and giving birth to new social and culturally appreciable solutions [34]; [32]. The same authors also understand that Ecodesign is a "project model" guided by ecological criteria, that is: the redesign of activities, production systems, techniques and even lifestyle habits.

In practice, the principles of sustainable agricultural systems can be described, but it is difficult to assess their sustainability in practice [35]. Macdonald and Patterson [35] mentions that sustainable agricultural systems show a greater diversity of cultures, making use of nutrients during cultivation, thus differentiating from the conventional agricultural system.

The mention of the term design related to agriculture also appears in Altieri [36], which calls attention to the use of self-sustainable agricultural design, in this case using biodiversity as a tool to implement design decisions that avoid what the author calls it the "ecological diseases" of a

poorly developed and malfunctioning system. However, Macdonald and Patterson [35] considers that ecological design strategies emerged in agriculture and that they seek to produce food for human populations in a sustainable way, in a way that they do not adversely affect environmental impacts, enable increased productivity and are reliable and consistently productive.

But, Macdonald and Patterson [35] cautions, the focus of these strategies varies and therefore their design strategies vary as well. Therefore, the design process must be flexible and dynamic. However, it is clear that agricultural sustainability has emerged as a global concern largely due to the dependence of current conventional agriculture on non-renewable inputs and fossil fuel energy [37]; [38]; [39]. Therefore, the search for projects of alternative agricultural practices, such as the case of biodynamic systems, in favor of the sustainability of vine growing systems has become constant in some wine producing regions around the world as well as in Brazil.

2.2 Biodynamic cultivation system

According to the Biodynamic Institute [9], which certifies Brazilian organic products, the Biodynamic practice, which began in 1924 with Rudolf Steiner in Europe, today corresponds to a movement that involves more than 4,900 producers worldwide. But to be considered biodynamic and receive the Demeter seal, each segment of agriculture must seek to meet criteria.

As for environmental sustainability, it is noted that the biodynamic vineyard makes less intensive use of machines and, consequently, of fuels, in addition to fewer insecticides and herbicides, but requires greater participation of human labor. Authors such as White [10]; Hassall et al [11]; Badgley et al [12] and Seufert et al [13], draw attention to the fact that, despite the attractive gains in the marketing of wines and the reduction of inputs, there is now a significant reduction in the volume of vintage in the vineyards.

Grape production (Vitis vinifera L.) is considered one of the most economically important crops in the world [40]. Cultivated vines (Vitis vinifera spp. Sativa) are considered domesticated, and their vinifera origin is in wild populations of Vitis vinifera spp. Sylvestris [41]. These wild vines are dioecious plants still present in small isolated populations in Eurasia. It is very likely that the wild grape was explored by man in the Paleolithic, but its domestication began later, linked to wine production (8,500 to 4,000 BC), even if the process before the other is not clear [42].

The species Vitis vinifera can be consumed in natura, in raisins, in the production of wines, spirits, juices and sweets of various types. In addition, it can provide other by-products such as natural dyes, tartaric acid, seed oil and tannins. When compared to other fruits, it has the following positive aspects: a) it does not need to be peeled, which prevents the juice from running off; b) it is easily handled, as it is attached to the bunch; c) it has a crunchy texture and good balance between sweet and sour flavors; and d) it supports storage and transport relatively well, as, in addition, the flavor is quite diversified and varies according to the variety [43].

However, to obtain a sustainable product, it is necessary to balance the use of natural resources (soil, water, energy), human and economic. The combination of these resources can lead to a significant increase in results, adding value to the product in a given region. But, it is necessary to consider a new design of the cultivation stages, as each stage is essential to obtain a satisfactory result in the design of a good quality wine.

In the wine production process, it is also necessary to consider the occurrence of uncertainties, considering the possibility of variations from season to season, due to climatic issues and the vegetative cycle of the soil. Because of this, some criteria in the ecodesign of vineyards must be considered, such as: a) the geographic characteristics of the region; b) the rainfall index; c) the type of vines; and d) the natural conditions prevailing in a given crop [43].

In the case of southern Brazil, and particularly in Serra Gaúcha, the most used criterion to evaluate a production is the glucometric degree (sugar content). This concern is due to the fact that wine is the product resulting from the process of transforming the sugar contained in the grape into alcohol and other secondary products. In this case, the aromatic compounds and phenolic compounds contained in the grape are related to the increase in sugar content [43].

In a way, for Villanueva-Rey et al [8], the wines obtained with biodynamic practice have peculiar characteristics, which are the result of the vineyard management system, such as the low concentration of sulphites and the excellent organoleptic quality. Even in the face of such benefits from the use of the practice, the same authors warn that the environmental benefits of applying these techniques, with regard to climate change or levels of toxicity, are still uncertain.

Thus, biodynamic agriculture can be an ecodesign project of great challenge for winegrowers in Brazil, in view of climatic uncertainties and soils that still have a history of agriculture with intensive use of pesticides. Therefore, the need for a rebalancing of the ecosystem is perceived, and this requires adequate management and the involvement of

human resources that seek results in a systemic way, as well as believing in the redesign of production systems.

III.   MATERIAL AND METHODS

This work is a case study, descriptive of qualitative analysis. For Yin [44], "the case study is an empirical investigation that investigates a contemporary phenomenon in depth and in its real life context, especially when the boundaries between the phenomenon and the context are not clearly evident". The research carried out was descriptive, which allows measuring or evaluating different aspects or components of the researched phenomenon [45].

The sample was intentional, for convenience and not probabilistic. For Levine et al [46] non-probabilistic samples can offer certain advantages, such as convenience, speed and low cost. The research subjects were consulted through semi-structured interviews. The identification of the names and characteristics of the participants is reserved to preserve confidentiality commitments. Interviews were carried out with open questions, applied to the technicians responsible for the wine estate, named in this study as follows: Vineyards "D" and "U", respectively, with the use of audio recording and annotations. In order to interpret the data, qualitative analysis was used, which for Vieira and Zouain [47] attaches fundamental importance to the testimonies, contents and meanings conveyed by the interviewees.

Next, for the treatment of responses and reports, the technique of content analysis was used, which consists of a set of techniques of systematic and objective procedures, the description of the content of the messages, which allows the inference of knowledge related to the conditions of production and/or reception (inferred variables) of messages [48]. But Richardson [49] emphasizes that the analysis of interviews also means describing the text according to its form, that is, the symbols used, words, themes, expressions, phrases and its background, which tries to verify the trends of the texts and the adequacy of the content, which here too, was carried out. Thus, it follows an analysis of the audios and notes of those responsible for managing the respective vineyards studied here as a case of adequacy of the use of biodynamic practice for the production of Vitis Viniferas grapes, in the region of the Serra Gaúcha, Brazil.

Map 1- Study Region, 2017

Source: Research, 2017

The winemaking properties participating in the study are located in Serra Gaúcha, RS-Brazil, Northeast Mesoregion of Rio Grande do Sul, a region with a humid and rainy climate, characteristics that are present in the characteristics of the wine as well as interfering in the results of identity and product quality, mainly in its climatic precipitation.

But that, the winemakers and technicians try to seek cultivation practices that allow the production of wines that can result in unique wines, in balance with the ecosystem in convergence with the needs of all stages of the wine production chain. As shown in the following results.

IV.   RESULTS AND DISCUSSION

Therefore, studies for the use of biodynamic practice in agriculture in rural properties in **Serra Gaucha** are still being developed gradually and can still be considered experimental. According to the winemaker from the "U" vineyard, "interests remain only centered on the monetary interest that wine produced in biodynamic practice can add, and not on the benefits it can provide for better use of the soil and for the quality of the biodiversity of the environment, what still leaves something to be desired in the use of biodynamic practice is the lack of conviction of some adepts". It is noticed that biodynamics can be a relearning of soil management, necessary for the producer to understand the relationships within the production unit.

Biodynamic cultivation signals the desire to pay more attention to vines and wines, as it requires discipline, work

and sensitivity on the part of the winegrower. Therefore, biodynamic agriculture requires deconstructing and detaching from conventional concepts and techniques and seeking to innovate on rural properties, but for this, the expected results must go beyond business profits, they must be sustainable in social, environmental and economic matters.

In view of the observations and analysis of the contents, it is evident that the choice of the winegrower to use the biodynamic practice must balance biodiversity and improve soil quality, taking into account the principles of living soil, an ecosystem in balance and respect. to the cycles and rhythms of nature. Because, according to IBD-DEMETER standards, the practice significantly reduces the use of fungicides and eliminates the use of herbicides. As the winemaker from Vinhedo "D" says, "adopting biodynamics means seeking results in the production of grapes with more intense flavor, with a greater concentration of aromas and color, and thus, having a balance between the production system and the results, ensuring a better terroir".

According to the winemaker of the "U" vineyard "make use of biodynamic practice to preserve vineyards, soil, biodiversity and human health". In this same perception, the winemaker from vineyard "D" agrees that Yes "...the biodynamic practice is a sustainable way to manage vineyards".

However, the interviewees are unanimous in stating that the use of biodynamic practice in viticulture in Serra Gaúcha "...it's a long way to go". For the respondent from vineyard "D" "...the biodynamic practice is a start to minimize the use of synthetic additives in the production of Vitis vinifera, but it is necessary to be aware of the climatic variations of the Serra Gaúcha, which configures a humid and subtropical climate. Under these conditions, the biodynamic practice in viticulture requires care, as it is in an environment of constant climatic imbalance. However, it is possible to make adjustments between the conventional and the biodynamic process for the production of vines, using less pesticides and an environmentally sustainable vineyard".

Note that the production of vines requires care and behavioral changes in the management of production techniques. The respondent from vineyard "D" reports that: "...the use of insecticide and herbicides in viticulture is present on the surface of the grape, which is in contact with the must, in a two-phase system, composed of a liquid phase (must) and a solid phase (dregs). Cabras and Angiorni [50] draw attention to the fact that such residues can still be found in ready-to-drink beverages, even with the reduction in the concentration of most agrochemicals during fermentation processes.

However, in order not to use pesticides in the production of the vine, it is necessary to be careful with the vine to balance it in the face of climatic variations and improve the quality of the vines, not compromising the harvest with the attack of fungi and diseases during the maturation phase. According to Turinek et al [51], biodynamic preparations are important for the application of the practice, and in addition, the rituals involving the preparations are unconventional actions and sometimes difficult to understand the mechanics of the underlying updated natural science, which is still under investigation, which in at first, they were explained as repairs with less nitrogen fertilization.

However, Koepf, Pettersson and Schaumann [52]; Koepf, Schaumann and Haccins [53], point out that the use of preparations in the practice of biodynamic agriculture should be applied in very small amounts to the soil and crops, and the expected effect is to stimulate the nutrient cycle, in photosynthesis and in better evolution of compost, increasing the quality of the soil and crops rather than the amount applied.

Finally, the use of biodynamic practice goes far beyond the understanding of an agricultural technique, because, according to Steiner [54], the ecosystem is formed by hidden forces such as: "gnomes, undines, sylphs and spirits of fire are actively involved in plant growth" [54]. But, despite the eccentricity and the lack of an obvious connection with the production of high quality wines, adherence to the practice of biodynamic cultivation gained a favorable reception from critics and consumers, and its use became related to a quality standard. in viticulture.

Thus, it is understood that there is a lot to learn about biodynamic practice, and to be willing to innovate and build new concepts of soil management techniques, which not only produce productivity in the production volume, but cherish the good quality of the environment , this is the only way to guarantee the sustainability of the vineyards for the use of future generations.

V.   FINAL CONSIDERATIONS

Therefore, the environmental profile of the biodynamic vineyard is characterized by the balance of biodiversity, not the use of insecticides and herbicides, but the use of compounds, biodynamic preparations, a calendar based on the phases of the moon and also in the philosophy of a production system in balance with living things.

Therefore, the use of biodynamic practice in vineyards will depend on the viticulturer's ability to adjust behaviors,

beliefs and economic and social conditions delimited by market behavior. As well as the climatic, geographic and morphological conditions of the territory, which may allow for desired results in cultivation with biodynamic practices. But, it is essential for all this to converge with technical monitoring, to make use of soil analysis frequently as a monitoring tool, especially in the intercrop phases, for the preparation and use of nutrients in an adequate manner for the new phase of planting and restructuring of vines, as well as evaluation of foliage, sprouting and fruit.

However, for the specific case of vines, the fruit stage is the period considered critical for winegrowers in the Serra Gaúcha region, due to pests and diseases caused by the climate, in the period before harvesting, especially for those who need greater grape maturation to obtain a greater degree of sweetness and less acidity of the fruit. With the occurrence of rain, followed by humidity and high temperatures, it causes the emergence of diseases and pests that compromise production. This leads many winegrowers to give up the biodynamic cultivation system and others even seek to adapt the use of biodynamic preparations at the beginning of cultivation, but at the end of cultivation they end up resorting to herbicides and fertilizers to avoid crop loss.

In these cases, they choose to use biodynamic agriculture, but give up the certification of the product, because at some point they still use chemical fertilizers for treatments, but how to solve this? What was noticed from the reports is that the winegrowers need tools that allow them to alleviate uncertainties and measure their risks in this type of cultivation in a more timely manner. Therefore, what needs to be taken as a path for the production of wineries requires technical monitoring that is effective and efficient, because you cannot be an amateur, it is not enough to have passion, you must master the knowledge of processes and technology as well as having the knowledge of the system and all interfaces, manage decision-making in the agricultural unit.

Finally, what these winegrowers actually consider when choosing to manage sustainable vineyards is due to the urgent need for soil recovery and the longevity of vineyards, which can be provided by the use of low environmental impact techniques, which consequently enable maintain and restore the balance of the vineyard's biodiversity. As a result, better productivity and wines as an identity.

The final considerations of the study showed that the wine growing system in the country is still very incipient and amateur, rooted in feelings of ancestry. It is recommended for the search for the professionalization of cultivation based on research, technique, design, training and adequate and conscientious preparation of the vineyard for the use of natural, human and financial resources for production.

However, it is faced with research limits such as access to data, the lack of a history of production areas, as well as studies of soil morphology and the seriousness that must be given to each cultivation system by the actors involved in the production chain of wines.

The suggestion for future work is to carry out research with monitoring of all stages of the wine production process in the biodynamic system and to identify the main resistances and bottlenecks in the application of the practice in the southern region of Brazil.

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Heuristic Usability Evaluation: A Case Study of Online Enrolment System of a State University

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Abstract— The primary purpose of the study is to perform a thorough assessment of the user interface design of the Nueva Ecija University of Science and Technology's Online Enrollment System (NEUST-OES). From there, human-computer interaction concepts such as metaphors, models, appearances, and the overall interface structure and logic flow were evaluated using the Nielsen Ten Usability Heuristics as a model.

The results of this study can be utilized for further system improvements, particularly on increasing user productivity and performance by structuring the elements based on design standards that follow cognitive psychology laws. The significant findings of this study were given to the developers of NEUST-OES so that they can use them as bases on improving the system user interface design. It is hoped that with these results, the system's user-friendliness and ease of use will be improved, hence, offering a smoother user interaction experience for both the students and the enrolling teachers.

I. INTRODUCTION

Rationale

The new normal has brought upon various changes in the way society does things. Due to the restrictions it imposes, online transactions have become the ideal option for consumers. Hence, organizations and businesses have been switching to online channels to accommodate their customer's needs. The conversion from face-to-face to online transactions also applies to the education sector. Schools have started to utilize online platforms to make their services available for their stakeholders.

To accommodate the changes and keep up with the new normal, the Nueva Ecija University of Science and Technology has come up with online solutions for its services, such as the Online Enrollment System. The system is designed to enable students from different campuses to enroll in the University in the comfort of their own homes.

The Nueva Ecija University of Science and Technology - Online Enrolment System (NEUST-OES) has been first implemented to handle online enrolment for the 1st Semester, S.Y. 2020-2021 and is continuously being utilized and improved. Thus, the researchers find it timely to conduct an interface design assessment through heuristic evaluation to further enhance the system.

The primary purpose of the study is to perform a thorough assessment of the user interface design of the Nueva Ecija University of Science and Technology's Online Enrollment System. From there, human-computer interaction concepts such as metaphors, models, appearances, and the overall interface structure and logic flow were evaluated using the Nielsen Ten Usability Heuristics as a model. [1]

The study results can be utilized for further system improvements, particularly in increasing user productivity and performance by structuring the elements based on design standards that follow cognitive psychology laws.

Incorporating the study results to develop an improved system user interface design can add to the system's user-friendliness and ease of use hence offering a smoother user interaction experience.

Related Literature

Human-computer interaction (HCI) plays an integral part in system design and development. Based on the various related studies mentioned above, the importance of human-computer interaction in maximizing usability, productivity, and user satisfaction can be established.

One aspect of HCI is applying metaphors, mental models, navigation, and appearance as essential design considerations as explored in the study conducted by Alexander and Ishak in 2018 [2]. They have proven that proper use and incorporation of such HCI components contribute to the increased user interactivity and engagement.

Another criterion, that the components mentioned above may impact, is the usability of the overall user interface design. In the context of HCI, Punchoojit and Hongwarittorrn (2017) have defined usability as contributory to productivity and performance [3].

Having established the usability definition, a proper tool to measure interface usability should also be considered. One of the most popular evaluation models is the Nielsen Ten Usability Heuristics which was developed in 1994. It may have been an old methodology, but it has been proven to be functional and effective in today's setting, as demonstrated in the study conducted by Kraweic and Dudycz in 2020. [4]

In relation to this, Iqbal (2020) has utilized the Nielsen Ten Usability Heuristics as the evaluation tool for the Uppsala University Student Portal. [5] Based on the results, the researchers were able to develop design guidelines to improve the user interface design. The findings reinforce the claims of the study made by Krawiec and Dudycz that even today, the Nielsen Heuristics can still be applied in usability evaluation.

Based on the analysis of the related studies above, it can be said that human-computer interaction (HCI) can indeed be a significant part of the whole design process. Properly chosen and applied metaphors, appearance, mental models, and other HCI components that make up the interface design can enhance the user experience by increasing productivity, engagement, and interactivity. Moreover, the validity of the Nielsen heuristics has also been verified. Therefore, the study of evaluating the Online Enrollment System using Nielsen Ten Usability

Heuristics is feasible in terms of the proposed scope, the purpose, and the methodology.

Statement of the Problem

The study aims to assess the Nueva Ecija University of Science and Technology's Online Enrollment System's interface design and its impact on user interactivity. In relation to this, the researcher seeks to answer the following questions:

1. How can the user interface of the NEUST Online Enrollment System be assessed using Nielsen's Ten Usability Heuristics for interface design?

2. What are the possible impacts of the heuristic evaluation results to the overall system improvement?

3. How can the University utilize the results of the study for system enhancement?

II. METHODOLOGY

The research study intends to perform a heuristic evaluation on the NEUST Online Enrollment System using the Nielsen's Ten Usability Heuristics tool. As Nielsen (1994) defines it, a heuristic evaluation is used to find usability problems in a user interface design to provide better information for improvements [6]. Although a panel of experts usually does a heuristic evaluation, the researchers have surveyed the users to grasp better what the users think and experience while using the system.

The researchers employed convenience sampling technique. As defined by Saunders (2012), convenience sampling is a non-probability sampling method that considers a sample population that is convenient for the proponents to connect and reach out to [7]. In addition, Luciano (2020) stated that this type of sampling carefully considers the availability and willingness of the respondents to participate in the study [8]. An online questionnaire was distributed to four hundred twenty-eight (428) respondents comprised of students and enrolling teachers.

The population size has been validated using Slovin's formula, where the ideal sample size recommended was three hundred twenty-two (322).

The questionnaire was comprised of ten practical questions about their usability experience based on the Ten Usability Heuristics. The respondents were asked to rate each criterion based on the table shown below.

Table 1. Likert Scale for User Evaluation

Scale	Verbal Description
4	Strongly Agree
3	Agree
2	Slightly Agree
1	Disagree

For the interpretation and consolidation of the final results, the researchers used weighted mean to compute and generate a summary of all the responses from the respondents. The range and verbal description of the final results were described in the table below.

Table 2. Likert Scale for Final Results

Scale	Range	Verbal Description
4	3.26 – 4.00	Very Satisfactory
3	2.51 – 3.25	Satisfactory
2	1.76 – 2.50	Poor
1	1.00 – 1.75	Needs Improvement

III.   FIGURES AND TABLES

Figure 1 shows the ratings given by the respondents as regards the visibility of the system status. There are 179 responses (41.8%) who strongly agreed. Then, 216 (50.5%) agreed, 28 (6.5%) find it slightly agreeable, while there are 5 respondents (2%) who disagreed about the system having its status information readily available.

The system includes status that is visible and keeps me informed about its availability on a clear and timely manner.
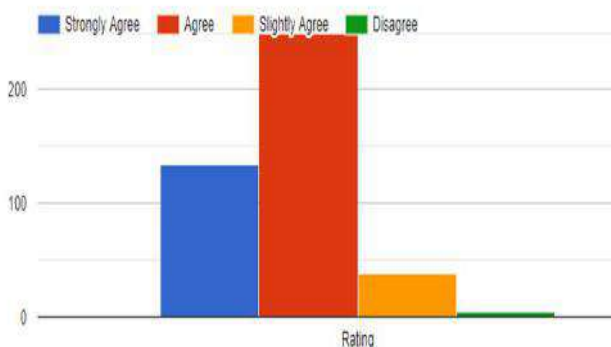
Fig.1: Visibility of System Status

Figure 2 shows the results about the user-friendliness of the system with regards to the choice of words and terminologies. There are 199 (46.5%) strongly agreed with the statement, 196 (45.8%) agreed, and 33 respondents (7.7%) slightly agreed, and no one disagreed.

The system uses simple words that I can easily understand.

Fig.2: Match between system and the real world

Figure 3 shows the response summary about user control and freedom. There are 152 (35.5%) Strongly Agree responses, 224 (52.3%) agreed, 49 (11.5%) slightly agreed, and 3 (0.7%) disagreed.

The system allows me to undo an action using the clear, cancel and delete buttons.
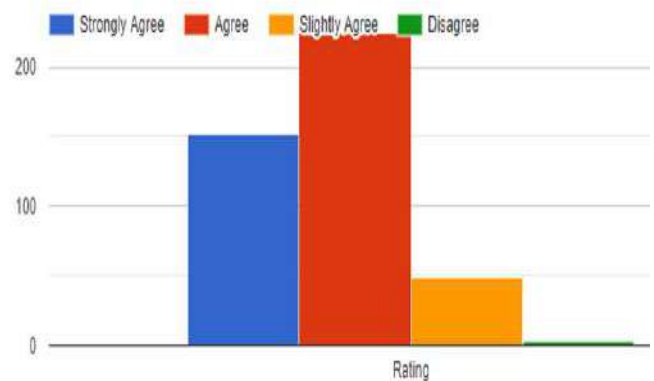
Fig.3: User Control and Freedom

Figure 4 presents the earned ratings of the consistency and standards criterion. There are 134 respondents (31.3%) strongly agreed that the OES uses the standard design and controls, 241 (56.3%) agreed, 48 (11.2%) slightly agreed, while 5 (11.7%) disagreed.

The system uses standard design and controls similar to other applications I am using which make it less confusing.
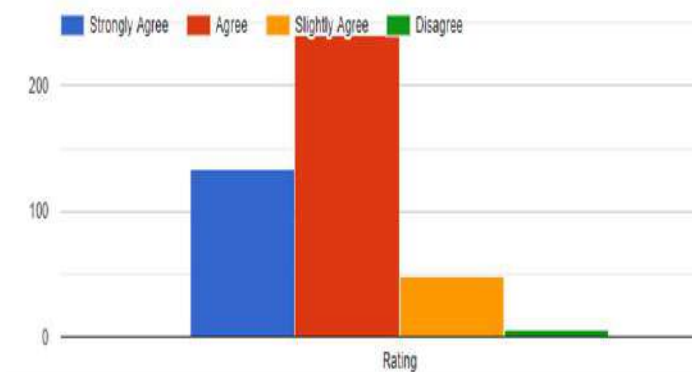
Fig.4: Consistency and Standards

The system elements such as buttons, interface, and functions are easy to recognize and to navigate.
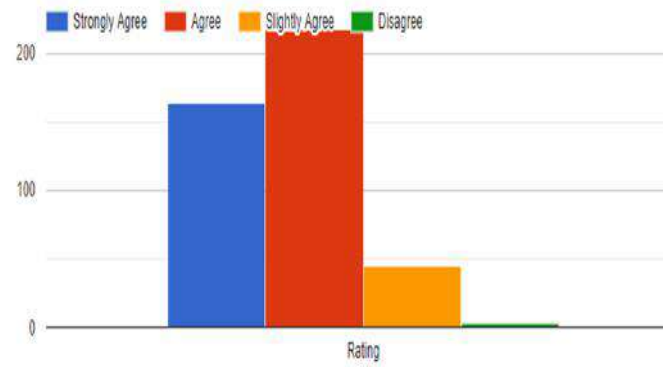
Fig.6: Recognition rather than recall

Figure 5 shows the summary of responses regarding the error prevention capability of the system design. There are 152 (35.5%) Strongly Agrees, 231 (54%) agree on its error prevention capability, 41 (9.6%) slightly agreed, and 4 (0.9%) disagreed.

The system provides validation of my entries in important fields, thus, enabling me to minimize occurrence of errors when processing my enrollment.

Fig.5: Error Prevention

Figure 6 shows evaluation of the respondents with regards to the controls and navigation experience with the system. There are 163 (38%) who strong agreed on the easy recognition of buttons and functions, 217 (50.7%) agreed, 45 (10.5%) slightly agreed, and 3 (0.8%) disagreed.

Figure 7 presents the results of the survey about system short-cuts that offer flexibility and efficiency. There are 156 (36.4%) strongly agreed on its availability, 213 (49.8%) agreed, 55 (12.9%) slightly agreed, and 4 (0.9%) disagreed.

The system allows me to use the usual short-cuts such as Ctrl+C (copy), Ctrl+V (paste), Ctrl+S (save), Ctrl+P (print).
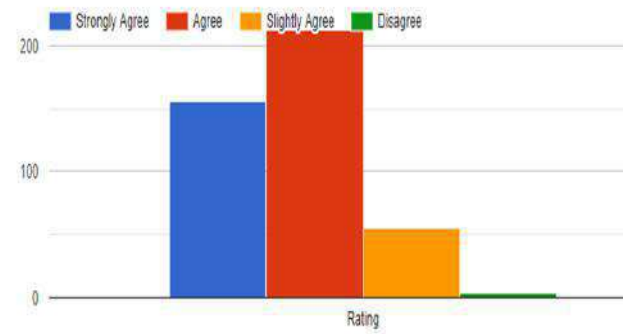
Fig.7: Flexibility and efficiency of use

Figure 8 illustrates the responses gained based on the adaptation of minimalist design. There are 147 (34.3%) strongly agreed that the system employs a simplistic design, 243 (56.8%) agreed, 35 (8.2%) slightly agreed, while 3 (0.7%) disagreed.

The system design includes only necessary elements and words important and related to the enrollment process.
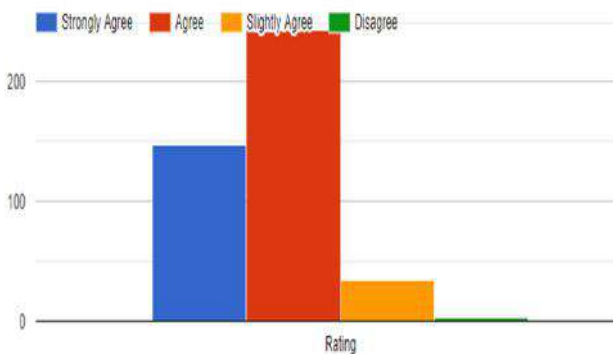
Fig.8: Aesthetic and minimalist design

Figure 9 illustrates the user responses about the user-friendliness and helpfulness of the error messages. There are 169 (39.5%) who strongly agreed that the system provides helpful error messages, 222 (51.9%) agreed, 35 (8.2%) slightly agreed, and 2 (0.4%) disagreed.

The system design includes easy-to-understand and helpful error messages that make it easier for me to correct my entries.
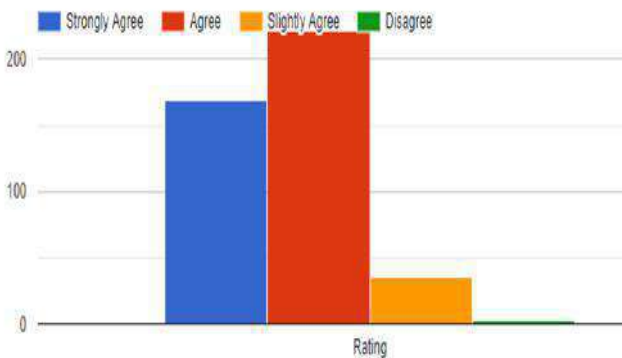
Fig.9: Help users recognize, diagnose, and

recover from errors

Figure 10 shows the agreement level of the respondents with regards to the existence of help section and clear instructions. There are 179 (41.8%) strongly agreed, 216 (50.5%) agreed, 28 (6.5%) slightly agreed, and 5 (0.2%) disagreed.

The system design includes a help section and/or clear instructions on what to do so I can understand how to use it.
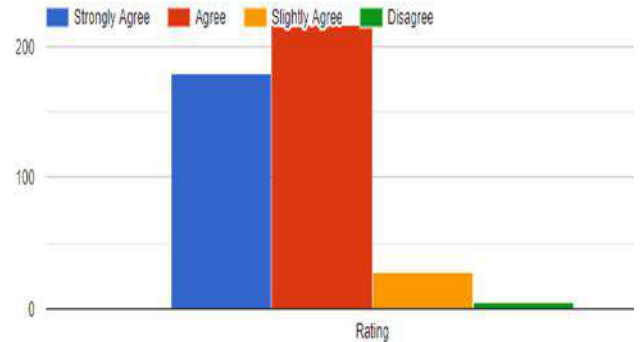
Fig.10: Help and Documentation

Table 3 below shows the summary of the findings of the study. The student-respondents evaluated the enrolment system with a Very Satisfactory rating as evidence by the computed weighted mean of 3.27. This result implies that the NEUST enrolment portal satisfies its users as far as the heuristic usability of the system is concerned.

Table 3. Summary of Results

Heuristic	Weighted Mean	Verbal Interpretation
Visibility of the system status	3.33	Very Satisfactory
Match between system and the real world	3.39	Very Satisfactory
User control and freedom	3.23	Satisfactory
Consistency and standards	3.18	Satisfactory
Error prevention	3.24	Satisfactory
Recognition rather than recall	3.26	Very Satisfactory
Flexibility and efficiency of use	3.22	Satisfactory
Aesthetic and minimalist design	3.25	Satisfactory
Help users recognize, diagnose, and recover from errors	3.30	Very Satisfactory

Heuristic	Weighted Mean	Verbal Interpretation
Help and documentation	3.33	Very Satisfactory
GRAND MEAN	**3.27**	**Very Satisfactory**

In particular, respondents evaluated the system "Very Satisfactory" on these areas: (1) help and documentation; (2) error recognition; (3) recognition rather than recall; (4) visibility; and (5) match in the real world.

IV.   CONCLUSION

Based on the findings discussed above, the researcher was able to come up with the following conclusions:

For research problem number 1, the NEUST-OES garnered a Very Satisfactory result from the respondents' heuristic evaluation. Incorporating Nielsen's Ten Usability Heuristics, the researchers came up with relatable scenarios to help the respondents rate the system better.

For research problem 2, based on the findings, visibility of system status, the match between the system and the real world, recognition rather than recall, error recovery, and help and documentation are the strongest suits of OES in terms of usability and user experience. However, user control and freedom, consistency and standards, error prevention, flexibility and short-cuts, and aesthetics resulted in satisfactory results, which can prompt further improvement.

For research problem 3, the University can utilize the research results by coming up with a system design proposal based on the areas that need improvement presented in this study. Furthermore, the systems analysts, designers, and programmers can use the summary of products as a basis for design consideration as part of the continuous development and enhancement of the system.

ACKNOWLEDGEMENTS

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Operation of Reservoirs in Kura River Basin in Azerbaijan

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Abstract— The given article is devoted to the ways of solving the problems connected with the rational use of water resources in high-muddy mountain rivers. The analysis of technical and operational indicators of reservoirs constructed on mountain rivers characterized by high turbidity is carried out and silt control measures are investigated. The silt control issue is now gaining a big actuality and national economic significance. This problem is especially acute in the South Caucasus, Central Asia and other places where many mountain reservoirs have been constructed. The given article analyzes the existing methods of sediment wash out from reservoirs and proposes a new method for silt control during the operational period.

I. BACKGROUND

Reservoirs are gigantic sediment basins, that trap a significant part of suspended sediment flow. When the reservoir gets filled with dead volume of sediment, further sediment deposition leads to a decrease of useful volume of the reservoir and operating upset. The experience of operating reservoirs constructed in the world over the past 70-80 years shows that reservoirs constructed on many mountain rivers, due to siltation, in a short time lose their useful volume and become unusable without completing their intended operation life.

Most of the reservoirs located on mountain rivers flowing through the territory of the North Caucasus and Central Asia lost their 70-90% volumes within 5-10 years. Pirsaatchay, Bolgarchay, Javanshir and Airichay reservoirs can be taken as an example of the most prone to siltation in the Republic of Azerbaijan. The Ayrichai reservoir, commissioned in 1986 with a useful volume of 80 million m^3, is 80% silted by 2016. Pirsaatchay and Bolgarchay reservoirs, which are constructed in 1964-1965 are totally

out of use due to siltation. The main reason for the rapid siltation of all these reservoirs is the increased turbidity of the river and the lack of preventive measures during exploitation.

There are several mountain rivers with increased turbidity on the territory of the Republic of Azerbaijan, the water resources of which are not rationally used for this reason.Examples include the rivers Sumgaitchay, Bolgarchay, Tyuryanchay, Karachay, Girdymanchay, and Pirsaatchay. Girdimanchay is relatively abundant, but also very muddy among these rivers. At present, the water resources of the Girdymanchay River are used only to a small extent. The reason for this is the high degree of turbidity in this river and the passage of frequent destructive mudflows. Attempts to build a reservoir on this river were made several times, but for the above-mentioned reasons, construction works were not started.

II.   GENERAL METHOD FOR THE EXPLOITATION OF RESERVOIRS IN AZERBAIJAN

All reservoirs in Azerbaijan, the total volume of which is approximately 22.8 billion cubic meters, are regulated according to the schedule of irrigation consumption. The operation of reservoirs is mainly carried out in the following order

- systematic supervision over the condition of structures;

 - ensuring trouble-free flood passage;

 - ensuring the safety of hydraulic structures operation;

- ensuring the specified mode of filling and depleting the reservoir;

-timely detection of structures damage;

-regular measurement of water levels in the pools;

- current repair of structures.

  Despite the high rates of reservoirs siltation, not a single measure is taken to flush sediments from the basin or to pass high-muddy waters into the downstream. Unfortunately, during the exploitation period, more transparent water is passed from the reservoir to downstream through the surface spillway.

The main method and rules for reservoir operation is, without taking into account the ecological consequences on the environment (ecological pass and fish passing facilities), to maximize the accumulation of river flow in the reservoir.

III.   MAIN CHARACTERISTICS OF HIGH-MUDDY RIVER GIRDIMANCHAY

The Girdimanchay River is a left tributary of the Kura River and originates at an altitude of 2900 m on the southern slope of the Big Caucasus Range. After the river flows from the mountains, it forms a wide cone delta in the Garamaryam plateau and splits into many tributaries. According to the water regime, the Girdymanchay River is full-flowing in spring and subject to floods in autumn. The average long-term flow rate of the river is 6.5 m3 / sec. Frequent mudflows are considered hazardous hydrological events on the river. Mudflow springs occupy more than 50% of the catchment area.

According to the observed data, the highest catastrophic water discharge was 201.0 m3 / sec. in July 15, 1988. According to the data on suspended sediment, the amount of annual runoff was equal to 2-3.5 million tons. Since 1960, several options of reservoir design in Girdymanchay River have been studied. To determine the volume of designed reservoir, the calculations were carried out

according to the water flow rate of 75% in Girdymanchay River (Q = 4.69 m3 / sec). At the same time, the volume of water flow per year is 149.76 million m3, the volume of sediment is 1.5 million m3 (80% of this sediment occurs in July and October). According to calculations, the required useful volume of the reservoir will be 50.0 million m3. Over a 50-year period of operation, the volume of siltation will amount to 75.0 million m3. The total volume of the reservoir will be 125.0 million m3. Taking these parameters into account, the height of the earth dam will be approximately 140 m.

The construction of earth dam of such a height in a valley of mountain rivers with specific heavy mudflows and flood conditions is not feasible from an economic and operational point of view. Taking into account the current situation, the construction of the reservoir was postponed.

Our research has shown that, considering the solid discharge management and a cost-effective operating regime, it is possible to build a reservoir in such conditions.

New approaches to the operation of medium and small reservoirs in the context of climate change.

   Climate change will have significant consequences for water resources. Some of these consequences are already visible today. It is expected that in near future, almost all the countries of the South Caucasus and Central Asia and beyond it will experience negative impacts from the increased frequency and intensity of floods and droughts, and an increase in the shortage of water resources. Moreover, the impacts of climate change on water resources will affect various sectors - agriculture, energy and hydropower, shipping, health, tourism and the environment. Adaptation to climate change is thus a moral, social and economic imperative: action must be taken now, and water resource management must be a central element in any country's adaptation strategy. On the territory of Azerbaijan, it is expected that water reserves will decrease by 15-20% until 2035. In this regard, it is planned to build more than 20 reservoirs on mountain rivers.

IV.   METHODS FOR SEDIMENT CONTROL OF RESERVOIRS DURING THE OPERATIONAL PERIOD.

Silting up of reservoirs causes a rapid decrease in the volume of reservoirs, which complicates their operation and shortens the service life of waterworks. Mostly the sediment control measures of reservoirs have passive character. Usually, after siltation of the reservoir, hydraulic flushing or removal of silt by hydromechanical method is carried out. Due to the hardening of silt in the reservoir,

the use of these methods is accompanied by the loss of a large amount of water and is considered ineffective from an economic point of view. Measures to reduce siltation of mountain reservoirs can be divided into two groups - **preventive and operational**.

Preventive measures include measures aimed at a general decrease in the flow of sediments into the reservoir by reducing soil erosion in the flow regulating basin. These measures are the most effective means of sediment control and the introduction of mountain reservoirs. Operational measures by execution way can be grouped as follows:

- hydraulic washing of sediments after emptying the reservoir;

- mechanical cleaning of deposits (used for small containers);

- building up the dam to increase the reservoir capacity;

- transit discharge of the total flood discharge into the downstream through spillways with low thresholds. With this option, a lot of clean water will be lost.

- flood water diversion discharge devices (bypass canals, tunnels) into the downstream without lowering the reservoir level. In difficult mountainous areas, the construction of bypass tunnels requires large capital investments.

Thus, the main disadvantage of operational methods of protection against siltation and entry of riverbed mountain reservoirs is that they do not prevent siltation of reservoirs, but are aimed at cleaning up the mass of sediment that has already compacted solidified at the bottom of the reservoir. The concentrated flush flow washes out the soil only along the path of its movement, forming a narrow deep channel at the bottom of the reservoir. The main part of the bowl remains silted up as before / **1,2** /.

As the review of existing works on sediment control of mountain reservoirs shows, none of the above options allows the more turbid parts of the stream to be passed into the downstream without a particular violation of the reservoir filling regime. The layout of the existing water collectors does not allow to solve the assigned tasks, since they are located within the limits of the dam and the discharge of excess flows into the downstream comes from the more clarified part of the reservoir. They do not provide monthly discharge of a certain part of the high-turbidity flow into the downstream and this leads to premature siltation of mountain reservoirs. *To solve the tasks, we have developed two options for dealing with sediment during the operational period of the reservoir.*

First option. To flush bed silt and pass of a part of the high-turbidity flow into the downstream, without disturbing the hydraulic regime of mountain reservoirs (the length of the lake is relatively short, the height of the dam is large), we have developed a new layout of the spillway structure. It is known that in almost all design solutions for regulating the flood discharge in the reservoir, a spillway is constructed near the dam, which passes a more clarified flow into the downstream pool.

In the new layout, the head of the spillway structure on mountain reservoirs is moved to the initial section of the reservoir / **5** /. The head of the spillway structure in the form of a water intake tower is located in the river bed between the horizons of the–dead volume level (DVL) and the – normally supported level (NSL). The location of the head part is assigned depending on pump regime of the rivers. For the passage of high-turbidity wash flows into the downstream pool of the reservoir, a wash gallery is laid inside the bowl. A sediment collector and a spillway are located on this wash pipe. Depending on the hydrological regime of the river and the hydraulic parameters of the dam, the spillway tower can be two-tiered. In this case, the first water intake threshold (hole) is located at the level of the reservoir, which corresponds to the passage of the first spring flood. The second threshold is located at the level of the NSL and operates in an automatic mode - the type of a mine spillway.

The first water inlet is closed by gates when the surface water inlet sills operate. Such arrangement of thresholds allowsdischarging into the downstream more turbid layer of the flow when the reservoir is not filled with the help of the first water intake threshold during the passage of floods and mudflows. When the reservoir is completely filled, the automatic spillway - the second threshold, provides the escape of extra water discharges. At the same time, the more turbid part of the flow is discharged into the downstream.

For partial regulation and direction of bed siltation into the flushing pipe, it is proposed to construction of silt carrying dam at the wedging site, near the bottom water intake openings. With this option, the bed sediments are completely deposited at the beginning of the reservoir and by partial opening of the gates, are washed into the downstream without disrupting the operation of the reservoir. This arrangement allows the entire mud-stone flow to be passed into the downstream during mudflows and at the same time ensure the safety of the reservoir. The layout of the structure makes it possible to flush out the alluvial deposits from the initial section of the reservoir bowl during the spring and autumn floods, without disturbing the hydraulic regime of the reservoir.

The application of the proposed layout of the spillway structure makes it possible to effectively deal with sediments during the operational period, without reducing

the water level in upstream pool.As shown by our preliminary calculations, the use of such design of spillway structures on the Girdimanchay River will significantly reduce the dead volume of the reservoir (reduced from 75.0 to 20.0 million cum-meter) and, at the same time, significantly reduce the height of the dam (approximately two times). Lowering the height of the dam dramatically reduces the estimated cost of the reservoir. (Figure 1.)
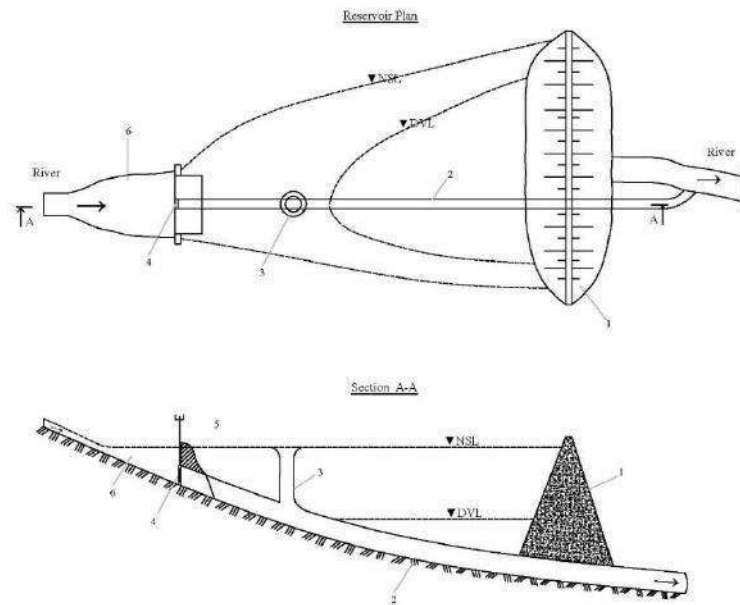
Fig. 1 Schematic plan and section of reservoir structures.

1-dam; 2-bottom pipes; 3-surface spillway; 4-bottom water intake; 5-sediment retention spillway dam; 6- basin of preliminary desilting of bed sediments.

The proposed method of silt control of the reservoir bowl is carried out during the operational period and therefore it is more effective than the methods used for cleaning after siltation.

Second option. One of the effective ways to preserve the useful capacity of the reservoir, and does not exclude other methods, is the passage of turbid river flows that form bottom suspension currents in reservoirs through specially designed holes in the body of the dam. In some cases, this way helps to remove from 50 to 60% of all sediments entering the reservoir annually./ **3,4**/

To discharge bottom suspension flows from the reservoir into the downstream,special sediment-capturing structures can be used, which are located in front of the dam inside the reservoir. Such structures can be constructed on the principle of a continuously flushing sediment basin. In order to save the washing flow, we have developed a fundamentally new design of the sediment-entraining "flooded sediment basin" / **6** /. The design is made in the form of a rectangular chamber with washing galleries -2. The ends of each gallery are secured with special locks -1. The chambers of the "sediment basin" are covered from above with perforated plates. In order to increase the ascending velocities, truncated cones, turned upside down, are located above the slab -3(Fig. 2).
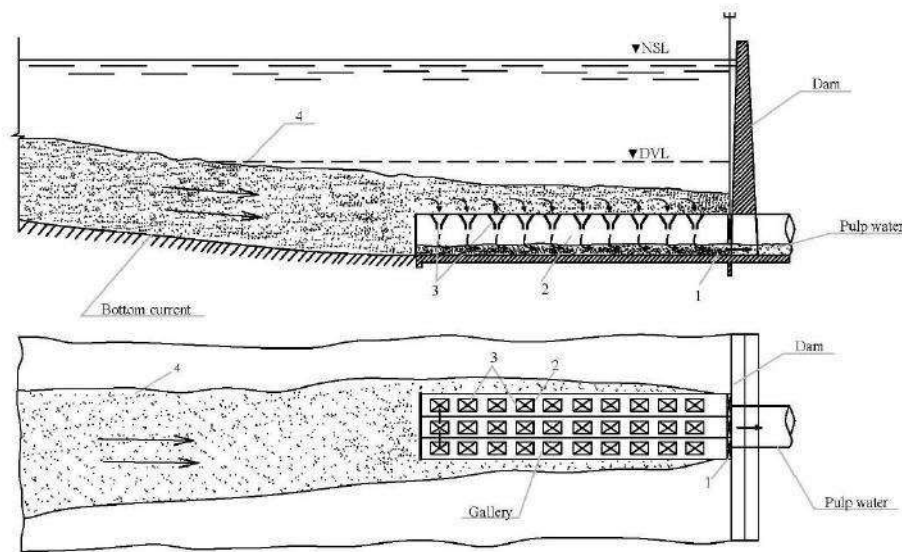
Fig. 2. Construction for the passage of bottom suspension flows from the reservoir.

Bottom flow-4, stepping on the sediment-entraining gallery-2, move towards the dam. By opening the control gate-1 at the end of the wash gallery-2, it is possible to catch a part of the bottom currents with high turbidity and discharge into the downstream of the dam. With such design of the structure, sedimentation and removal of sediments from bottom currents occurs identically to non-periodic sediment basin. The use of such structures makes it possible to increase the concentration of sediments in the washing flow by several times in comparison with the incoming bottom sediments. This allows you to significantly reduce water consumption for flushing the sediment.

Depending on the hydraulic regimes in the wash gallery, the gates can be used to regulate the value of vertical velocities in the bottom layer of bottom currents. These vertical "suction" -currents accelerates desilting in the bottom currents.

An example of the calculation for the proposed design was carried out on the example of the Nurek reservoir (flow rate of bottom currents - 40 m3 / s; depth of bottom currents h = 10 m; depth of reservoir H = 150.0 m; width of bottom currents B = 45.0 m; bottom current velocity V = 0.088 m / s; hydraulic size of sediments W = 0.2 mm / s; turbidity of bottom currentsρ = 15.0 kg / m3, throat d1 = 0.1 m, D = 5.0 m). As shown by the calculation example, letting one fourth of the bottom currents out of the reservoir, it is possible to achieve an increase in the turbidity of the washing flow by about 4 times, in comparison with the initial turbidity. The developed design makes it possible to partially precipitate and wash out the turbidity of the bottom currents. With the help of this

design, it is possible to intermittently let the thicker parts of the stream from the "lake of turbidity" into the downstream. In such cases, the concentration of turbidity in the wash stream sometimes reaches 15-20%.

V. MAIN CONCLUSIONS

1. Long-term observations on the reservoirs of Azerbaijan show that a large volume of siltation of the reservoir basin occurs mainly with the passage of spring and autumn torrential floods. In about 4-5 months, more than 80% of the solid annual river flow is deposited in the reservoir.

2. 90% of Agrichai reservoir was siltedover the 30 years of operation, with a decrease in its total volume from 80 million m3 to 10 million m3. For almost 40 years of operation, the Pirsaatreservoir is silted for 95%, and trees have grown inside the bowl.

3. As our research shows due to climate change, the hydrological characteristics of rainfall and, accordingly, the peaks and periods of floods in rivers have changed. Already in our region, the frequency of spring and autumn flash floods has increased.

4. One of the most effective ways to remove sediment from reservoirs is hydraulic flushing. The maximum volumes of sediment washed into the downstream of the hydroelectric complex are achieved only with optimally selected discharge flow rates when the reservoir is completely emptied.

5. The use of hydro mechanization, when cleaning the bottom of reservoirs from sediments, allows them to be

removed from large areas and in almost any volume. However, the cost of such work is extremely high

6.The most optimal way is to pass high-muddy waters during a flood bypassing the collected water in the reservoir. In the operational and water management calculations of the reservoir, it is necessary to take into account the passage of high-turbidity waters during the flood from the reservoirs.

7. Project processing for the construction of a reservoir on the Girdimanchay River in Azerbaijan showed that when applying our proposals (first option), it is possible to significantly reduce the dead volume of the reservoir and, accordingly, the height of the dam.

8. The use of a constructive solution to remove the solid discharge of the river from the basin of the reservoirs during the operational period will significantly lengthen the operating life of the reservoirs and, at the same time, improve the environmental conditions of the river bed in the downstream.

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The importance of cross-contamination prevention in the architectural design phase in hospital environments

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Abstract— The Civil Engineer always seeks to reconcile structural security and the lowest cost when designing a work; however, when the work in questionis a hospital unit, attention should also be paid to the disposal of the sectors of that, so it provides the lowest possible level of contamination. For this work, nine documents were used as a parameter of study and analysis in order to establish a lineage to be followed in the sectorization of the hospital environment, since no technical notes or re-gulamenting standards were found regarding reducing the hospital infection of the environment as a whole as much as possible. Then an investigation was made on site in a hospital in the Region of Amazonas, Brazil and from this visit was elaborated a plan of sectorization of its ground floor, in order to exterminate foci of cross contamination. Bin this plant, another was created by rearranging the sectors and showing that, in the new sectorization, the foci of contamination can be drastically reduced only by changing some sectors of place, thus altering the flow of people in the dependencies of this hospital floor. The COVID-19 pandemic reinforces the warning about the care of cross-contamination, one of its greatest forms of transmission. Thus, at the end of this article it was found that there is a great literary vacuum referring to hospital projects that prevents cross-contamination; there is no specific standard for hospital sectorization, except for some sectors governed by specific norms; it was also noted the little interest of municipalities in promoting a standard that regulates this sectorization, because one of the documents referring to this dates almost thirty years ago.

I. INTRODUCTION

Cross-contamination is defined as the transfer of contaminant microorganisms from one surface, site or even from one grocery to another, by means of instruments, utensils, equipment, among others contaminated, thus spreading (ANVISA, 2015).

The design of any construction or renovation is more useful to avoid errors before, during and after the execution phase. In civil engineering it is common to have greater concern with the structural part of the project and the structure itself, but in this work will be given greater emphasis on the layout of areas according to possible areas of contagion. Its area of propagation is comprehensive because it has as its own principle the hospital structure to

the utensils and materials used, and it is necessary a joint mobilization of effective measures continuously so that the areas are free of contaminants(MS, 2014).

When analyzing the related concepts on the subject in order to evaluate the location of the environments in the projected plants that meets this analysis, so that it is possible to visualize and understand the internal structure and its sectorization, because it is necessary to observe the movement of people and equipment in the respective areas. Being that, for the creation of any project are necessary the three basic steps such as: a previous study (people flow, material needs, environments, among others), the base project and the execution project (MS, 2002). As the focus is on the prevention of cross-disease, the analysis will be carried out on top of the foundations of the first stage of previous study.

According to RESOLUÇÃO No. 216, DE 15 SEPTEMBER 2004, of the National Health Surveillance Agency, contamination occurs according to the passage of microorganisms of biological origin, substances or even physical substances, which are seen as harm to the health of the human being, through these characteristics, all utensils and surfaces used to handle food must be free of odors, flavors, any toxic issues with is constituted by legislation and be kept in a good state of conservation having to have a corrosion resistance to resist the various cleanings.

In the case of ANUs (Food and Nutrition Units) there is a standardization directed to the dimensioning (Annex G) of these spaces, that is, it follows RESOLUTION RDC N.50, FROM FEBRUARY 21, 2002 that gives the regularization of planning, programming, creation and evaluation of physical projects for health units (MS, 2002).

The building and facilities should be designed in such a way as to enable an orderly flow into the environment, being compatible with all necessary movements and operations, as well as facilitating maintenance, cleaning and, where applicable, disinfection operations. There must be a physical separation between the various activities in order to avoid cross-contamination (MS, 2014).

RESOLUÇÃO No. 216, DE 15 SEPTEMBER 2004, of the National Health Surveillance Agency also provides for measures that, if prevention measures are not sufficient or ineffective, the need to hire a specialized company, in accordance with the specific legislation, using them and products approved and regularized by the Ministry of Health (MS, 2004).

II.   MATERIAL AND METHODS

This is adescriptive study, of the type ana

lysiscomparativa,based onlithic reviewsand aiming to answer the keyquestion for theentirework,where all available informationwere collected, througharticles,books and resolutions, provided to the public.

As a meansof construction, this workwas carried outin a process that was established by nine steps, sendo them: the choice of the problematic, object desired, the whole ofsearch,   inclusion criteria, the search sites, screening of documents, analysis of results, discussion and the statement of results.

Posteriormente to the choice of the problemática, h hearsthe selection of the key words or descriptor terms to serve as a source of and search for documents preexi stentes,being the following terms used for research: "Hospital architecture", "Hospital structure", "prevention of cross contamination" and "hospital architectural project". The search was to havevirtual on reliable sites suchas Virtual Health Library (VHL), Ministério da Saude (MS), National Health Surveillance Agency (ANVISA) and Scientific Electronic Library Online (SCIELO).

The search date of the materiais had its extension from March to June 2021,where the filter "free full text" was applied in order to present only free texts. Como each search source has different means not following a pattern, searches were made according to each site, howevermaintaining if the search descriores.

The documents collected, in the Portuguese language, have an extensive publication date, and the conditionused from1995 to 2018,presents information on the theme abordado, even if in afractional way, because it was necessary to join cross-section andhospital structures to be able to support the article.

The choice ofthe cumentos occurred in twostages: the first was the reading of the titulus and its abstract; second its full reading to know if it would cover in a compatible waywith the proposed theme.

Nine documents were   found, all of which were used during the work-construction process, and only one addressed thesubjectdiscussedand the other ones wereused as support for the basisand complementary information.

Listen to the need for data storage, so the Program Office - Word, version 2021, with the data: Title, author, type of study, , place, language and yearof publication , for the end of the construction of aspreadsheet.

For the elaboration of the sectorization plant, an *on-site visit was* made at the hospital in the amazon state region, because it was not publicly available and there is no need to mention the hospital in question.

III.   RESULTS

The general structure has 9 documents, which were selected in the period from 1995 to 2018 as year of publication, the languages in Portuguese and English, being present in table 1, in order of analysis according to title, author, type of study, language, and year of publication.

Table 1. Data used in the analysis, Manaus, Amazonas, Brazil, 2021.

STUDY 1	
variable	**definition**
title	Use of HACCP in the food industry.
author	Larissa Lagoa Ribeiro-Furtini; Luiz Ronaldo de Abreu.
Type of study	Support study.
language	Portuguese.
Year of publication	2006.

STUDY 2	
variable	**definition**
title	Architecture in prevention and control of hospital infection: isolation rooms in emergency and emergency units.
author	Thaize Vanessa Bortoluzzi Coast.
Type of study	Supportive study.
language	Portuguese.
Year of publication	2018.

STUDY 3	
variable	**definition**
title	Standards for physical projects of health care facilities.
author	Ministry of Health Health Department of Health Care.
Type of study	Supportive study.
language	Portuguese.

Year of publication	1995.

STUDY 4	
variable	**definition**
title	Relationship between hospital architecture and prevention of hospital infection.
author	Tatiana Maia Pereira do Nascimento.
Type of study	Support review.
language	Portuguese.
Year of publication	2010.

STUDY 5	
variable	**definition**
title	Resolution No 216 of 15 September 2004. Technical regulation of good practices for food services.
author	National Anti-State Surveillance Agency.
Type of study	Support review.
language	Portuguese.
Year of publication	2004.

STUDY 6	
variable	**definition**
title	It provides for the Technical Regulation for planning, programming, preparation and evaluation of physical projects of health care facilities.
author	National Health Surveillance Agency.
Type of study	Support review.
language	Portuguese.
Year of publication	2002.

STUDY 7	
variable	**definition**
title	"Case study of general aspects of works in hospital buildings".
author	Juscelino Rodrigues Mariano.

variable	definition
Type of study	Support review.
language	Portuguese..
Year of publication	2010.
STUDY 8	
variable	**definition**
title	Architecture in the prevention of hospital infection.
author	Domingos Marcos Flávio Fiorentini; Vera Helena de Almeida Lima; Jarbas B. Karman.
Type of study	Review in full.
language	Portuguese.
Year of publication	1995.
STUDY 9	
variable	**definition**
title	Introduction hospital architecture.
author	Antonio Pedro Alves de Carvalho.
Type of study	Support review.
language	Portuguese.
Year of publication	2014.

It is observed that study material used in Estudo 8 is a support review and only 1 is reviewed in full,and it is possibletohighlight that they wereresearched in another language and were not successful.

IV. DISCUSSION

According to the research carried out for the elaboration of this work, and to the point where knowledge was permissible, it was not found in an accessible way or there was no reasonable amount of specific literature on this theme. This situation shows the need to start studies referring to the hospital structure aiming at non-contamination with phase in the appropriate sectorization.

There is a lack of standardization in the hospital structure as a whole. Offices, various sectors, wards, do not have a specific standard or regulations that define their ideal location in the architectural plant. The designer

engineer always elaborates his project with a phase in the infrastructure, aiming mainly at the safety of the building and the lowest possible cost, however, in a hospital building it is necessary to take into account biosafety, as well as the flow of people in the facilities. As a way of exemplifying, a sector plant of a hospital in the Amazonas region of Brazil was adapted.
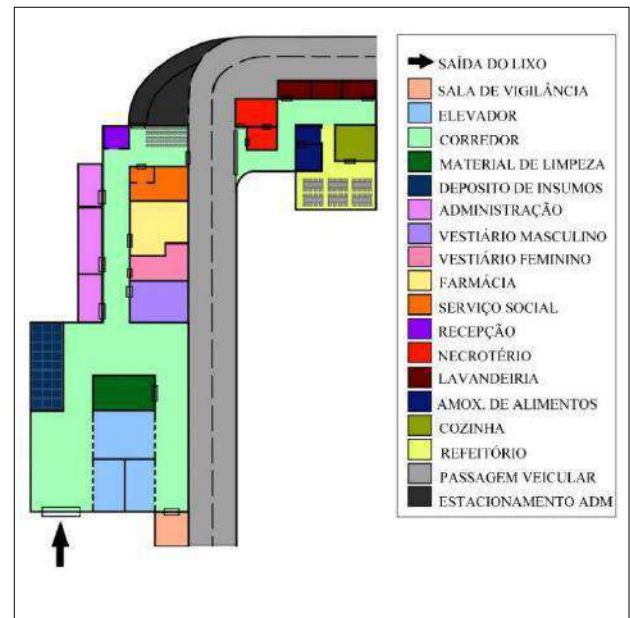
Fig.1: Plant 01 referring to hospital sectorization in the region *of Amazonas, Brazil - Adapted by the authors.*

Plant 01 refers to a hospital unit in the Amazon region, Brazil, which offers low, low-day, high-complexity hospital services. In this figure, certain incongruities and incoences regarding the disposition of sectors and the movement of persons are noted.

As evidenced by the sectorization, it can be noticed that the nutrition facilities of the workers (cafeteria and kitchen) are located in the vicinity of the morgue and laundry, and the access to both is unique and the same. That is, through the same entrance pass health workers, raw and cooked foods, companions of patients, dead bodies, hospital clothes (surgical center, bedsheets, clothes of biological risk), being clean and dirty and all the garbage produced in these environments, because the entrance and exit are both through the same door, generating a huge risk of cross contamination in various instances.

According to item 4.1.1 of RDC NRO 216 DE 2004 DA ANVISA that has on the facilities and buildings of environments for the purpose of nutrition, states that they must be designed so that there is no crossing of food with any other insums that may contaminate them, thus

evidencing the impossibility of the facilities described in the paragraph above.

The elevators are of wide and common use, therefore the three available in addition to allowing access to all floors of the complex, convey and confine the people of the most diverse sectors in their interiors. These elevators serve as a route to the wards, intensive care units, outpatient clinics.

Briefly, it can be said that patients, whether these patients, discharged, transferred or even who died; hospital workers, whether nurses, doctors or even general service agents; clothes in general, bed, scratch, clean or dirty; garbage, both common and hospital; finally, absolutely everything goes through these elevators, often even simultaneously, making them serious vectors of contamination and contagion.

The same situation of the elevators is also found in the access corridor. It is noted that it consists of the only entrance and exit that gives access to the hospital complex. Whatever the origin or destination of the material or person transiting through the sectors of the hospital, the only access route is through this corridor.

According to the work of preliminary recommendations entitled Body management in the context of the new coronavirus Covid-19, first version, issued by the Ministry of Health and published on March 23, 2020, the management of bodies in hospital occurrence can *only be* made by professionals properly equipped with specific EPIs for biological risk, that is, any person devoid of such equipment could never stay in the same environment as a see of this nature.

Fig.2: Plant 02 with hypothetical solution for errors found in plant 01

A possible solution for the incongruences applied in plant01, can be noted in this hypothetical sectorization shown in plant 02. The sectors within the hospital in question were situated in different order in order to restrict the movement of people, considerably reducing the risk of contamination.

The kitchen and cafeteria have been remained, making the access to them with those of the laundry and morgue no longer cross. These, in turn, had their sectors isolated because they were the greatest focus of contamination in relation to the other hospital dependencies.

The garbage path was also re-suited. The garbage, whether hospital or common will no longer circulate throughout the hospital or the elevators intended for employees and patients, because it can be noticed an exclusive and access elevator for situations of greatest contamination.

Such sectorization plant is based on the norms of good practice for the allocation of cafeterias and avoiding cross-contamination from infected materials that once circulated along the same paths as the non-infected ones.

This need for engineering concern when designing a hospital, preventing cross-contamination, was evident with the advent of the Covidpandemic-19 which, when it comes to the abor region given Amazonas, Brazil, led to the collapse of hospital networks as a whole, whether public or private. Among the most distinct factors, we had cross-contamination as the main form of disease contagion, especially within the hospital environment.

Because there is no specific standard, the sectorization of a hospital environment ends up being because of the current management (director or manager) in public hospitals and by the owners in the private sector. As an emergency measure, during the critical phases of the pandemic, some hospitals isolated internal areas to perform differentiated care to patients with suspected covid-19 in order to avoid agglomerations and reduce the spread of the virus.

However, this emergency measure was not enough to avoid contamination of the other facilities, as the areas were isolated, but in some cases, attention was not paid to the flow of people, causing patients with and without covid-19 c to go in the same environment, as well as health professionals and even see and being taken to the morgue, all using the same access routes.

It is up to the Engineer to design and sector the facilities of his work; with the hospital should be no different. Once designed, the hospital plant needs to see, from the other situations, the non-contamination of its various ambientes, before its construction and, after
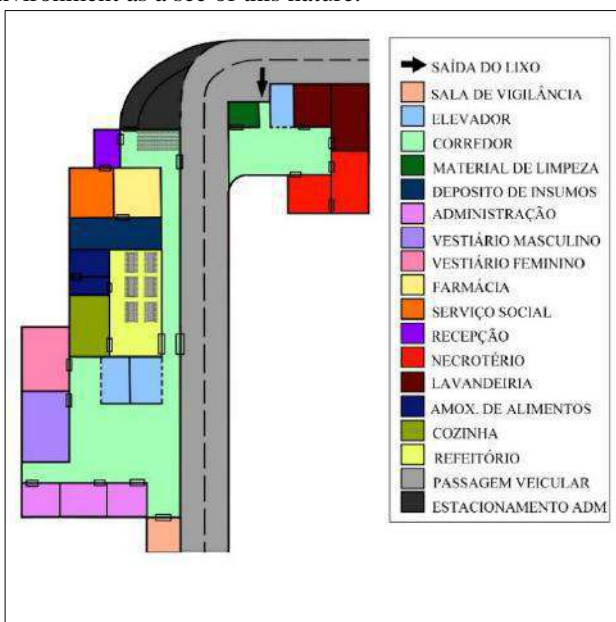
construction, should not be changed without first consulting the responsible engineer or the existing Engineering sector within the Municipal Health Department.

In the Manaus region, Amazonas, Brazil, the inspection related to architectural plants taking care of the use of cross-contamination exists, and is carried out by the engineering sector of the Sanitary Surveillance (VISA) of Manaus, but its competence is restricted only to facilities with nutritional purpose(kitchens, cafeterias, restaurants) including inside hospitals, and in the case of these, it is necessary a standardization for future inspections in other environments and facilities.

The state decrees referring to measures to combat Covid -19 in the Amazonas, the last of NRO 43596 OF MARCH 20, 2021, were given powers of supervision and action to several public authorities, among them visa Manaus for the question of circulation of people of fearing virus dispersion risk.

The Architect, Physician and also Professor of Architecture and Hospital Planning Domingos Flávio Fiorentini published in 1995 by the Ministry of Health a series of texts with the intention, According to him, to make available study material related to architectural projects in complex hospital facilities, because they were almost not widespread at the time and, as can be evidenced , almost 30 years later remains scarce of research material.

V. CONCLUSION

This work concluded that this theme requires a more specific approach and studies. The work shows that there is a need for the engineer to worry about the location of the sectors when designing a hospital, but because it is not a common practice or because there are no specific rules that ratify this, there is no way to charge or supervise the work and who suffers are the people inside the hospital facilities, be they patients or health workers.

The present study shows the importance of the discussion on the theme, because if there was a greater concern with cross-contamination in the hospital environment, the contagion of several s disease could be avoided, including Covid19,which shows an unpreparedness in hospital networks related to this item.

In view of the scarcity of literary material on this subject, there is a need for greater visibility and investment in it, so that the perception of the prevention of cross-contamination is taken more seriously, because due to this lack of material the definition of cross-contamination was removed from a DRC for food. There is data collection to design hospital units, which uses some sector localization

standards, but there is no standardization for the leasing of sectors.

In founded documentation, a range of studies and works are based on cross-contamination focused exclusively on the food part, always with the concern of preventing intoxication due to poor handling, transportation or storage of food. However, our study showed that food poisoning should not be the only concern related to cross-contamination, since can be linked by various follow-ups, in any environment and disseminate numerous diseases.

Engineering professionals need to understand that a hospital unit needs more than just environmental structuring standards. Tobe able to find the need for environments isolating areas of biological risk, canoes and common environments is of paramount importance because many variables intersect the possibility of contamination becomes high and extreme dangerous.

It is possible to see the importance of the prevention of cross-disease in hospital environments according to the literature and the exemplification through the plants because, with a stucco of flow and sectorization becomes feasible isolates grouped risks in only one nucleus, thus making elevators of exclusive use, with only one route of garbage, cadavers, hospital clothes of normal beds and surgical center, minimizing contact and unwanted circulation by areas of common access.

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Survey of pathological manifestations in flexile pavement in the city of Manaus/AM

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Abstract— *This work demonstrates a case study of pathological manifestations in a flexible pavement street, in order to point out the apparent pathologies and permanent deformations contained in an average flow road pavement in the city of Manaus-AM. Due to its important location in the south of Manaus, the stretch of Luiz Antony Street was chosen as a study, between the parallel avenues of Leonardo Malcher Avenue (at the end of the avenue, towards Aparecida neighborhood) and Ramos Ferreira Avenue. Renowned theoretical and normative references for the case study were addressed so that a visual inspection of the road could be made, diagnosing the problems encountered and defining the best solutions for them. Finally, the work reports the importance of planning and managing maintenance services on urban roads.*

I. INTRODUCTION

Currently, civil construction is debating improvements in the area of trafficability of public roads, intending to find low costs with returns in the short and long term. Every day there are several studies on the condition of paving in Brazil, since the traffic infrastructure is very deficient, added to the lack of commitment and investment by the government, causing serious damage to the economy and society.

Paving is essential in a country's infrastructure, as the displacement and flow of our products and services depend on the trafficability of our highways. Land distribution logistics is intrinsically linked to this factor, given the high volume of transported cargo, intense traffic, lack of conservation and constant maintenance. In addition to the wear mentioned above, the natural depreciation suffered by constant use entails high financial costs (operational and fuel).

Each type of pavement has its useful life, depreciated by the manifestations of defects on the road, not only because of the materials used, but also because of the structural behavior of the pavement. Thereafter, it checks that this information can help engineers to understand the technical problems detected and the best ways to perform maintenance for each type of pathological manifestation that appears on the road. Pathological manifestation is an expression used when a degradation mechanism appears, causing financial losses and accidents because they are not resolved with the correct and effective material.

II. THEORETICAL REFERENCE

Initially, this case study will address the concept and classification of pavement and its pathological manifestations in order to identify

correctly the type of anomaly in the roads and the repair techniques.

1.1. Pavement Definition

It is every structure existing on the streets where people move.

It is composed of layers of varying thickness, depending on its function. The sizing of the thickness of each layer depends on factors such as traffic studies, geotechnical studies and materials to be used (SOLANKI; ZAMAN, 2017, p. 99).

These are structures that are built on the final earthmoving surface, economically and technically designed to withstand the efforts arising from vehicle traffic and the weather, moreover, being able to offer users an improvement in rolling conditions, with safety, economy and comfort (BERNUCCI et al., 2012, p. 95).

Therefore, in all definitions, they always call the pavement as being a structure that is formed by several layers, each one performing a different function.
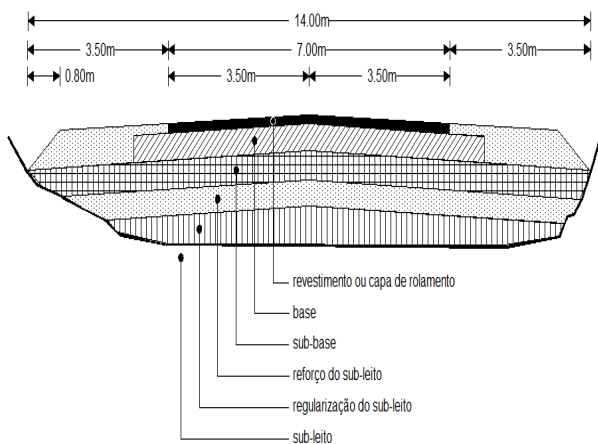
Fig 1 Pavement layer scale, Faleiros (2005).

1.2. Pavement Classification

For DER/SP (apud SIAN, 2007, p. 22) pavements are classified into three types: Flexible, rigid, and semi-rigid, as detailed. Flexible pavement is composed of a layer of bituminous material, which one of its functions is to serve as a coating, which is superimposed on one or more layers of granular material or stabilized soils, which act as a base. The rigid pavement consists of cement concrete slabs

Portland on a cemented or granular material base. The semi-rigid pavement is composed of a layer of bituminous material on a base of stabilized material with cement.

Rigid pavements are layers that work essentially in traction, unlike flexible pavements. Its design is based on the resistant properties of Portland cement concrete slabs, which are supported by a transition layer, the sub-base (BERNUCCI, 2012).
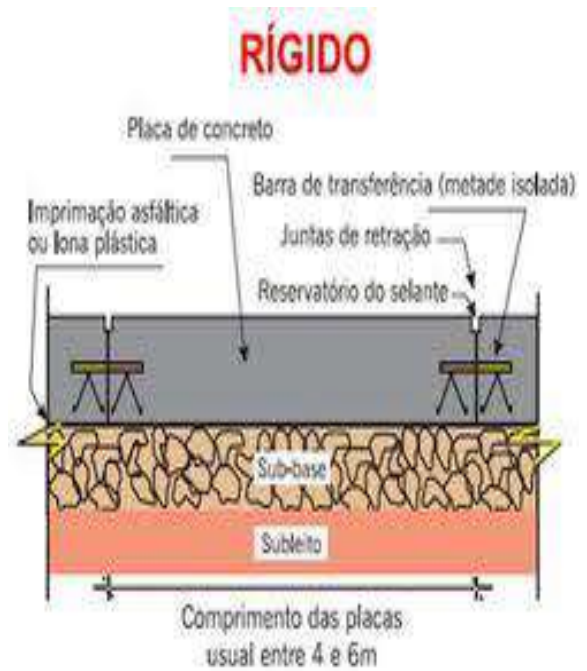
Fig 2 Rigid Pavement, IBRACON (2008).

The semi-rigid pavement is, therefore, a pavement composed of an asphalt coating with a base or sub-base in material treated with high rigidity cement, excluding any type of concrete (BALBO, 2007).
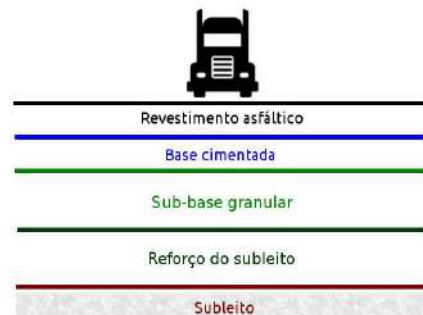
Fig 3: Semi-rigid pavement, IBRACON (2008).

According to the DNIT Pavement Manual (2006), flexible pavement is the one in which all layers undergo significant elastic deformation under the applied load and, therefore, the load is distributed in approximately equivalent portions between the layers.
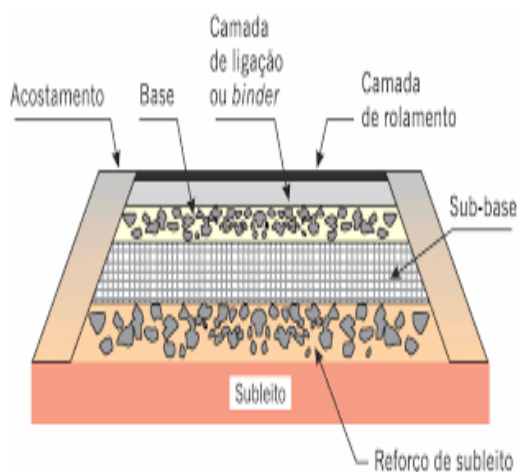
Fig 4 Flexible Pavement, BERNUCCI *et al* (2012).

Fig 5: Flexible pavement layers, CAPEL(2017).

1.3. Flexible Pavement

1.3.1. Distribution of flexible pavement tension.

In flexible pavement, the load is distributed in portions proportional to the rigidity of the layers, in which all layers undergo significant elastic deformations, deformations up to a limit do not lead to rupture, and the quality of the soil is relevant, as it is subjected to high tensions and absorbs greater deflections (ARAÚJO, et al, 2016).

According to Pinto (2013), flexible pavement usually requires large thicknesses, due to the use of deformable materials or of dubious quality, and

the application of high loads. Thus, such thicknesses ensure that the tension on the foundation soil is less than its resistance.

1.3.2. Flexible Pavement Layers

First and foremost, as completely as possible, the pavement has the following layers: coating, base, sub-base, reinforcement of the subgrade and subgrade, the latter being the foundation and an integral part of the structure. Depending on the case, the pavement may not have a sub-base or reinforcement layer, but the existence of the coating, even if it is primary, and of the subgrade are minimum conditions for this structure to be called pavement (SILVA, 2008).

As for the flexible pavement, object of this study, its layers are represented below.

The subgrade is called the pavement foundation space, composed of natural and compacted material, for example.

As for the reinforcement of the subgrade, it is a non-mandatory layer, however, if used, it has a constant thickness, built, if necessary, above the regularization, with technological characteristics superior to those of regularization and inferior to those of the layer immediately above, that is, the sub-base.

The sub-base is the complementary layer to the base, when, due to technical and economic circumstances, it is not advisable to build the base directly on the regularization or reinforcement of the sub-grade.

The base should have better quality material than the sub-base material, because it is the most important layer of the pavement structure, as it is located just below the pavement coating.

The pavement coating is the last layer existing in the structure, which directly receives the action of traffic and is intended to improve the running surface in terms of comfort and safety.

2.4 Pavement pathology

Asphalt pathologies that may appear over time can have different origins, such as improper project performance, failure to select materials, inadequate alternatives for conservation and maintenance, among other factors, that may affect the usefulness of the pavement.

Generally, the pathologies presented in the asphalt are caused by the responsibility of human work, which derives from the wrong choice of material to a improper performance of the procedures that must be carried out.

2.4.1   Types of defects that occur on flexible pavements

On flexible pavements, pathologies can be classified as set out in Table 1.

Patologias Estruturais	Corrugações
	Afundamentos
Patologias Funcionais	Exsudação de Asfalto
	Desgaste
	Escorregamento do Revestimento Betuminoso
	Trincas e Fissuras (Fendas)
	Panela

2.4.1.1 Corrugations

According to the DNIT 005/2003 – TER (DNIT, 2003) norm, it is defined as transverse undulations on the pavement surface.

The figure below shows an example of corrugations, also known as Ribs, and it is common to find them on climbs, ramps, curves and intersections (SILVA, 2008, p. 31).

Fig 6 Corrugation example, DNIT (2003)

2.4.1.2. Foundering

It is characterized as a permanent deformation through a depression on the surface, which may be accompanied by lifting.

Therefore, the DNIT (2003) states that foundering is a perennial defect determined by depression in the pavement coating, combined or not with lifting, showing itself as a plastic foundering or consolidation.

Fig 7 Afundamento da trilha de roda, DNIT (2003)

2.4.1.3. Asphalt exudation

According to Balbo (2007), he explains that this type of pathology may be related to the segregation of the asphalt mixture at some moments during its execution, excessive compaction of the mixture, excess binder, use of low viscosity binder in places with high climate average temperatures or the lack of adhesiveness of the asphalt binder. It may also be related to the slipping of the asphalt mixture.

Fig 8 Asphalt exudation, DNIT (2003)

2.4.1.4. Wear

According to Dnit (2003), wear is conceptualized as a result of the progressive pull out of the paved structure's aggregate, identified by the roughness of the bearing cover surface and caused by tangential loads caused by traffic.

It is noteworthy that surface wear can be classified as the association of traffic with bad weather. At the limit we may have a polished surface, which can compromise skidding safety. In the progressive pullout of aggregates, surface wear is at an advanced stage. Wear is characterized by surface roughness. (SILVA, 2008).

Fig 9 Wear exmple, SONEGO (2018)

2.4.1.5 Slip of bituminous coating

For Balbo (2007), it is described as a transverse displacement of the asphalt mixture, usually occurring in lanes requested by commercial vehicles and attributes its origin to inadequate priming of the coating on the lower layer, inadequate compression of the asphalt mixture before the release of the lane for traffic, the inadequate viscosity of the asphalt cement for the conditions of use and the excess of binder in the mixture.

Fig 10 Slip, DNIT (2003)

2.4.1.6 Cracks and fissures (Slot)

In flexible pavements, cracks are a more common form of pathology, due to the flexural traction of these layers repeatedly with the passage of load from vehicles (BESKOU, et al, 2016, p. 476).

There are several types of cracks, however, the most common are alligator or crocodile skin cracks, isolated retraction cracks, block cracks, longitudinal cracks, transverse cracks and edge cracks.

According to DNIT (2003), crack is any break in the structure's coating that leads to greater or lesser degree grooves, presenting itself in various forms, it can present as a fissure or crack according to what is exposed ahead.

Fig 11 Alligator skin crack, Bernucci et al.(2012)

2.4.1.7. Pan

Also called a hole, thus, the DNIT (2003) states that pan is precisely the hole formed in the coating due to various factors (including the lack of cohesion between overlapping layers, generating the peeling of these), which can reach the underlying layers of the pavement, leading to the disaggregation of these layers.

Fig 12 Panela ou buraco, DNIT (2003)

Therefore, in addition to these defects, what can occur would also be design errors, highlighting the traffic conditions and the selection of materials and execution errors.

2.5 Repair techniques

It stands out that (DNIT 2010) in order to ensure a strategic plan that has a better cost-benefit in the application of public resources, since keeping the asphalt in good condition is more viable than intervening several times to recover it, it was created the Pavement Management Manual.

For some of the asphalt pathologies, some repair techniques can be applied.

According to DNIT (2006), the making of patches should consist of the following steps: regularization of degradation (geometric delimitation of the pan); waterproofing (priming) of the affected granular layers; spreading, shaping and compacting the filling

material and surface sealing (when the filling material has high void rates).

The superficial patch is also known as a filler, and its use is quite common, with the objective of repairing degradations in the road.

Fig 13 Superficial patch

Deep patching is already a more corrective technique, in which fractions of underlying granular layers can be removed.

Fig 14 Deep patch

In relation to isolated cracks, the procedure starts with the opening of the crack for cleaning and sealing, then the application of the sealing product is made and finally the application of lime for protection, however the cracks interconnected ones need some control measures and reduction of reflection using geotextiles impregnated with asphalt binder at the interface between the old deteriorated coating and a resurfacing, with this the cracks are delayed.

For the treatment of foundering, two techniques are suggested: recapping and crimping, as seen in the following figures:

Fig 15 Resurfacing

In the event of undulation/corrugation, the recommended techniques to recover pavements with this defect are also the same used in the recovery of foundering: resurfacing and milling.

Fig 16 Milling

III. METHODOLOGY

The methodology for execute this course conclusion paper was developed through a case study.

This research is exploratory and explanatory, as its objective is to show the type of pavement, its complications and which techniques can be used to recover the urban road.

3.1 Place selection

Due to its important location in the south of Manaus, the stretch of Luiz Antony Street was chosen as a study, between the parallel avenues of Leonardo Malcher Avenue (at the end of the avenue, towards the Aparecida neighborhood) and Ramos Ferreira Avenue in the Centro neighborhood.

3.2 Used material

The material used in this technical visit were the following items:

- PPE helmet

- Measuring tape

- Ruler

- Pen

-       Note block

3.3 Result Analysis

Three types of pathological manifestations were constated during the visit, namely: cracks and fissures, pans and foundering, factors that occur due to the lack of maintenance and conservation of the road. It is noticed that the urban road had no design or execution error, however, in the observed occurrences may be applied techniques of patching application of sealant, resurfacing and crimping.

A large amount of heavy vehicle traffic was also observed and this facilitates the deformation of the urban road.

For significant improvements, the city of Manaus-AM could draw up a schedule of visits in order to carry out maintenance or conservation for the comfort and safety of the population.

IV.   CONCLUSION

The objective of the work was to explore the concepts of pavement and pathological manifestations in order to clarify and identify the possible problems and causes found in public roads.

Therefore, it can be concluded that with the use of proper maintenance we can avoid various types of manifestations having an execution alignment and correct materials related to each type of pathology presented, this can prevent the total wear of the pavement.

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Application of a Questionnaire to Pregnant Women to Assess their Knowledge Regarding Breastfeeding

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Abstract— Introduction: Breastfeeding is able to provide many benefits to the health of the child, the woman and the society. It is essential for a good child development and for the prevention of diseases. If the child is nurtured exclusively with breast milk until 6 months of age, it can avoid impacts on infant mortality. For this, it is essential to start the guidance on the importance of correct breastfeeding, in prenatal and postpartum, clearing doubts and frequent difficulties, as well as protecting the right to exclusive breastfeeding. Objective: to assess the level of knowledge about breastfeeding. Methodology: Exploratory research on the knowledge of pregnant women in the state of Rondônia about breastfeeding. This research was carried out in the Google Drive Forms platform, consisting of 19 questions prepared by the students, accompanied by the attached ICF. Results: It was noticed that even though the pregnant women had previous knowledge about breastfeeding, the percentage of women who breastfed exclusively with breast milk was equivalent to those who did not breastfeed. Conclusion: we can evaluate that the interviewees have good prior knowledge about breastfeeding, understanding that breast milk is the best food for the infant.

I. INTRODUCTION

Breastfeeding has the capacity to provide multiple benefits to the health of the child, the woman and society, promoting a strong impact on child mortality. If the child was nourished exclusively with breastfeeding until the age of six months and the breastfeeding was continued after the introduction of a healthy complementary diet it could prevent about 13% of deaths in children under five years of age. (SILVA, 2014).

The consensus is that breastfeeding is fundamental to provide essential nutrients for the infant development process, to strengthen the bond, and to contribute to the development of the immune system, which is essential to protect against pathogenic microorganisms. However, many mothers face problems that interfere with breastfeeding, especially primiparous women who report lack of knowledge and proper guidance, misconceptions in multiparous women are also noted, related to their family and their cultural issues and those problems are common processes that influence early weaning. (CANDIDO DE BORTOLI et. al., 2019).

The appropriate moment for the beginning of the orientation on how to breastfeed correctly is defined prenatal care. It is also important to reinforce that is vital

to have a professional available at the maternity hospital to solve doubts and frequent difficulties, from the first hour after birth, orientate how to correctly latch on, so that the newborn sucks the milk and does not hurt the nipples of the lactating mother. Always aim to empty the first breast offered to the baby and then offer the other, and in the next feed always start with the one that was not completely emptied. These measures prevent the child from becoming agitated and crying, affecting the production of milk and insecurity in the puerperal woman (CASTRO; ARAÚJO, 2006).

Worldwide, incentive policies for maternity leave and for the practice of exclusive breastfeeding during the first six months of a child's life are developed. However, hundreds of thousands of working women still have no or inadequate maternity protection. Protecting the right to exclusive breastfeeding reduces maternal and infant morbidity and mortality (RIMES; OLIVEIRA; BOCCOLINI, 2019).

In support of nursing mothers, laws have been created to encourage and ensure the right of mothers who are in the labour market to reserve a period of 1 hour's rest for breastfeeding during the first 6 months of the child's life, in accordance with the CLT (Consolidation of Labour Laws), Law No. 5452 of 1 May 1943, Art. 396, and may have flexible working hours in accordance with the agreement between the mother and employer (BRASIL, 1943).

That being said, the determination of this research is to identify the understanding of postparturient women about the importance of exclusive breastfeeding until the first six months of life of the infant.

II. METHODOLOGY

The study is an exploratory, descriptive, and quantitative research carried out in the municipality of Porto Velho, Rondônia, with pregnant women over the age of 18 who agreed to participate in the research.

The questionnaire was conducted through an online research platform, Google Forms, consisting of 19 questions designed by the students, based on SOUZA's questionnaire (2008), regarding the knowledge about breastfeeding. Soon after answering the questions, a flyer with the theme breastfeeding, its importance to the lactating woman and the baby, and the correct breastfeeding technique will be made available.

Once the data was collected, the data was saved in Microsoft Excel 2010 spreadsheets and statistical observations were made to analyze the pregnant women's knowledge about the topic.

The project was approved by the Research Ethics Committee of São Lucas University Center, CAAE: 43367421.0.0000.0013 and Opinion: 4.581.675.

III. RESULTS

Thirty-one people took part in the survey, all females aged between 18 and 59, with an average age of 27 years, most of whom have higher education (58.1%), were married or in a stable union.

Firstly, the pregnant woman was asked if she had ever breastfed, and the majority, i.e. 61.3%, answered negatively, and those who answered positively corresponded to a percentage of 38.7%, so that they are equivalent in the question type of breastfeeding between: did not breastfeed with breast milk and those who breastfed exclusively with breast milk until the six months of age of their offspring, as shown in graph 1.
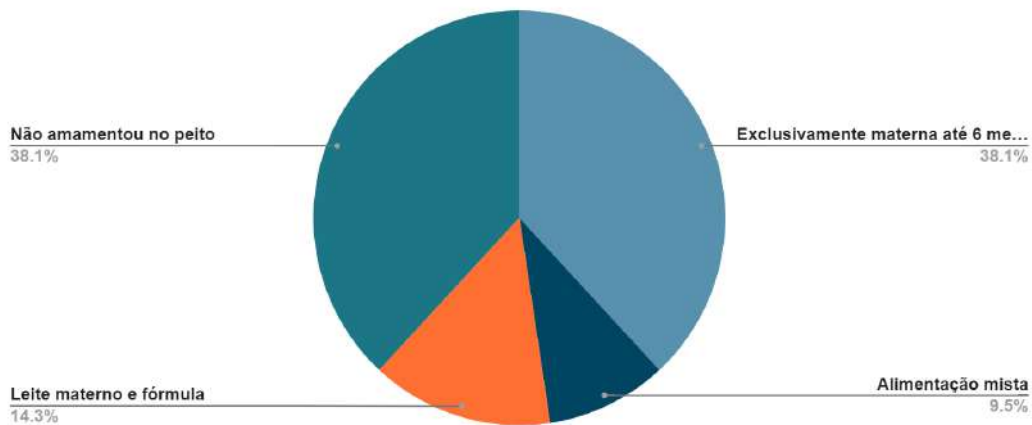
Graphic 1. Percentage of the type of food that the baby received.

Santos, G. B., et al., 2021.

In addition, data on previous knowledge on breastfeeding were included in which 83.9% of the answers were affirmative where 1/3 were acquired in the private network, approximately 1/4 in preparatory courses for childbirth and 1/4 obtained information in Basic Health Units (UBS, the acronym in Portuguese) or maternity hospital where the birth occurred.

Furthermore, 93.5% of the population acknowledges that it is recommended to place the newborn for breastfeeding within the first hour of life, 3.3% believe that it can be placed until the third hour of life and 3.2% do not know and there were no answers for "until the sixth hour of life". Therefore, it is understandable that the group which states that the ideal is to put the baby to breastfeed in the first hour of life is the same that also recognizes that the correct lactation should be maintained until six months of age. As shown in Graph 2.
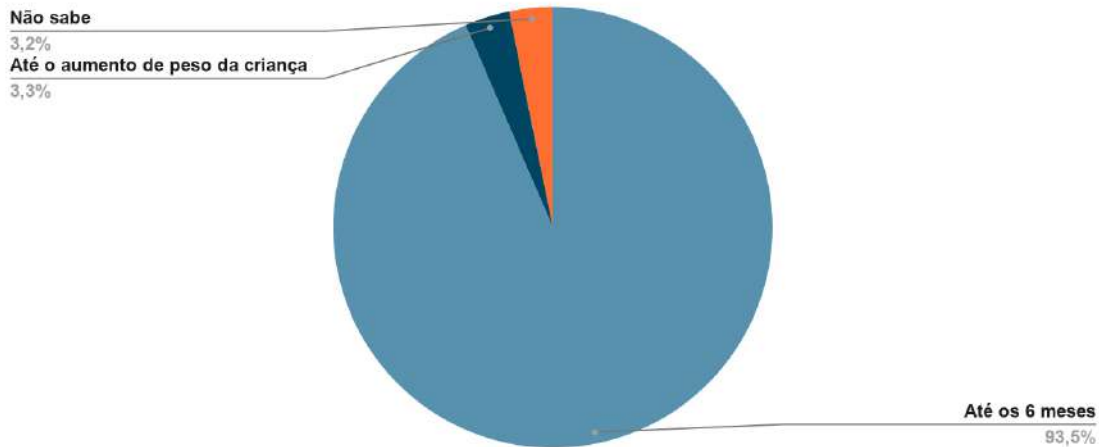
Graph 2- Percentage of required breastfeeding duration.

Santos, G. B., et al., 2021.

Subsequently, the questionnaire addressed whether breast milk contains all the essential nutrients for the baby's development, and all the answers were positive in this regard: breast milk is more adequate and certainly provides better digestion for children.

However, when asked who benefits from breastfeeding, 58.1% claim mutual benefit, i.e., respectively mother and baby; 19.4% believe it is advantageous for the whole society, 22.6% have the belief that it is convenient only for the child.

Furthermore, it was found that 96.8% of the interviewees believe that breastfeeding is able to prevent infections and allergies and only 3.2% did not know how to inform exactly. However, it is essential to emphasize that all interviewees recognize that breast milk is essential for the satisfactory progression of the child's immune system and favors the bond between mother and child.

In conclusion, it inferred questions based on breastfeeding as an ally against child obesity, and there is agreement between 87.1% but 12.9% did not know how to inform; It was verified that 64.5% of the interviewees affirm that breastfeeding helps in uterine involution and 35.5% do not know this fact. Finally the majority (93.5%) of the respondents ratify that breastfeeding attributes to the mother's weight loss and 6.5% responded that there is no success in losing weight.

IV. DISCUSSION

The Brazilian Society of Pediatrics (SBP), (2021), recommends that breastfeeding should be exclusive until the age of 6 months, being of utmost importance due to the benefits it offers to the child, as it helps in the child's development and health protection, meeting all nutritional needs. This fact is also recommended by the Ministry of Health (2013), and is also known by most of the interviewees (93.5%); however, among those who had already breastfed, it was found that only 38.1% of the respondents had done it ideally, showing that knowledge is not necessarily linked to the practice of breastfeeding.

In addition, the Brazillian Society of Pediatrics (2021) states that breastfeeding generates benefits not only for the child, but also for the mother, since it helps her return to normal weight, reduces the chances of developing diabetes and heart attack, reduces postpartum bleeding, and prevents breast and ovarian cancer. It should also be noted

that breastfeeding is practical, economical, safe, effective and intensifies the bond between mother and child. Moreover, when asked who benefits from breast milk, most (58.1%) believe that the benefit is for both, the mother and offspring and 19.4% understand that it is beneficial for the whole society, confirming the information recommended by the BSP (2001) (SBP, in Portuguese).

According to the World Health Organization, (2015), breastfeeding can be classified into:

- Exclusive breastfeeding: when the baby only gets breast milk, with the exception of vitamins, supplementation or medication.

- Predominant breastfeeding: where the child receives water, teas and juices in addition to breast milk.

- Breastfeeding: when the child, regardless of whether or not it receives other foods, is breastfed.

- Complementary breastfeeding: in addition to breast milk the child receives semi-solid/solid food.

- Mixed or partial breastfeeding: when the child receives other types of milk in addition to breast milk.

Of the 31 women interviewed only 38.1% revealed adherence to exclusive breastfeeding until 6 months, the recommended by the World Health Organization (WHO) (2015); 14.3% adhered to mixed or partial breastfeeding, association of breast milk with formulas, and 9.5% of the interviewees claimed to have employed mixed or complemented feeding, according to WHO (2015). This reveals that, despite efforts to raise awareness about the importance of exclusive breastfeeding for up to six months, many women are still reluctant. It is important to emphasise that there are several reasons for non-adherence to exclusive breastfeeding. The lack of information corroborates, but we cannot neglect the referred pain, the emotional state of the lactating woman in relation to the act, and the return to work before the baby is six months old.

According to Damião (2008) and Sales et al (2017), breastfeeding is related to the woman's schooling and the insertion in the labour market, as this increased the production of milk formulas and decreased the exclusive breastfeeding time. Furthermore, there are analyses claiming that older women have more knowledge about the child's development, a fact that was deconstructed in our research, as the interviewees, who have an average age of 27 years, understand that breastfeeding contributes to

preventing infections, helps development, and has all the necessary nutrients for the child.

In relation to the intervals of the feeds and the offer, it is important to emphasize that in the first 10 days of life until one month the free demand is the best way. The breast should be offered whenever the baby asks for it and there is no fixed interval between feeds, the ideal being to avoid leaving the baby more than three hours without breastfeeding during the first days of life. So that the baby learns to recognize when he/she is hungry and when there is satiety, and this recognition is linked to lower rates of obesity in adulthood. This is known by the interviewees (87.1%). Moreover, sucking is the main stimulus for the production of breast milk, therefore, the more often the baby sucks the greater the stimulus for milk production, besides contributing to uterine involution, a fact unknown by 35.5% of the interviewees. The BSP (2021), postulates that the first feed should be offered in the first hour of the baby's life, preferably soon after birth, which proved to be known by the interviewees (93.5%) while only 3.3% believe that it is good to breastfeed until the third hour of life.

Therefore, the encouragement of breastfeeding should occur both in the private sector and in the Single Health System (SUS in Portuguese), since prior knowledge helps in the preparation, knowledge and practice of the mother.

According to Santiago et al (2003), the multidisciplinary breastfeeding support teams, together with the pediatrician, have great influence on the results related to breastfeeding, providing guidance on diet/nutrition and family habits. However, surveys show low demand of pediatricians for courses and training. In this research, ⅓ of the interviewees reported acquiring knowledge through the private network, ¼ in preparatory courses and ¼ in Basic Health Unit/maternity/hospital. Of the 31 people interviewed in total, 83.9% said they had prior knowledge related to breastfeeding, i.e., knowledge proved to be greater than the lack of information. According to Rebouças et. al. (2020), pregnant women who receive some information, get that from nurses or nutritionists. In our study, we found that the knowledge about breastfeeding was mostly acquired (37%) in the maternity hospital where the mother gave birth, followed by information passed on private networks (33.3%) and preparatory courses for childbirth (22.2%).

V. CONCLUSION

This study was relevant in order to assess the knowledge of pregnant women about breastfeeding and provide health education to them. Furthermore, the benefits for the mother were reported, such as decreased

risks of diabetes, heart attack and postpartum hemorrhage, in addition to preventing breast and ovarian cancer, as well as being a safe, effective, economical and practical method. Orientation was given regarding the best supply for the baby, emphasizing the importance of free demand in the first month of life.

It was concluded that the interviewees have a good prior knowledge about breastfeeding, understanding that breast milk is the best food for the infant, so the flyer used was helpful in the intervention, as it added information for health education practice offering more knowledge about breastfeeding.

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Geotechnologies and Artificial Intelligence as a Tool of Riparian Forest Management

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Abstract — *Geotechnologies are important tools for natural resource management in the face of urgent questions and answers demanded by society. They are able to offer a range of mechanisms that, through technique and science, enable the understanding of the starting points through location, dimension, acquisition and processing. For this purpose, the use of Artificial Intelligence (AI) techniques has helped in the manipulation of data ascending from the extensive volume of information generated, as well as the improvement of computational systems. The objective of this paper was to verify the relationship between geotechnologies with emphasis on Remote Sensing (RS) in the management of natural resources, such as riparian forest Permanent Preservation Areas (PPAs) and the use of Artificial Intelligence (AI). For this, a quali-quantitative and descriptive work hereby presented has been considered in the research: Science Direct, Resergate, Scielo and Google Scholar, with emphasis on articles published in journals in both English and Portuguese languages between 2018 and 2020, and explored in the first half of 2021. The summation of the two databases enabled the following results: 07 articles (2018), 15 articles (2019), 32 articles (2020), dissertations (50), articles in proceedings (01), chapters (02), e-books (07), articles in symposia (03), pages without access (13), theses (25), monographs (20), totaling 162 works. The data also revealed little publication on the theme, especially in Portuguese, of articles related to the use of artificial intelligence. However, the use of AI has presented itself as an important tool in research allied to remote sensing and GIS software. Therefore, it was not possible to verify the existence of studies of riparian forest APP using artificial intelligence, indicating a relevant research gap in this area. Thus, it is suggested in future researches the increase of applications of artificial intelligence directed to the study of riparian forest APP associated with geotechnologies.*

I. INTRODUCTION

Technological advances have enabled the progress of science and research through the interrelation of data. Great impetus in computing systems, both hardware and software, has eased this evolution in the analysis, manipulation, and extraction of data, e.g. geotechnologies (ALVES; MARTINS; SCOPEL, 2020; MEDEIROS; ALBUQUERQUE, 2019; LEITE; RODRIGUES; LEITE, 2018). Moreover, the use of artificial intelligence has expedited the manipulation of information (OLIVEIRA; CÂMARA, 2019), as well as machine learning, deep learning, and neural networks, in which these processes are differentiated (DIKSHIT; PRADHAN; ALAMRI, 2020).

Among the geotechnologies, Remote Sensing (RS), Geographic Information System (GIS) and the Global Navigation Satellite System (GNSS), with emphasis on the Global Positioning System (GPS), are worth mentioning. These are instruments, which allow the study of land use, as well as the occupation in real time (MORANDI et al., 2018).

In this process, machine learning is found (SAMBATTI et al., 2019; OLIVEIRA; CÂMARA, 2019; GILL et al., 2019; RIZEEI et al., 2019). On the other hand, the use of Artificial Intelligence (AI) has also become an important tool in data resolution (SAMBATTI et al., 2019; GILL et al., 2019). Accordingly, discussions about sustainability have been acquiring other perspectives with the frequent use of geoinformation.

Consequently, there is a possibility of joining data with geographic databases among various institutions in the world (MIRTL et al., 2018). This process enables the completeness of information, in order to permit new allusions related to the quality of the environment (VIEGAS; ALMEIDA; SOUZA, 2018).

Geotechnologies are fundamental (SIMONETTI; SILVA; ROSA, 2019; LEITE; RODRIGUES; LEITE, 2018; MORANDI et al., 2018). This is due to the spread of free and open-source software in geoprocessing. There is also the use of mathematical models in which the purpose is outlined according to the research proposal (HARFOUCHE et al., 2019; SAYAD; MOUSANNIF; MOATASSIME, 2019). However, such georeferencing by artificial neural networks is a current perspective (BRUBACHER; OLIVEIRA; GUASSELLI, 2020).

It is not about computational knowledge alone, but about methodological knowledge for perfect data analysis (LEITE; RODRIGUES; LEITE, 2018). Thus, as GIS and remote sensing (MORANDI et al., 2018; REIS et al., 2018; THEVENIN; PIROLI, 2018; SIMONETTI; SILVA; ROSA, 2019; SCCOTI; ROBAINA; TRENTIN, 2019; SPETH et al., 2020), add, also, the increasing mathematical models of computational nature (HARFOUCHE et al., 2019).

Through georeferencing, it is possible to measure the phenomenon in space and assign to each geospatial data information, being wide the possibilities of geotechnologies (FIORESE; TORRES, 2019; ALMEIDA et al., 2020). In this panorama, one finds controversially the use of artificial intelligence, technologies for the study of natural resources.

Riparian forests, as important natural resources, are supported and protected by the Brazilian Forest Code (Law #. 12651, of 2012, amended by Law # 12727, of 2012) (MORANDI et al., 2018). Their maintenance, study, and

enforcement are facilitated by the use of geotechnologies (REIS et al., 2018; FIORESE; TORRES, 2019; ALVES; MARTINS; SCOPEL, 2020). The main objective of this article was to verify the relationship between remote sensing in natural resource management, as well as riparian forest PPAs and the use of artificial intelligence, given that they are important tools for studying riparian vegetation.

II.   THE GEOTECHNOLOGIES SCENARIO

The use of geotechnologies becomes fundamental, due to the pressures that human activities perform on the environment (MEDEIROS; ALBUQUERQUE, 2019). This way, it is possible to use geoinformative technologies to make society more participatory and active in relation to environmental issues, and therefore, these actions should not remain only at the level of ideas (LEITE; RODRIGUES; LEITE, 2018; VIEGAS; ALMEIDA; SOUZA, 2018).

Leite, Rodrigues & Leite (2018) assert that geotechnologies become important tools, in view of being able to provide answers, as well as analyze the space, in the face of the pressure that economic development entails in the natural environment. They are tools aimed at maintaining life in the biosphere, besides being essential for the study of large areas and socio-environmental phenomena, telecommunication, defense, and economy.

A tool for data analysis, extraction and manipulation requires a set of methodological knowledge, being, moreover, necessary for the individual to develop multidisciplinary skills (LEITE; RODRIGUES; LEITE, 2018). It is urgent in this process to be acquainted with other areas of knowledge, such as programming language.

Geotechnologies, in addition to assisting in the study of natural resources, allow expanding the discussion of the issues on environmental quality. Therefore, the management of geographic space becomes more dynamic with the possibility of analyzing various spatial aspects, such as Hydrography, Pedology, Edaphology, Agriculture, Livestock, Climatology, and Vegetation. From this point, the biosphere becomes a field of analysis from the perspective of technology with emphasis on geoinformation (LEITE; RODRIGUES; LEITE, 2018; MORANDI et al., 2018).

Morandi et al. (2018), Simonetti, Silva and Rosa (2019) highlight the importance of geotechnologies in understanding the interrelationship between natural and cultural environments. Geoinformation is fundamental because, through access to geographic databases, multitemporality aids in the process of geodecision making

(REIS et al., 2018; SPETH et al., 2020), being special in the reconstitution of degraded areas.

Viegas, Almeida and Souza (2018), as well as Speth et al. (2020) stress that geotechnologies are employed in the management of urbanized areas, and its employment assists, mainly, the performance of public institutions before such issues as urban zoning. Moreover, it helps as a supervisory tool in the fulfillment of environmental conservation standardizations (SIMONETTI; SILVA; ROSA, 2019; TREVISAN et al., 2020).

The use of computational systems comes to be an important ally in various fields of knowledge, not restricted only to the ecological dimension. This favors the dynamic use of geotechnologies whose purpose is to strengthen the understanding and confrontation of environmental issues. To this end, as reiterates Sampaio (2019), geotechnologies help to understand the forms of power and appropriation of the environment by the Human Beings.

Simonetti, Silva & Rosa (2019) highlight, in this process, GIS and remote sensing, as also highlighted by Araújo, Bastos and Rabelo (2020), reiterated also by Medeiros and Albuquerque (2019). However, the bench study, done remotely should not discard the importance of the study on-site (ALMEIDA et al., 2020).

Sccoti, Robaina & Trentin (2019), still, highlight the relevance that GIS has acquired as well as Speth et al. (2020), because it streamlines the research work, becoming an important resource for the perfect apprehension of phenomena. For this to occur, the use of computational systems are fundamental.

In this sense, Mirtl et al. (2018) highlights the importance of "big data" in the treatment of large volumes of data at a time when ecological movements have sought strengthening, since obtaining information in an integralized manner has been faster, and geotechnologies are components of this development.

Geotechnologies are essential in maintaining the quality of natural resources, since, with the development of these technologies, new methodologies for the study of land use have provided answers to the aggressions imposed on the environment (LEITE; RODRIGUES; LEITE, 2018; MORANDI et al., 2018; REIS et al., 2018; THEVENIN; PIROLI, 2018; VIEGAS; ALMEIDA; SOUZA, 2018).

III. SCENARIO OF DATA ANALYSIS IN GEOTECHNOLOGY

For image processing, in the view of Oliveira & Câmara (2019), science has resorted to and developed algorithms, mathematical models for refinement of predefined data (HARFOUCHE et al., 2019; SAYAD; MOUSANNIF; MOATASSIME, 2019). These are technologies such as artificial intelligence, machine learning, deep learning, and neural networks, although these processes are interrelated, they are quite different (DIKSHIT; PRADHAN; ALAMRI, 2020).

The development of artificial neural networks has been made possible with the knowledge of brain neural networks (OLIVEIRA; CÂMARA, 2019). The authors highlight the importance of Convolutional Neural Networks for image processing. Marques Junior & Covolan (2018) reiterate its importance for the treatment of big data, as does Gill et al. (2019) and Jena et al. (2020). The difference between the two is in the number of layers (KLOMPENBURG; KASSAHUN; CATAL, 2020).

The study of georeferenced information through artificial neural networks is a significant aspect (BRUBACHER; OLIVEIRA; GUASSELLI, 2020). It stands out because of the increasing advancement of computational tools to process large amounts of data (SAMBATTI et al., 2019; HARFOUCHE et al., 2019). This process has enhanced artificial intelligence studies, one of the highlights of which is machine learning (SAMBATTI et al., 2019; OLIVEIRA; CÂMARA, 2019; GILL et al., 2019; RIZEEI et al., 2019).

Machine learning allows computers to develop processes capable of being built by experience, and hence the development of artificial neural networks. Moreover, the use of the artificial intelligence tool enables collection, as well as analysis of information for an instant decision-making (SAMBATTI et al., 2019; GILL et al., 2019; TIYASHA; YASEEN, 2020).

Consequently, it is a much-updated technical and scientific process (OLIVEIRA; CÂMARA, 2019; HARFOUCHE et al., 2019). Despite being based on mathematical models, several fields of the human sciences have benefited and aided its development, according to the authors. As an example, the data obtained by satellite images and the supervised classification methodology proposed in artificial intelligence (NETO; GONÇALVES; SENNA, 2020; MARQUES JUNIOR; COVOLAN, 2018; SAMBATTI et al., 2019; SAYAD; MOUSANNIF; MOATASSIME, 2019).

As techniques on artificial intelligence advance, computational systems have taken a deep insight (TINÉ; PEREZ; MOLOWNY-HORAS, 2019). This requires the improvement of search techniques and the refinement of information. Therefore, mathematical models based on computational data are increasing (HARFOUCHE et al., 2019). Segments such as Big Date (MIRTL et al., 2018;

SAMBATTI et al., 2019; SAYAD; MOUSANNIF; MOATASSIME, 2019; KHAN; GUPTA; GUPTA, 2020), as well as advancement in sensor and satellite types. They are the future-proof in the study of data, especially in geosciences (GIL et al., 2019).

With the use of artificial intelligence, remote sensing techniques are improved, as coupled sensors have provided data with excellent resolutions. In this process, the Internet of Things (IoT) tool gains importance to assist in the processes of obtaining data regarding some environmental phenomenon (SAYAD; MOUSANNIF; MOATASSIME, 2019; GILL et al., 2019; KHAN; GUPTA; GUPTA, 2020; BALTI et al., 2020). On the other hand, Gill et al. (2019), emphasize the trends of Block chain technology.

Rizeei et al. (2019) stresses that the association of these techniques with GIS software has enhanced data retrieval. Jena et al. (2020) reiterate the use of machine learning. All this reinforces the importance of Artificial Intelligence to address environmental issues (DIKSHIT; PRADHAN; ALAMRI, 2020). On the other hand, deep machine learning solves the human difficulty in analyzing information through data correlation (SENGUPTA et al., 2020).

IV.   MATERIAL AND METHODS

This is a qualitative, quantitative and descriptive research, in which data were collected from the websites of governmental and research institutions and from research sources such as Science Direct, Google Scholar, Scielo and Resergate.

It was carried out in two moments during the first semester of 2021. Alves, Martins and Scopel (2020) reiterate that geotechnologies are a set of technologies. The search was carried out according to Table 1. To this end, only articles published in periodicals, that were both in English and Portuguese were catalogued, covering the period from 2018 to 2020. It is also worth mentioning that the choice of research sources was due to their relevance and coverage worldwide. The choice of the time was due to the need to discuss the current state of the art.

Table 1 – Relation Between Strings And Research Sources

String	Data source
Riparian forest permanent protection area AND remote sensing AND legislation AND artificial intelligence AND artificial neural network AND AI geospatial	Scielo and Google Scholar
permanent riparian forest protection area AND remote sensing AND legislation AND artificial intelligence AND artificial neural network AND geospatial IA	Resergate and Science Direct

Developed by the authors

In the second step, the identification, the segregation into tables, and the analysis of the data was done using key words to quantify and qualify the form of use and its applications in articles published in periodicals, in the data sources cited in the research.

V.   DISCUSSION AND RESULTS

The Scielo data source reported zero results. However, the Google Scholar search platform returned 124 results, distributed as follows 05 articles (2018), 06 articles (2019), 05 articles (2020), theses (25), dissertation (50), article in proceedings (01), chapter (02), e-book (07), articles in symposium (03), pages without access (04), monograph (20). Considering, however, the data presented in Table 2.

*Table 2 – Found In Scielo And Google Scholar (**Relevant Researches**)*

Contents	Authors
Remote Sensing	(ALMEIDA *et al.*, 2020)
Geotechnologies	(ALVES; MARTINS; SCOPEL, 2020)
Occupy river banking	(FIORESE; TORRES, 2019)
Remote sensing, use and land cover	(LEITE; RODRIGUES; LEITE, 2018)
Geoprocessing, preserved areas	(SIMONETTI; SILVA; ROSA, 2019)
Brazilian Forest Code, Riparian Forest, Remote Sensing	(MORANDI, *et al.*, 2018)
PPA; Geographical Information System (GIS)	(SPETH, *et al.*, 2020)
Permanent Preservation Area; Geoprocessing	(VIEGAS; ALMEIDA; SOUZA, 2018)

Developed by the authors

The data source Resergate presented 01 article (2018). Science Direct reported 37 results. Thus distributed 01 article (2018), 09 articles (2019), 27 articles (2020), and

pages without access (09). To this end, the most important data have been highlighted in Table 3.

Table 3 – Found In Resergate And Science Direct

(Relevant Researches)

Content	Authors
Artificial Intelligence (AI)	(HARFOUCHE *et al.*, 2019)
Artificial Intelligence	(GILL *et al.*, 2019)
Artificial Intelligence; Machine Learning; Remote Sensing	(SAYAD; MOUSANNIF; MOATASSIME, 2019)
Neural artificial network	(CHEN *et al.*, 2019)
Machine learning, GIS (Geographic Information System)	(RIZEEI *et al.*, 2019)
Machine learning; Deep learning; Artificial Intelligence (AI)	(DIKSHIT; PRADHAN; ALAMRI, 2020)
Deep learning; Machine learning;	(KLOMPENBURG; KASSAHUN; CATAL ,2020)
Artificial intelligence	(TIYASHA; YASEEN, 2020)
Artificial intelligence; Satellite imagery; Remote sensing	(KHAN; GUPTA; GUPTA, 2020)
Artificial intelligence; Machine learning; Remote sensing	(BALTI *et al.*, 2020)
Deep Neural Networks	(PATAN et al., 2020)
Machine learning; artificial intelligence	(GHARAIBEH et al., 2020)
Deep learning; Commercial satellite imagery	(WITHARANA et al., 2020)
Machine learning; GIS (Geographic Information System)	(JENA et al., 2020).
Deep learning	(YEKEEN; BALOGUN; YUSOF, 2020)
Deep neural network; deep learning	(SENGUPTA et al., 2020)
Machine learning	(SHARMA et al., 2020)
Machine learning	(ZEKIĆ-SUŠAC; MITROVIĆ; HAS, 2020)
Deep learning, Convolutional Neural Network	(OLIVEIRA; CÂMARA, 2019).
Geoprocessing	(NETO; GONÇALVES; SENNA, 2020)
Apprenticeships and Machine; Convolutional Neural Network	(MARQUES JUNIOR; COVOLAN, 2018)
Artificial Intelligence; Apprenticeships machine	(SAMBATTI *et al.*, 2019)
Geoprocessing	(BRUBACHER; OLIVEIRA; GUASSELLI, 2020)
Modelling of Complex Systems	(TINÉ; PEREZ; MOLOWNY-HORAS, 2019)

Developed by the authors

Both in Table 2 and Table 3, the data were categorized according to keywords, since they are important structural elements and highlight relevant topics of the scientific article (AQUINO, 2010). When compared, the categories reveal important aspects of technological development for geospatial data mining.

5.1 Remote Sensing and Applicability

Geotechnologies offer several possibilities to obtain data, among them, remote sensing. According to Leite, Rodrigues, & Leite (2018) information can be obtained in several ways in this method. Therefore, the existence of platforms in which sensors decode information captured by the earth's surface.

It is possible to study the images both qualitatively and quantitatively, since both complement each other. This data processing constitutes steps arising from and known as Digital Image Processing (DIP). For Leite, Rodrigues, & Leite (2018), it is a primary element in satellite image processing.

For the treatment of images, points out Leite, Rodrigues & Leite (2018), it is vital the knowledge of spectral characteristics that is contained in every object. With this in mind, it is necessary that elements of the environment be taken into account in this manipulation of the data (MORANDI et al., 2018; REIS et al., 2018; VIEGAS, ALMEIDA, SOUZA 2018; THEVENIN, PIROLI, 2018).

The environmental management, from the remote sensing, ceases to be a difficulty, especially in public institutions, in the way highlighted by Viegas, Almeida & Souza (2018), since it is possible to perceive and analyze the phenomenon independently of the presence of a researcher, becoming this another important tool for inspection (SAMPAIO, 2019; TREVISAN et al., 2020).

5.2 Use of Geographic Information System (GIS)

Science has a very important role in the process of maintaining natural resources, and to this end, it is necessary to use technology to assist in the maintenance of life (MIRTL et al., 2018; LEITE; RODRIGUES; LEITE, 2018; MEDEIROS; ALBUQUERQUE, 2019). The authors reaffirm the necessity of using big data and its importance in understanding anthropogenic actions, because of a huge amount of instantaneous information.

Trevisan et al. (2020) stress the importance in the utilization of GIS, as it allows the integration of spatial data and information to research geographic phenomena. However, a GIS software involves the apprehension of multidisciplinary knowledge (LEITE; RODRIGUES; LEITE, 2018; MORANDI et al., 2018; REIS et al., 2018; THEVENIN; PIROLI, 2018; VIEGAS; ALMEIDA; SOUZA, 2018; FIORESE; TORRES, 2019; MEDEIROS; ALBUQUERQUE, 2019; SAMPAIO, 2019; SIMONETTI; SILVA; ROSA, 2019; ARAÚJO; BASTOS; RABELO, 2020; SPETH et al., 2020).

As an example of GIS software used in geoprocessing, according to Table 4, the authors communicate the importance that this tool has acquired. This notoriety, also, occurs because of the popularization of geospatial data, computer systems, as well as constant improvement.

Table 4 – Relation Sig Software By Author

SIG Software	Reference
SPRING 4.3.3	Leite, Rodrigues and Leite (2018)
ArcGIS 10.3.1	Morandi (*et al.*, 2018)
ArcGIS 10.1	Reis (*et al.*, 2018)
ENVI 5.0	Thevenin and Piroli (2018)
ArcGIS 10	Thevenin and Piroli (2018)
ArcGIS 10.1	Viegas, Ameida and Souza (2018)
ArcGIS 10.2.2	Fiorese and Torres (2019)
ArcGIS 10.5	Medeiros and Albuquerque (2019)
ArcGIS	Sampaio (2019)
ArcGIS 10.4	Sccoti, Robaina and Trentin (2019)
Envi 4.8	Sccoti, Robaina and Trentin (2019)
ArcGIS 10.4.1	Simonetti, Silva and Rosa (2019)
Erdas 2014	Almeida (*et al.*, 2020)
ArcGIS 10.5	Almeida (*et al.*, 2020)
ArcGIS 10.1	Alves, Martins and Scopel (2020)
QGIS 2.16	Alves, Martins and Scopel (2020)
ArcGIS 10.2	Araújo, Bastos and Rabelo (2020)
ArcGIS	Garcia and Longo (2020)
ArcGIS 10.5	Speth (*et al.*, 2020)
ArcGIS 10.5	TREVISAN *et al.*, 2020

Developed by the authors

The amount of GIS software does not end as shown in Table 4, but highlights the importance that this technology has acquired and become necessary for the study of georeferenced information. It can be either free software or proprietary software.

5.3 The importance of APPs and the standardizing instruments

The failure to comply with the Federal Constitution of Brazil, as described by Speth et al. (2020), in order to ensure the urgent quality of life for all, and the environment, as provided in Article 225. This legal, political, and administrative aspect is also observed in specific normative regulations protecting natural resources (MORANDI et al., 2018; THEVENIN; PIROLI, 2018; VIEGAS; ALMEIDA; SOUZA, 2018).

In Brazil, the first normative instruction dealing with the Forest Code, according to the reporting agency of the Chamber of Deputies, was Decree # 23793, of 1934. Another change came with the enactment of Federal Law # 4.771, of 1965. In relation to subsequent legislation, it meant a breakthrough in discussions about the limits of PPAs, as well as their definition. Sequentially, the Federal Law # 12651, of 2012, which, in a short time of effectiveness, underwent modifications with the Federal Law # 12727, of 2012.

However, anthropic action is a recurring variable (VIEGAS; ALMEIDA; SOUZA, 2018). There is in this a historical non-compliance with the Law (THEVENIN; PIROLI, 2018; SIMONETTI; SILVA; ROSA, 2019; ALVES; MARTINS; SCOPEL, 2020). In this process, geoprocessing and artificial intelligence techniques become very relevant.

5.4 Discussion of the data

The summing of the two databases enabled the following results 07 articles (2018), 15 articles (2019), 32 articles (2020), dissertations (50), articles in proceedings (01), chapters (02), e-books (07), articles in symposia (03), pages without access (13), theses (25), monographs (20), totaling 162 works.

The relationship between geotechnologies and artificial intelligence in the study of natural resources has been discussed. Although the data reflect little publication on the subject in question, with respect to the breadth and the need for discussion of very important categories such as artificial intelligence, geotechnologies and riparian forest.

However, in the period analyzed it was observed a larger quantity of discussion of articles in the English regarding the use of artificial intelligence and the need to expand them in the Portuguese. This is due to the understanding of the use and occupation of land, through geotechnologies, which is an important tool that enables the study of natural resources and various socio-environmental phenomena that occur on the Earth's surface (LEITE; RODRIGUES; LEITE, 2018).

The use of the artificial intelligence tool in this process should enhance the relationship of the environment by man as a management tool (GHARAIBEH et al., 2020). However, the use of GIS and remote sensing software, despite the lower amount of relevant articles in Portuguese, their discussion was more extensive than the English data.

The digital image processing techniques that takes into account the methodological aspects of geospatial data analysis of satellite images through the supervised classification model, the use of artificial intelligence has stood out (NETO; GONÇALVES; SENNA, 2020; MARQUES JUNIOR; COVOLAN, 2018; SAMBATTI et al., 2019; SAYAD; MOUSANNIF; MOATASSIME, 2019).

The study of Permanent Protection Area (PPA) using remote sensing and GIS software, with emphasis on riparian forests has proven satisfactory (MORANDI, et al., 2018; MEDEIROS; ALBUQUERQUE, 2019; SIMONETTI; SILVA; ROSA, 2019), mainly with methodological processes made through temporal cutting by sensor systems (THEVENIN; PIROLI, 2018; ARAÚJO; BASTOS; RABELO, 2020), which helps the elucidation of the phenomena (SPETH et al., 2020; ALMEIDA et al., 2020).

The development of new techniques allowing the relationship between AI and geotechnologies is necessary, because there is a process of degradation of riparian forests

and remote sensing has been shown to be important for the study of land use and coverage (ALMEIDA et al., 2020). However, the analysis only from this perspective is insufficient since it is necessary to consider the development of the anthropocentric process on water resources.

On the other hand, one may see the urgent necessity of management in a participatory way with the various sectors of society as the implementation of sustainable practices (ALVES; MARTINS; SCOPEL, 2020), since it is important the wide investigation with the purpose of identifying the pressures suffered by the hydric bodies (FIORESE; TORRES, 2019).

The use of GIS software in the analysis and collection of spatial data on vegetation located on river banks are indispensable (SIMONETTI; SILVA; ROSA, 2019; VIEGAS; ALMEIDA; SOUZA, 2018; MORANDI et al., 2018). The use of this tool, complementary for the analysis of geospatial data, in the papers presented in Portuguese was broader than in English.

VI. CONCLUSION

There is an important discussion and improvement in the use of geotechnologies, artificial intelligence, and GIS software concerning methodological processes for studying spatial data. This type of analysis of space from an ecological point of view has been strengthened with the new study possibilities that the development of AI makes possible.

It was not possible to verify, the existence of APP studies of riparian forests using artificial intelligence. Although its analysis by means of GIS software and RS are consolidated, but it is possible to verify that new techniques in geoprocessing are growing with the use of artificial intelligence.

The AI technologies applied to riparian forest management can result in a broad discussion about this important natural resource in order to better characterize water resources, since these computer systems can provide and analyze large volumes of data.

The period applied to the research presented itself as an obstacle to the discussion about the proposed objective. The search sources showed insufficient results, considering the existence of other databases, and there may be articles that are not linked to the period analyzed, as well as other languages. Therefore, it is suggested as future works research related to the development of artificial intelligence for the study of APP of riparian forests associated with geotechnologies.

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Assessment of different domain impairments in Cognitive Functions and Functionalities found in Euthymic Patients with Bipolar Disorder I / II - during the early and late phases of the disease, using the FAB and FAST tests.

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Abstract — Objective: In this study, we focus on assessing two key predictors and outcomes in Bipolar Disorder (BD), which are: cognition and functionality performance, dividing them into two subgroups, and then researching for a correlation between them. Methods; Fifty patients with BD in a euthymic phase were divided into two subgroups (≤ 3 years (n=25) and ≥ 10 years (n=25) of the disease) and were then compared with healthy controls (n=25). Psychosocial functioning was assessed using the Short Functionality Assessment Test (FAST), and the Frontal Assessment Battery (FAB) test to assess frontal cognitive functions. Clinical and sociodemographic characteristics were analyzed using unilateral variance analysis, or the chi-square test. In order to verify the correlation between the FAB and FAST tests, Spearman's correlation coefficient test was used Results: Both subgroups of euthymic patients had higher FAST total scores than the healthy control group (9.80 ± 5.94). The groups with ≤ 3 years (20.63 ± 8.21), and ≥ 10 years (27.80 ± 12.50) of the disease presented(p<0.001). Associated with these results, bipolar patients had higher FAST scores in all domains, predominantly with moderate impairment (score 21-40), and lower scores in the following four FAB test domains: conceptualization, sensitivity to interference, inhibitory control, and motor series (p<0.05). The correlation between the FAB and FAST tests showed moderate intensity (r^2 = -0.539). Conclusion: This study reinforced the impact of BD on functionality and frontal cognitive functions, demonstrating changes in several domains, and impairment in social, occupational, and cognitive functions in patients with different times of disease onset. Understanding all factors is essential for these patients, which increases the possibility of rehabilitation and response to treatment.

I. INTRODUCTION

Bipolar Disorder (BD) is characterized as being a chronic disease with severe morbidity, mortality, and high suicide rates **[1].** It is a progressive disease with episodes becoming successively shorter, and frequent over time. Multiple alterations occur in the brain such as changes in neuroplasticity, neurotransmission, failures in apoptosis, activation in the immune-inflammatory process, changes in the calcium signaling pathway; and more recently, on oxidative stress. These events involve a pathological reorganization in the brain and therefore are associated with morphological changes such as a reduction in the volume of the prefrontal cortex, hippocampus, and an enlarged amygdala **[2];[3].** These structural and biochemical changes are highly recurrent and disabling, developing a process known as neuroprogression, with a difference between the initial and final stages of BD. These secondary alterations are possibly caused by multiple episodes of mania and depression during the disease, raising the hypothesis that bipolar patients may have had changes in their neurocognitive performance, with an impact on their daily functionality and psychosocial aspects **[4];[5];[6];[7];[8];[9].** These modifications are usually measurable and characterized by reductions mainly in Executive Functions (EF). The EF is a generic term to describe cognitive processes that allow a person to develop a flexible and independent goal-directed behavior **[10];[11].** The EF present particularly three main domains (working memory, inhibition, and cognitive flexibility), and they are considered as the basis for other more complex EF, such as; planning, problem-solving, abstract reasoning, among others **[12];[13];[14];[15].** For this reason, many different neuropsychological tests can be used like the recent FAB test **[16].** An impairment of EF is present in several neurological conditions, such as neurodegenerative disorders, traumatic brain injuries, strokes, and more recently in various psychiatric disorders like substance-use disorders **[17];[18],** and schizophrenia **[19].** Although the significance of EF`deficits is not yet fully understood, many studies have shown that patients with BD, even in the euthymic phase, have cognitive dysfunctions, in several domains, such as; verbal memory, EF, impulsivity control, attention, among others. Furthermore, it has also been observed that important functional difficulties, at an occupational, social, and autonomy level, persist in a significant number of patients, even after symptomatic remission **[20];[21];[22];[23].** The presence of this neurocognitive dysfunction in different dimensions during the euthymic state may be one of the determining factors for functional incapacity, as it occurs in patients with other mental pathologies **[24];[25];[26];[27];[28];[29];[30].** Thus, remission in BD

(euthymia) is not synonymous with patients` recovery and functionality **[31].** Gitlin et al. **[32],**have already described that despite the treatment, 73% of the patients relapsed with depression and mania many times over a period of five years. Even for those who did not relapse, changes in their psychosocial functioning were observed, especially in the occupational area, generating a poor prognosis for the disease. The hypothesis related to this phenomenon is the cognitive deficits deriving from chronicity of the clinical course, and the persistent subsyndromal symptoms **[21];[31].** Also, research with patients after the first manic episode, showed that functional impairments were present in up to 70% of patients **[33].** Furthermore, occupational impairment was not significantly different in patients during their first episode, than in those with multiple episodes. Even in a prospective observational study including 3681 patients with episodes of acute or mixed mania for two years (2004 to 2006), Goetz et al. **[34],** found that functional and occupational impairment were already present in the year before their first mania episode. This low functional performance seems to be the norm in patients with BD. However, studies are lacking to establish which clinical variables are associated with cognitive impairment, and what are the impacts of these impairments in BD **[35];[36];[37].** Thus,there are still few studies that compare the profile of the neurocognitive and functional performance of patients with BD in an euthymic phase, with less than 3 years of the disease onset (early), and with more than 10 years of the disease (late), in the above-mentioned category. Therefore, the objectives of this study are to determine a) whether there is any impairment of functionality and frontal neurocognitive functions between two different groups of 25 patients with BD I/II, in an euthymic state ($\leq$ 3 years since the diagnosis of BD since their first manic episode, and $\geq$10 years since the diagnosis of BD since their first manic episode) compared to healthy controls using FAST and FAB tests, respectively b) what is the nature and magnitude of this cognitive and functional impairment in euthymic bipolar patients at different stages of the disease onset c) whether there are differences in demographic, clinical, and pharmacological characteristics between the euthymic groups ($\leq$ 3 and $\geq$ 10 years of the disease) and the healthy control group d) if there is any cognitive deficit, which deficits are the most frequent in patients with ($\leq$ 3 and $\geq$ 10 years of the disease) during euthymia e) if the cognitive and functional deficits in euthymic patients ($\leq$ 3 and $\geq$ 10 years of the disease) are correlated with younger and older patients f) if cognitive and functional deficits in euthymic patients ($\leq$ 3 and $\geq$ 10 years of the disease) are correlated with study time g) research which category of cutoff scores prevails in the FAST and FAB tests between

euthymic patients (≤ 3 and ≥ 10 years of the disease) h) to correlate the variables in the FAB and FAST tests, and to assess whether the scores in the FAB test had an influence on the scores of the FAST test in both patient groups (≤ 3 years, and ≥ 10 years) which were diagnosed with BD since their first manic episode.

II.   METHOD

2.1 Ethics

This study was approved by the Research Ethics Committee of Universidade da Região de Joinville - UNIVILLE (protocol number 655.037) and followed the ethical rules of the Helsinki Declaration of 1975. All participants provided written informed consent before entering the study. Each patient underwent a clinical and psychiatric evaluation, where demographic, anthropometric, pharmacological data and clinical variables (age at onset, disease duration, number of episodes, number of hospitalizations, time since last relapse and hospitalization, history of suicide attempts, history of psychosis symptoms, rapid cycling history, and family psychiatric history), were collected.

2.2 Participants

The study evaluated 50 outpatients, with BD types I/II, in their euthymic state, who were recruited from the Porto Seguro Psychiatric Hospital, located in the city of Curitiba, Brazil. The participants were divided into three distinct groups, each one with 25 individuals: 25 euthymic BD patients in the early stage of disease (≤ 3 years since the diagnosis of BD from the first manic episode); 25 euthymic BD patients in the late stage of disease (≥ 10 years since the diagnosis of BD from the first manic episode), and 25 healthy controls. The groups were matched by age, gender, profession, marital status, and educational level. Most bipolar patients (84%) of this study participated in a psychoeducation program, which was implemented over the last four years. During sessions, patients are trained in strategies to be applied in their daily routines, as well as coping with stressful situations that present themselves as triggers for new crises.The treatment of these patients includes pharmacotherapy combined with psychoeducation, and some of them have psychological interventions **[38];[39];[40].** The psychiatric diagnosis of BD patients for types I/II was defined in the Manual Diagnosis and Statistics of Mental Disorders (DSM-V), and confirmed by Semi-Structured Clinical Interview, according to DSM-V (SCID-5-CV). Manic and depressive symptoms were assessed using the Young Mania Rating Scale (YMRS) **[41],** and the 17 items version of the Hamilton Depression Rating Scale (HAMD-17) **[42],** respectively. With HAM-17 scale, were evaluated depressive symptoms that had occurred within

the last week, and in YMRS, manic symptoms that had presented themselves within the last 48h. The cutoff scores used in the study were: YMRS > 7 as indicative of mania and, HAMD-17 > 7 as indicative of depression. This selection was made to minimize the bias of symptomatology on psychosocial functioning, which has been widely proven in the literature.

2.3 Criteria

The inclusion criteria of bipolar patients in the euthymic stage were: (a) the patients had been in euthymic phase at least six months (b) active age (18 - 60 years); (c) none of the patients had a history of addiction or substance abuse in last year; (d) no history of neurodegenerative diseases, cancer, morbid obesity or trauma (e) patients had no significant comorbid medical conditions, and did not receive medication in addition to those prescribed for their psychiatric condition; these should have been used for at least four weeks; (f) non-smokers (g) not pregnant or breastfeeding (h) patients were able to understand the procedures and protocol and provided written informed consent, and did not present cognitive impairment with disability or dementia, physical disabilities, e.g., visual or hearing impairing.

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

2.4 Demographic, Clinical, and Pharmacological Data

All this data was systematically obtained and included in the study. Demographic variables were age, gender, marital status, education level, employment situation, and years of education.Clinical variables were age at onset, illness duration (years), hospitalization and the duration of hospitalizations, suicide attempts, relatives' antecedents of mental diseases, and participation in a psychoeducation group.Also, some psychometric tests were included to

observe the following: to assess the manic symptoms we used the Young Mania Rating Scale (YMRS), and to evaluate the depressive symptoms we assessed the 17 items version of the Hamilton Depression Rating Scale (HAMD-17). To obtain information about functional impairment, we used the Functioning Assessment Short Test (FAST, and to assess frontal lobe functions we used Frontal Assessment Battery (FAB).

2.5. Neuropsychological Assessment

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

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

2.5.2. Functioning Assessment Short Test (FAST)

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

The FAST scores are evaluated through six functional domains: **Autonomy** (the capacity to make decisions and do things by oneself); **Occupational Functioning** (the capacity to maintain a paid job, the efficiency of performing tasks at work, working in the field in which the patient was educated and earning according to the level of the employment position); **Cognitive Functioning** (the ability to concentrate, perform simple mental calculations, solve problems, and learn and recall new information); **Financial Issues** (the capacity to manage one's finances); **Interpersonal Relationships** (relations with friends and family, involvement in social activities, sexual relationships and the ability to defend one's interests), and **Leisure Time** (the capacity to engage in sports or physical activities and to enjoy hobbies). Four categories were established in the FAST scale of functional impairment

cut-offs. No impairment: from 0 to 11 in the FAST total score. Mild impairment: from 12 to 20 in the FAST total score. Moderate impairment: from 21 to 40 in the FAST total score, Severe impairment: scores above 40 in the FAST total score.). However, patients are not static in a category after an intervention, either pharmacological or psychological, patients can interchange through categories [44];[51].

2.5.3. The Frontal Assessment Battery (FAB)

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

by adding the scores of the six subtests (maximum score =18). Any performance score of 18 to 15 indicates a frontal lobe without disabilities. A performance of 14 to 11 is considered a moderate impairment and below 10 is considered a severe impairment. These score cutoffs were validated to a Portuguese population **[54].**

The FAB test can provide an easier, more reliable, and quicker measure of EF, useful in initial assessments, or when available time and resources are limited. We know that there is variability in the different tests concerning the specificity for some of the different EF measured, in different pathologies **[55].** Nevertheless, this specificity is still low and has been pointed out as a limitation. Another issue is the relative usefulness of these executive screening tools in the different stages of neurodegenerative diseases since the progression generally occurs towards generalized deficits **[56].** Thus, the tests above can be useful for the differential diagnosis in the early stages of the disease (when combined with other measures), while their contribution in later stages may be more related to the description of the neurocognitive phenotype.

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

2.6. Statistical analysis

Demographic and clinical variables were analyzed using descriptive statistics, including (mean), and (standard deviation) for quantitative variables and absolute frequency (n), and relatives (%), for qualitative variables with a confidence interval of 95% in both cases. For the qualitative nominal and ordinal data, we used the Chi-square test ($\chi2$) of Pearson and for two or more groups, we used Fisher's exact test. Parametric and nonparametric tests were used for the analysis of qualitative variables. The assumption of normality and homoscedasticity of each variable was analyzed with the Kolmogorov-Smirnov

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

III.　　RESULTS

3.1. Demographic, Clinical and Pharmacological Characteristics

The demographic and clinical characteristics of the different groups studied were evaluated. The sample included 25 healthy controls, and 50 patients with BD divided in two groups of euthymic patients (≤ 3 and ≥ 10 years of the disease). Initially, it was calculated the sample size - difference between two independent means (two tails). The analyses showed an effect size d = 0.853; α = 0.05; power (1-β err prob) = 0.80; noncentrality parameter δ =2.89; critical t = 2.01; Df = 44; sample size group 1 = 23; sample size group 2 = 23; total sample size = 46; actual power = 0.808.

Thirty-six euthymic patients (72%) were female. The healthy control group had a mean age of (36.1 ± 9.87) and the euthymic patients analyzed had a mean age of (34.9 ± 10.04years in the group of ≤ 3 years of the disease), and (47.4 ± 8.21 years in the group of ≥ 10 years of the disease). Utilizing theone-way ANOVA followed by Dunn's post hoc test, the means of healthy controls and euthymic patients differ between ages ($p < 0.01$). Utilizing the Chi-square test, there was no difference between groups in gender, occupational status, and marital status ($p > 0.05$). Also, it was observed after performing the Chi-

square test followed by Fisher's exact test, that the groups significantly no differed in terms of their educational level (*p* > 0.05). The mean years of education were (14.7 ± 2.18) years in the healthy control group, and the euthymic patients analyzed had a mean of (13.8 ± 2.70years in the group of ≤ 3 years of the disease), and (12.4 ± 2.77 years in the group of ≥ 10 years of the disease). After performing the Kruskal-Wallis test, the groups significantly differed in terms of years of education (*p* < **0.01)** as seen in **Table 1.**

Table 1: Sociodemographic Characteristics of the Sample

	Healthy Controls n = 25	Bipolar Patients ≤ 3 years of disease n = 25	Bipolar Patients ≥ 10 years of disease n = 25	p - Value
Age, years [b]	36.1 (9.87)	34.9 (10.04)	47.4 (8.21)	P < 0.01 c
Gender, n				P = 0,77 a
Male	9	7	7	
Female	16	18	18	
Marital status n (%)				P = 0,08 a
Married	12 (48.0)	9 (36.0)	15 (64)	
Divorced	1 (4.0)	2 (8.0)	5 (20)	
Widowed	1 (4.0)	0 (0.0)	1 (4)	
Single	11 (44.0)	14 (56.0)	4 (12)	
Education n (%)				P = 0 ,13 d
Illiterate	-	-	-	
Up to primary school	0 (0.0)	3 (12.0)	4 (16.0)	
Up to high school	10 (40.0)	10 (40.0)	12 (48.0)	
Graduate	12 (48.0)	12 (48.0)	9 (36.0)	
Postgraduate	3 (12.0)	0 (0.0)	0 (0.0)	
Years of education [b]	14.7 (2.18)	13.8 (2.70)	12.4 (2.77)	p < 0,01 e
Work situation n (%)				P = 0,17 a
Employed	23 (92.0)	18 (72.0)	13 (52%)	
Unemployed	2 (8.0)	6 (24.0)	10 (40.0)	
Medical benefits	0 (0.0)	1 (4.0)	0 (0.0)	
Invalidity	0 (0.0)	0 (0.0)	2 (8.0)	

[a] χ^2 [b] *Mean (SD)*   [c] *One-way ANOVA followed Dunn´s post hoc*   [d] *Fisher's exact test*   [e] *Kruskal-Wallis*

The bipolar patients had a mean of disease duration of ≤ 3 years (2.52 ± 0.65), and ≥ 10 years (15.64 ± 6.81), and the mean age at onset of the disease was ≤ 3 years (22.1 ± 7.01), and ≥ 10 years (25.1 ± 6.17). Twenty patients (40%) had previously been hospitalized. Among these patients, the mean duration of hospitalization was (13.2 days ± 0.967), and patients with ≤ 3 years of the disease, attempted suicide 18 times, whereas the patients with ≥ 10 years of the disease attempted suicide 40 times. The family history of BD was positive in 23 patients. Regarding pharmacologic treatment, our results showed that 10 (20%) of the patients were on monotherapy. Among the patients on polypharmacy, 18 (36%), 16 (32%), and 6 (12%) of the patients received 2, 3, and 4 psychotropic medications, respectively. The percentages of mood stabilizers, antipsychotics, antidepressants, and benzodiazepines used

in patients according to their clinical symptoms, are presented in **Table 2.**To evaluate the absence of depression or mania in the samples, the HAM-D and YMRS tests were used in the healthy control group, and the euthymic patients' group respectively. The observed results had a mean HAM-D score of (4.32 ± 2.49) for the healthy control group, and (4.10 ± 2.02) for euthymic patients with ≤ 3 years of the disease, and (3.71 ± 1.46) for euthymic patients with ≥ 10 years of the disease. After performing the ANOVA one-way test, the groups did not differ (*p* > 0.05). Regarding the YMRS score, the mean was (0.64 ± 0.90) to the healthy control group, and (0.88 ± 1.01) to euthymic patients with ≤ 3 years of the disease, and (1.28 ± 1.13) for euthymic patients with ≥ 10 years of the disease. After performing the Kruskal-Wallis test the groups did not differ (*p* > **0.05)** as seen in **Table 2.**

Table 2: Clinical and Pharmacological Characteristics of the Sample

	Healthy Controls n = 25	Bipolar Patients ≤ 3 years of disease n = 25	Bipolar Patients ≥ 10 years of disease n = 25	p - Value
Illness duration (years) [a]	N/A	2.52 (0.65)	15.64 (6.81)	p < 0.001 d
Age of onset (years) [a]	N/A	22.1 (7.01)	25.1 (6.17)	p = 0.62 d
HAM-D total score [a]	4.32 (2.49)	4.10 (2.02)	3.71 (1.46)	p = 0.53 b
YMRS total score [a]	0.64 (0.90)	0.88 (1.01)	1.28 (1.13)	p = 0.08 c
FAST score, median (IQR)	9 (7)	22 (10)	23 (20)	p < 0.001 c
FAB score, median (IQR)	16 (3)	14 (4.5)	14 (3.5)	p < 0.001 b
Hospitalizations n (%)	N/A	12 (48)	8 (32)	
Duration hospitalizations (day) [a]	N/A	13.4 (24.3)	13.0 (36.6)	p = 0.90 d
Suicide attempts n (%)	N/A	18	40	
Family history of affective disorders n (%)	N/A	10 (40)	13 (52)	
Psychoeducation Yes, n (%)	N/A	21 (84)	20 (80)	
Treatment n (%)				
Lithium	N/A	13 (52)	15 (60)	
Other mood stabilizers	N/A	11 (44)	13 (52)	
Atypical antipsychotics	N/A	8 (32)	12 (48)	
Typical antipsychotics	N/A	2 (8)	0 (0)	
Antidepressants	N/A	7 (28)	7 (28)	
Benzodiazepines	N/A	2 (8)	7 (28)	

HAM-D 17 = Hamilton Depression Rating Scale; YMRS = Young Mania Rating Scale; FAST = Functioning Assessment Short Test
FAB = Functioning Assessment Short Test   IQR = interquartile range   N/A = not available   [a] Mean (SD)   [b] Anova one-way
[c] Kruskal-Wallis   [d] Mann-Whitney test

3.2. Functional Status and Neurocognitive Performance.

3.2.1. Healthy Controls versus Euthymic Patients

Initially, the means of the 25 healthy control group patients were compared with the 50 euthymic patients. The results of the general functional and cognitive assessments were measured by performing the FAST and FAB tests (mean ± SD), respectively. The means of the FAST test were (9.80 ± 5.94) and (24.6 ± 11.15), respectively; and it was observed after performing the *t*-test followed by the Mann Whitney test ($t = 6.195$; U= 126; $p < 0.001$). The means of the FAB test were (15.72 ± 1.64) and (13.68 ± 2.61), respectively and the results were observed after performing the *t*-test followed by the Mann Whitney test ($t = 3.567$; U= 310; $p < 0.001$). Through the FAST and FAB tests, we concluded that the patients with BD had greater functional and cognitive impairment than healthy controls, as seen in **Table 3** and **Figs. 1-2.** Our results are compatible with other research performed **[44];[50];[45];[67].**
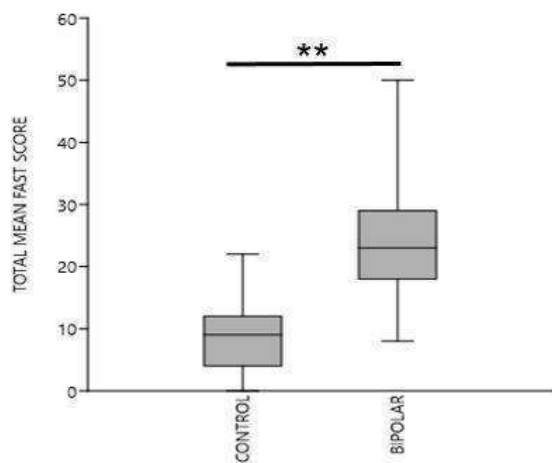
*Fig.1. Box-plot of total means (±SD) Functioning Assessment Short Test (FAST) score in Total BD patients (n=50) and their matched controls (n=25). Median levels are indicated by horizontal lines (Mann-Whitney: control vs. bipolar patients, ** p < 0.001)*
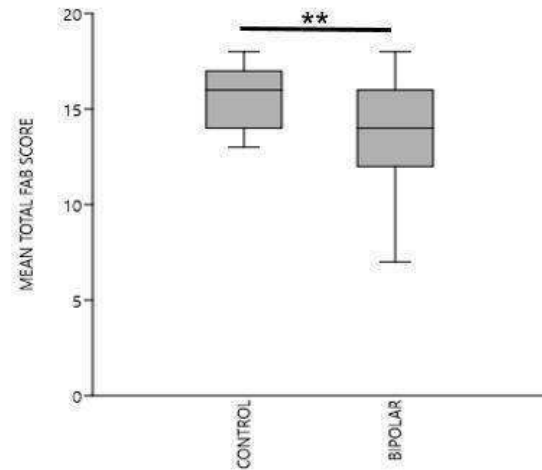
*Fig.2. Box-plot of total means (±SD) Frontal Assessment Battery (FAB) score in Total BD patients (n=50) and their matched controls (n=25). Median levels are indicated by horizontal lines (Mann-Whitney: control vs. bipolar patients, ** p < 0.001)*

Table 3: Mean Total of FAST and FAB Score in Health Controls and Euthymic Patients with ≤ 3 years and ≥ 10 years of disease

	Healthy Control n= 25	Euthymic Patients n= 50	t	U	p	d
FAST total score Means (± SD)	9.80 (±5.94)	24.60 (±11.09)	6.34	3.24	< 0.001**	-1.663
FAB total score Means (± SD)	15.84 (±1.64)	13.56 (±2.81)	3.56	2.50	< 0.001**	0.938

Note. Means ± standard deviation (SD). FAB = Frontal Assessment Battery FAST = Functioning Assessment Short Test. [*] indicate FAB and FAST scores significantly different between groups by t-test (t) and followed by Mann–Whitney test (U) for independent samples, d = Cohen's effect size. **p < 0.001

After this comparison, we divided the euthymic group (n= 50) into two groups (≤ 3 years (n= 25) and ≥ 10 years (n= 25) of the disease). The results of the general functional and cognitive assessments were measured by performing the FAST and FAB tests (mean ± SD), respectively. The total means of the FAST test score to the healthy control group was (9.80 ± 5.94) and the group with ≤ 3 years and ≥ 10 years of the disease were (20.6 ± 8.21 and 27.8 ± 12.50), respectively; and it was observed after performing the Kruskal-Wallis followed by de Dunn's post hoc test(*p<0.001*). Thetotal means of the FAB test score for the healthy control group was (15.84 ± 1.55), and the group with ≤ 3 years and ≥ 10 years of the disease were (14.6 ± 2.48 and 12.4 ± 2.78), respectively. The same results were observed after performing the Kruskal-Wallis followed by the Dunn's post hoc test(*p < 0.001*)as seen in **Table 4** and **Figs. 3-4.** Our results showed a significant difference between the groups which will be discussed later.
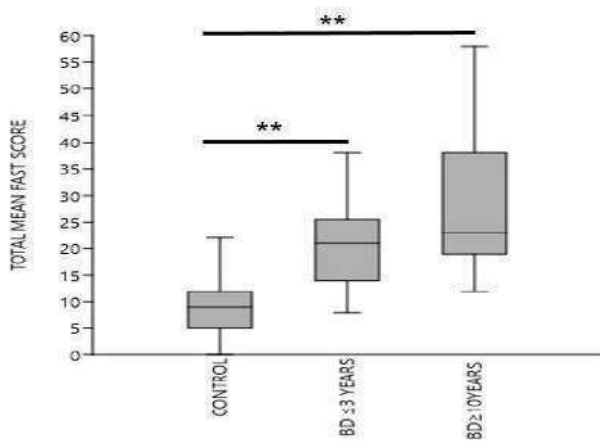
Fig.3. Box-plot of total means (±SD) Functioning Assessment Short Test (FAST) score between Healthy Control and Patients with ≤ 3 years of disease and ≥ 10 years of disease. Means levels are indicated by horizontal lines (Kruskal-Wallis followed by Dunn´s post hoc ** p < 0.001).
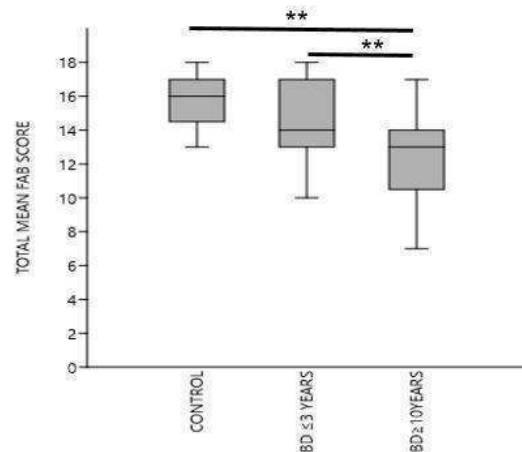
Fig.4. Box-plot of total means (±SD) Frontal Assessment Battery (FAB) score between Healthy Control and Patients with ≤ 3 years of disease and ≥ 10 years of disease. Means levels are indicated by horizontal lines (One-way ANOVA followed by Dunn´s post hoc ** p < 0.001).

Table 4: Mean Total of FAST and FAB Score in Health Controls and Euthymic Patients with ≤ 3 years and ≥ 10 years of disease

	Healthy Control n=25	Euthymic Patients ≤ 3 YEARS OF DISEASE n= 25	Euthymic Patients ≥ 10 YEARS OF DISEASE n= 25	p	f_2
FAST Means (± SD) [a]	9.80 (± 5.94)	20.63 (± 8.21)	27.80 (± 12.50)	< 0.001 **	0.7960
FAB Means (± SD) [b]	15.84 (± 1.55)	14.64 (± 2.48)	12.44 (± 2.78)	< 0.001 **	0.6042

Note. Means ± standard deviation (SD). FAB = Frontal Assessment Battery FAST = Functioning Assessment Short Test. [*] indicate FAB and FAST scores significantly different between groups. [a] Kruskal-Wallis followed by Dunn´s post hoc to FAST test **p < 0.001 [b] One-way ANOVA followed by Dunn´s post hoc to FAB test ** p < 0.001. f_2 =the overall Cohen's effect size

3.2.2. FAST and FAB score and age

Two variables presented a significant statistical difference between the groups; age and years of education, which will be discussed below. Based on previous results, our group decided to divide the euthymic group into two groups by age. For this purpose, we used the median age of the total euthymic patients (median = 41 years). Twenty-five patients were < 41 years old, and 25 patients were ≥ 41 years old, and the following results were observed. The results of the FAST and FAB tests were performed and were demonstrated for each euthymic patient group (< 41and ≥ 41 years old), respectively. The FAST scores between the group with < 41 years old, were (24.9 ± 11.72), and the group with ≥ 41 years old were (23.3 ± 10.60), and the FAB scores between the group with < 41 years old, were (13.6 ± 3.46), and the group with ≥ 41 years old were (13.7 ± 2.09) respectively. After performing the *t*-test, the FAST and FAB scores did not differ with the age groups between (< 41 and ≥ 41 years old). Thus this study showed that to be younger or older (age < 41 years and ≥ 41 years), did not differ in the total scores of the FAST and FAB tests. However, different authors observed that age could influence the results *p> 0.05*) as seen in **Table 5** and **Fig. 5-6.** Thus, this study showed that to be younger or older (age < 41 years and ≥ 41 years), did not differ in the total scores of the FAST and FAB tests. However, different authors observed that age could influence the results **[63];[77],** and it will be discussed later.

Table 5: Mean Total of FAST and FAB Scores in Health Controls and Euthymic Patients with median < 41 and ≥ 41 years old

	Euthymic Patients median < 41 YEARS n= 25	Euthymic Patients median ≥ 41 YEARS n= 25	*t*	F	*p* - Value	*d*
FAST Means (± SD)	24.9 (± 11.72)	23.3 (± 10.60)	0.50	2.73	$p > 0.05$ [a]	0.143
FAB Means (± SD)	13.6 (± 3.46)	13.7 (± 2.09)	0.44	2.73	$p > 0.05$ [a]	-0.034

Note. Means ± standard deviation (SD). FAB = Frontal Assessment Battery. FAST = Functioning Assessment Short Test. After performing the *t*-test *(t)*, the groups did not differ in age for independent samples. $p > 0.05$ *d* = Cohen's effect size
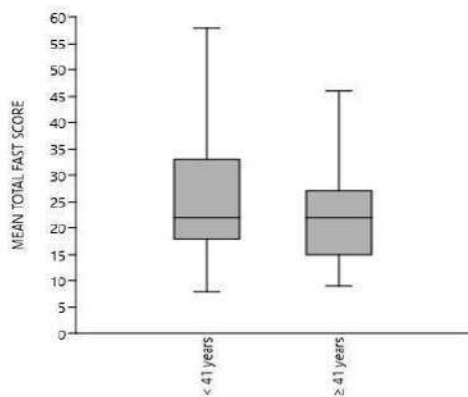
Fig.5. Mean Total of FAST Score in Euthymic Patients with Median < 41 and ≥ 41 years old
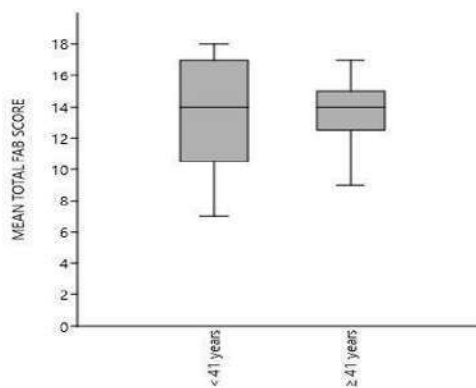
Fig.6. Mean Total of FAB Score in Euthymic Patients with Median < 41 and ≥ 41 years old

3.2.3. FAST and FAB score and years of study

In addition to age, another point that was assessed by our study and which may interfere in the FAST and FAB results, is the number of years spent studying. Various authors observed that the study time could influence the test results **[70];[68];[69].**

Our samples (healthy control patients and euthymic patients with ≤ 3 years and ≥ 10 years of the disease), presented a study time variation between (8 to 18 years). The mean total of years of study in the healthy control group, and in the groups with ≤ 3 years and ≥ 10 years of the disease, were (14.7 ± 2.18), (13.8 ± 2.70), and (12.4 ± 2.77) respectively. After performing the Kruskal-Wallis test the groups differed statistically(**$p < 0.001$**) as seen in **Table 1** and **Fig. 7.** The (means ± SD) of the FAST scores between the patientsgroup with ≤ 3 years and ≥ 10 years of the disease), were (20.5 ± 8.21) and (27.7 ± 12.50) respectively. After performing the *t*-test the groups differed in study time (*t* = 2.40; F = 2.41; **$p < 0.04$**). The (means ± SD) ofFAB scores between the patients group with (≤ 3 years and ≥ 10 years of the disease) were (14.6 ± 2.48), and (12.36 ± 2.76) respectively. After performing the *t*-test the groups differed in study time (*t* = 2.49; F = 1.25; **$p < 0.01$**), see **Table 6** and **Fig. 7.**
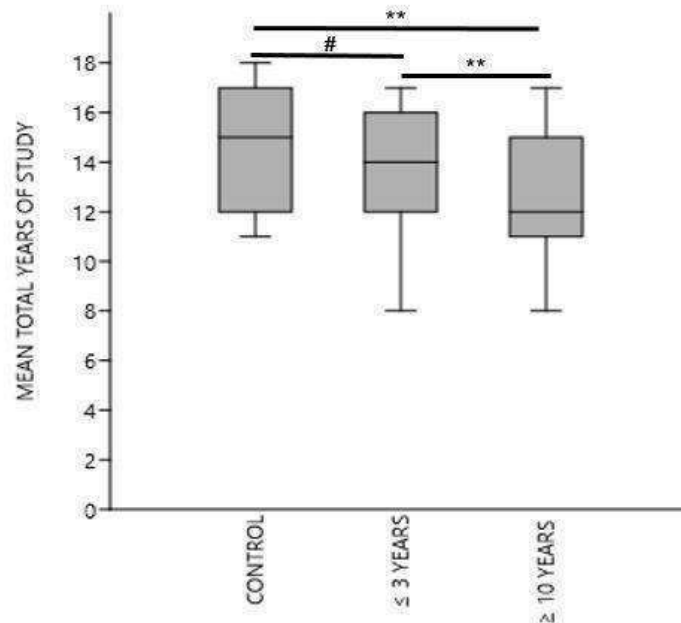
Fig.7. Mean Total of years of study between control group and Euthymic Patients with ≤ 3 years and ≥ 10 years. ** p < 0.001 # p > 0.05

Table 6: Mean Total of FAST and FAB Scores between Euthymic Patients with ≤ 3 years and ≥ 10 years of disease with the mean of years of study

	Euthymic Patients BD ≤ 3 YEARS n= 25 YEARS OF STUDY 13.84 (± 2.70)	Euthymic Patients BD ≥ 10 YEARS n= 25 YEARS OF STUDY 12.4 (± 2.78)	t	F	U	p - Value	d
FAST Means (± SD) [a]	20.5 (± 8.21)	27.7 (± 12.50)	2.40	2.31	209	p < 0.04 *	0.340
FAB Means (± SD) [a]	14.6 (± 2.48)	12.36 (± 2.76)	2.49	1.25	177	p < 0.01 **	0.417

Note. Means ± standard deviation (SD). FAB = Frontal Assessment Battery. FAST = Functioning Assessment Short Test. [*] indicate FAB and FAST scores significantly different between groups. [a] t-test (t) followed by Mann–Whitney test (U) for independent samples, *p < 0.05 **p < 0.01 f2 =the overall Cohen's effect size

Thus, this study demonstrated that the mean total of the FAST and FAB tests scores, differed significantly between the groups with (≤ 3 years and ≥ 10 years of the disease), related to the amount of years spent on education, as seen in **Table 6.**

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

As mentioned above, FAST and FAB tests have different scoring categories. These different categories demonstrate a greater or lesser severity in the patient´s functionality in their daily life using the (FAST) test, and impairment or non- impairment in the frontal cognitive activity, using the (FAB) test. **Tables 7-8** show the cut-off lines for the categories concerning functionality (FAST), and cognitive (FAB) impairments. **Table 7,**demonstrates that the majority of the euthymic patients (58%; n=29) presented a moderate level of impairment in the FAST test scores, both with ≤ 3 years (60%; n=15) and with ≥ 10 years (56%;

n=14) of the disease, when compared to the healthy control group where the majority were in the non-impairment group (76%; n=18). The same phenomenon was observed in **Table 8**; which also showed a moderate level of impairment in the FAB test scores, and an important number of euthymic patients (54%; n=27), as well as in the group with ≤ 3 years (52%; n=13) and the group with ≥ 10 years (56%; n=14) of the disease when compared to the healthy control group, where the majority were in the non impairment group (76%; n=18)(*p<0.01*). However,when we compared only the groups of euthymic patients with (≤ 3 years and ≥ 10 years of the disease) using the chi-square (χ2) test analysis, we observed that there was a significant

difference in the FAST test scores between the groups, but we did not observe the same concerning the FAB test.

Table 7: FAST total scale and the categories of functional impairment cut-offs

	Healthy Control N = 25	Euthymic Patients BD ≤ 3 YEARS n= 25	Euthymic Patients BD ≥ 10 YEARS n= 25	p - Value
FAST score				p < 0.0001 [a]
0 - 11 No impairment	18	5	0	
12 - 20 Mild impairment	5	5	7	
21 - 40 Moderate impairment	2	15	14	
41 - 60 Severe impairment	0	0	4	

(FAST) Functioning Assessment Short Test [a] χ^2 test

χ^2 Test p < 0.02

Table 8: FAB total scale and the categories of cognitive impairment cut-offs

	Healthy Control N = 25	Euthymic Patients BD ≤ 3 YEARS n= 25	Euthymic Patients BD ≥ 10 YEARS n= 25	p - Value
FAB score				p < 0.01 [a]
18 - 15 No impairment	18	8	5	
14 - 11 Moderate impairment	7	13	14	
10 - 0 Severe impairment	0	4	6	

(FAB) Frontal Assessment Battery Test [a] χ^2 test

χ^2 Test p > 0.05

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

Significant differences were found in all distinct domains of the FAST test between total euthymic patients (n = 50) and healthy controls (n = 25), showing the influence of BD over the functionalities. Specifically, patients showed a decrease in occupational, autonomy, cognitive and interpersonal domains, and also had the most significant statistical differences (*p< 0.001*), suggesting that these domains may be the most impaired. All effect sizes (*d*) were in the same direction, suggesting worse performance in the patient group than in the healthy control group, see **Table 9.**

Table 9: *Functionalities Assessed by the FAST Subtest in Total Euthymic Patients*

FAST subtests	Healthy Control n = 25	Euthymic Patients n= 50	*t*	F	*p* - Value	*d*
1. Autonomy	1.20 (±1.76)	3.32 (± 2.54)	3.52	2.20	*p* < 0.001 ** [a]	-0.916
2. Occupational Functioning	0.96 (±1.10)	5.48 (± 4.02)	5.03	14.93	*p* < 0.001 ** [a]	-1.407
3. Cognitive Functioning	4.00 (±2.25)	7.92 (± 3.36)	4.37	2.63	*p* < 0.001 ** [a]	-1.152
4. Financial Issues	1.32 (±1.49)	2.96 (± 2.20)	2.19	1.82	*p* < 0.04 ** [a]	-0.565
5. Interpersonal Relationship	1.24 (±1.56)	5.44 (± 4.47)	4.55	6.90	*p* < 0.001 ** [a]	-1.250
6. Leisure Time	1.20 (±1.22)	2.62 (± 2.39)	2.96	3.31	*p* < 0.01 ** [a]	-0.790
FAST total score	9.80 (± 5.94)	20.63 (± 8.21)	6.34	3.24	P < 0.001 **	-1.663

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

Using the data obtained from the evaluation of the subtests in all euthymic patients, the patients were divided into two groups (≤ 3 and ≥ 10 years of the disease) and were statistically evaluated. The analysis showed that there is no significant difference between the (≤ 3 and ≥ 10 years of the disease) groups, but there is a significant difference between the two groups comparing them with the healthy control group (*p*< **0.001**). As previously discussed, it was observed that the duration of the disease did not influence the results among euthymic patients; as seen in **Table 10.**

Table 10: *Functionalities Assessed by the FAST Subtest in Euthymic Patients with ≤ 3 years and ≥ 10 years of disease*

FAST subtests	Healthy Control n = 25 (a)	Euthymic Patients BD ≤ 3 YEARS n= 25 (b)	Euthymic Patients BD ≥ 10 YEARS n= 25 (c)	*p* - Value	Post-hoc analysis	*f2*
1. Autonomy	1.20 (±1.76)	3.32 (± 2.54)	3.16 (± 2.71)	*p* < 0.001 ** [a]	a < b a < c b ≈ c	0.405
2. Occupational Functioning	0.96 (±1.10)	5.48 (± 4.02)	5.16 (± 4.53)	*p* < 0.001 ** [a]	a < b a < c b ≈ c	0.579
3. Cognitive Functioning	4.00 (±2.25)	7.92 (± 3.36)	7.08 (± 3.95)	*p* < 0.001 ** [a]	a < b a < c b ≈ c	0.515
4. Financial Issues	1.32 (±1.49)	2.96 (± 2.20)	2.48 (± 2.00)	*p* < 0.01 ** [a]	a < b a < c b ≈ c	0.357
5. Interpersonal Relationship	1.24 (±1.56)	5.44 (± 4.47)	4.8 (± 3.76)	*p* < 0.001 ** [a]	a < b a < c b ≈ c	0.529
6. Leisure Time	1.20 (±1.22)	2.62 (± 2.39)	2.80 (± 2.19)	*p* < 0.04 * [a]	a < b a < c b ≈ c	0.354
FAST total score	9.80 (± 5.94)	20.63 (± 8.21)	27.80 (± 12.50)	P < 0.001 ** [a]	a < b a < c b ≈ c	0.796

Note. Means ± standard deviation (SD). FAST = Functionality Assessment Short Test. n.s. = no significant [a] Kruskal-Wallis followed by Dunn's post hoc to FAB test. [*] indicate FAST scores significantly different between groups. * $p < 0.05$ ** $p < 0.001$. *f2* =the overall Cohen's effect size

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

Our results demonstrated that significant differences were found in three distinct domains analyzing the FAB test scores between the total euthymic patients (n=50), and the healthy control patients (n= 25). Specifically, patients showed a decrease in Conceptualization, Inhibitory Control, and Sensitivity to Interference domains (*p*< 0.05),

suggesting that these domains may be the most impaired. All effect sizes (*d*) were in the same direction, suggesting worse performance in the patient group than in the healthy control group. Thus, in this study, we observed that the impact of BD, even in patients during a euthymic phase, was present in their cognition functions **[71],** as seen in **Table 11.**

Table 11: Neurocognitive Functions Assessed by the FAB Subtest in Total Euthymic Patients

FAB subtests	Healthy Control n = 25	Euthymic Patients n= 50	*t*	F	*p* - Value	*d*
1. Similarities (Conceptualization)	1.84 (± 0.85)	1.34 (± 1.08)	2.01	1.61	*p* < 0.04 * a	0.514
2. Lexical Fluency (Mental flexibility)	2.72 (± 0.46)	2.50 (± 0.61)	1.58	1.79	*p* > 0.05 a	0.407
3. Motor Series (Motor programming)	2.92 (± 0.28)	2.64 (± 0.72)	1.86	6.79	*p* > 0.05 a	0.512
4. Conflicting Instruction (Sensitivity to interference)	2.92 (± 0.54)	2.56 (± 0.77)	2.53	7.58	*p* < 0.01 * a	0.606
5. Go-No Go Task (Inhibitory control)	2.32 (± 1.14)	1.52 (± 1.50)	2.45	1.62	*p* < 0.02 * a	0.626
6. Prehension Behaviour (Environmental autonomy)	2.96 (± 0.20)	2.80 (± 0.60)	1.28	9.18	*p* > 0.05 a	0.202
FAB total score	15.84 (± 1.55)	14.64 (± 2.48)	3.56	2.50	*p* < 0.001 ** a	0.938

Note. Means ± Standard Deviation (SD). FAB = Frontal Assessment Battery. Analysis of FAB subtests scores by t-test (*t*) (F) for independent samples, *d* = Cohen's effect size. * *p* < 0.05 ** *p* < 0.001.

Using the data obtained from the evaluation of the subtests in all euthymic patients, we divided the patients into two groups (≤ 3 and ≥ 10 years of the disease) and were statistically evaluated. The analysis showed that there is no significant difference between the ≤ 3 and ≥ 10 years of the disease groups, but there is a significant difference between the group with ≥ 10 years of the disease and the healthy control group(*p*< 0.05). As previously discussed, it was observed that the duration of the disease did not influence the results among euthymic patients, as seen in **Table 12**.

Table 12: Neurocognitive Functions Assessed by the FAB Subtest in Euthymic Patients with ≤ 3 years and ≥ 10 years of disease

FAB subtests	Healthy Control n = 25 (a)	Euthymic Patients BD ≤ 3 YEARS n= 25 (b)	Euthymic Patients BD ≥ 10 YEARS n= 25 (c)	p - Value	Post-hoc analysis	f_2
1. Similarities (Conceptualization)	1.88 (± 0.88)	1.52 (± 1.15)	1.28 (± 1.02)	$p < 0.03$ * a	a ≈ b / b ≈ c / a > c	0.240
2. Lexical Fluency (Mental flexibility)	2.68 (± 0.47)	2.48 (± 0.58)	2.56 (± 0.65)	$p > 0.05$ a	n.s.	0.143
3. Motor Series (Motor programming)	2.92 (± 0.27)	2.84 (± 0.47)	2.48 (± 0.87)	$p < 0.02$ * a	a ≈ b / b ≈ c / a > c	0.323
4. Conflicting Instruction (Sensitivity to interference)	2.92 (± 0.27)	2.56 (± 0.77)	2.36 (± 0.95)	$p < 0.02$ * a	a ≈ b / b ≈ c / a > c	0.331
5. Go-No Go Task (Inhibitory control)	2.32 (± 1.14)	1.52 (± 1.50)	1.60 (± 1.41)	$p < 0.05$ * a	a ≈ b / b ≈ c / a > c	0.299
6. Prehension Behaviour (Environmental autonomy)	2.96 (± 0.20)	2.84 (± 0.47)	2.76 (± 0.72)	$p > 0.05$ a	n.s.	0.274
FAB total score	15.84 (± 1.55)	14.64 (± 2.48)	12.44 (± 2.78)	$p < 0.001$ ** a	a ≈ b / b > c / a > c	0.6042

Note. Means ± standard deviation (SD). FAB = Frontal Assessment Battery. n.s. = no significant [a] Kruskal-Wallis followed by Dunn´s post hoc to FAB test. * $p < 0.05$ ** $p < 0.001$. f_2 =the overall Cohen's effect size

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

Fig. 8 displays the impact of cognitive function (FAB test) of euthymic patients on functionality (FAST test). The correlation between frontal cognition and functionality was analyzed through the scores of the FAB and the FAST tests in euthymic and healthy control patients, using the Spearman Correlation Coefficient. Although only a small number of samples of euthymic patients were used (n=50) and healthy control (n=25), it was possible to observe a negative Spearman Correlation Coefficient, after assessing normality using the Shapiro-Wilk test. The correlation presented a moderate intensity **(r^2= -0.539)** to euthymic patients and a very weak correlation in healthy control **(r^2= -0.106).** This correlation between the variables FAB and FAST, demonstrated that euthymic patients who have lower scores on the FAB (decreased frontal activities and EF), had higher scores on the FAST (with greater loss of functionality). Since **r^2= -0.539**, it represents a moderate correlation, the FAB variable alone is not able to explain the total FAST variability. However, the sample results provide significant statistical evidence between FAB and FAST **(p< 0.0001).**Regarding the healthy control group, we did not find a significant correlation, **(p > 0.05).** Furthermore, it is important to remember that the correlation coefficient (r^2) is only an estimate of the population correlation coefficient (p), and we should not forget that the value of r is calculated based on some data pairs constituting random samples. Often the points in the sample may show a correlation, even though the population does not, in this case, we are facing an inference problem, since r ≠ 0 is not a guarantee that p ≠ 0.
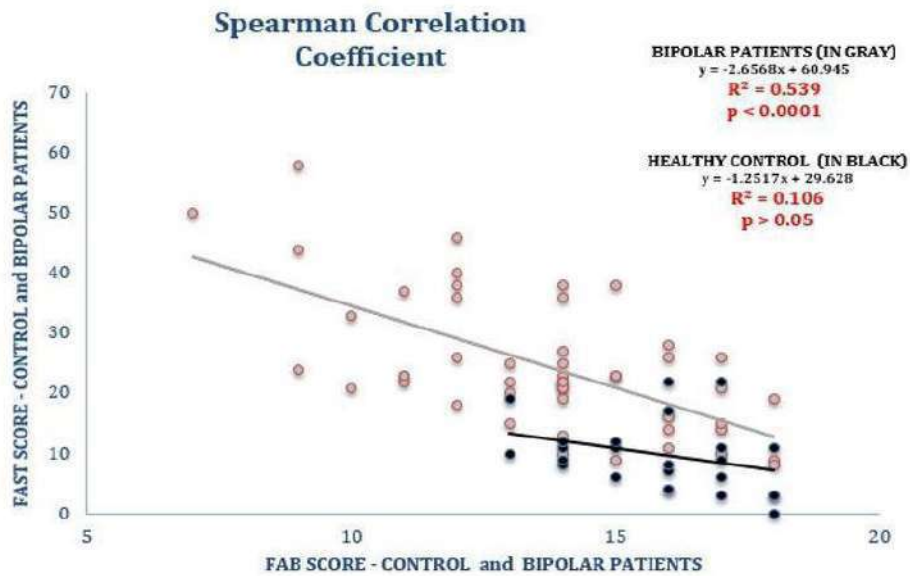
Fig. 8. Correlation between FAST and FAB test scores in healthy control (n= 25) (in black) and euthymic patients (n=50) (in gray), using the Spearman Correlation Coefficient.

The total group of euthymic patients was separated into two groups (≤ 3 years and ≥ 10 years of the disease), and later performed the Spearman correlation, where it was observed that the same negative correlation trend remained present, with (r^2=0.226;p< 0.001)in patients with ≤ 3 years of thedisease and (r^2= 0.352; p<0.001) in patients with ≥ 10 years of the disease.These results reinforce previous results whichthe correlation between the variables FAB and FAST, demonstrated that euthymic patients who have lower scores on the FAB test (decreased frontal activities and EF), had higher scores on the FAST (with greater loss of functionality), how as seen in**Fig. 9**.
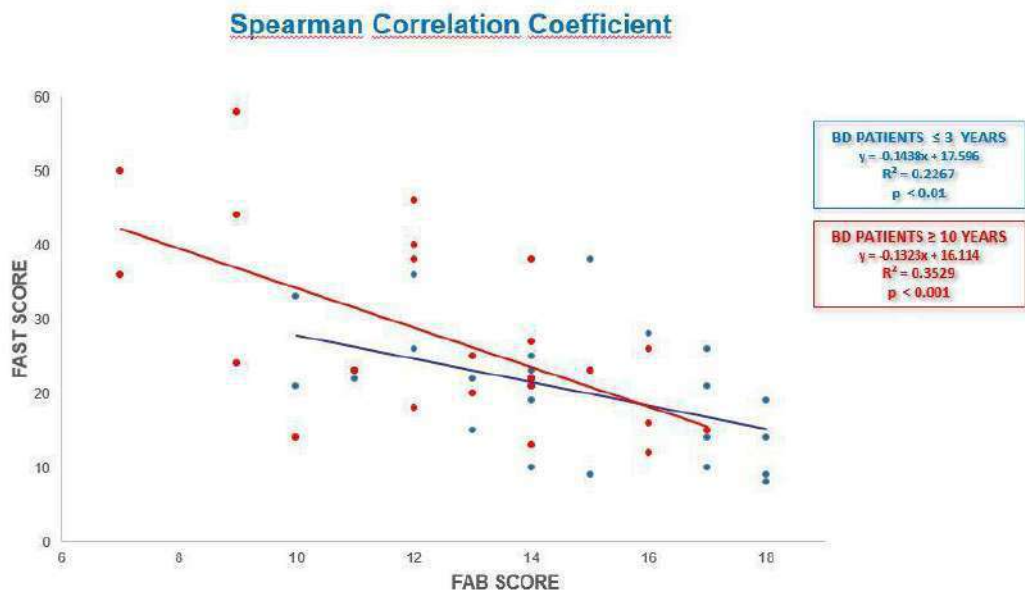
Fig.9. Correlation between FAST and FAB test scores between BD patients ≤ 3 years (in red) and ≥ 10 years of disease (in blue), using the Spearman Correlation Coefficient.

IV. DISCUSSION

Recently, our research group published an article on the assessment of impairment of functionality and executive functions in different domains, in 50 euthymic patients with BD I / II, using the FAST and FAB tests **[75].**In the present article, we evaluated 50 euthymic patients, but with different times of disease onset. A group (n =25) with ≤ 3 years of the disease and a group (n=25) with ≥ 10

years of the disease were evaluated. The current results found in this study were compared and discussed referring to previous research, and the results found were interesting, and produced a rich discussion. Initially, in this research, we have tried to apply standardized strict criteria for euthymic and the control group. We wanted to reduce the biases related to this research, as much as possible. The safety measurements, criteria, and diagnosis of the disease, as well as the sample of bipolar patients who had been in the euthymic phase for at least six months, resulted in more accurate data. The rigor in the application of all the tests used by our highly trained staff eliminated any dubious interpretation or results of FAST and FAB. In a meta-analysis, Rocca and Lafer **[72],** showed that many previous studies had not expressed this concern with standardization, producing a considerable variability in the results found **[73].** Despite the meticulous application of the tests by the staff; some biases were still present, e.g., the small number of patients in each group, the heterogeneity of the population, their educational level, as well as the diversity of medications used by patients, which may produce different effects on cognition. Another relevant point that was considered when analyzing the bipolar patients' cognitive abilities, was their age. Numerous age-related changes in cognitive abilities are significant to the everyday activities of the patients. According to Petersen **[74],** studies of the neurophysiological processes on cognitive performance have shown that cognitive skills reach their maximum point at the age of 30 and remain stable until they start to decline between 50 and 60 years old. Many studies demonstrated lower cognitive levels during aging **[76];[77];[78];[79].** This physiological decline in senescence is due to neuro-anatomical changes that cause a degradation of the brain structure. However, this decline in cognitive functions is not uniform. Functions such as the ability to communicate through language, the use, and definition of words; evocation and knowledge of general culture; practical or social reasoning; remain stable during their lives. However, they have difficulties in understanding long and complicated phrases, quickly forgetting specific names or terms, sometimes generating a more repetitive speech; difficulty in understanding organized and logical analysis of unfamiliar or abstract material. Performance in the planning, execution, and evaluation of complex scales of behavior and performance of new and fast perceptual-motor tasks, is also impaired **[74];[80];[75];[81];[82]**. For this reason, we only included patients with a maximum age of 60 years old, trying to reduce any bias related to the cognitive test results, both in the natural and pathological aging process.

By utilizing these strict criteria adopted for the inclusion of bipolar patients in our study, we observed significant statistical results after the application of the FAST and FAB tests. The results obtained in all euthymic patients (n=50), **see Figs. 1-2** and **Table 3,** showsome similarities in the subgroups (early (n=25) and late-onset (n=25) with ≤ 3 years and more than ≥ 10 years of the disease as shown in **Figs. 3-4** and **Table 4.** The same was observed for the different domains of the tests applied as shown in **Tables 9-10-11-12**. In the FAST test, we observed a significant decrease in the functional capacity of bipolar patients in all domains, which made us realize the impact of the disease and the patients' daily lives. These results are related to previous studies in the literature, where several authors also observed the same results **[24];[83];[84];[85];[67].** Furthermore, Bonnín et al. **[25],**evaluated a total of 32 clinically and neuropsychologically euthymic bipolar patients at baseline. After a median follow-up of 4 years, they were interviewed with the FAST test to assess functional outcomes. They observed that depressive symptoms together with neurocognitive impairments were related to verbal memory and that EF were variables that functioned as predictors for long-term functional outcomes in BD. Our study observed a result that remained present in all subtests of the FAST test when we compared the two groups of bipolar patients with different durations (≤ 3 and ≥ 10 years of the disease) and with the healthy control group. The two groups of euthymic patients showed a very significant difference from the control group in all subtests, but there were no changes in the groups with different disease durations. This data allowed us to raise the hypothesis that changes in functionality already occur since the onset of the disease, and continue over the subsequent years. Our results also corroborate with the present literature, where the subtests (autonomy, occupational functioning, cognitive functioning, and interpersonal relationship), seem to present the greatest impacts. In a recent categorical meta-analysis that included 11 other studies, with a total sample of 1083 patients, the prevalence of global functional impairment was 58.6%.Regarding specific domains, the meta-analysis showed a prevalence of impairment in the following domains: 65.6% in occupational, 49.2% in cognitive, 42.6% in autonomy, 42.1% in interpersonal relationships, 29.2% in leisure, and 28.8% in the field of financial issues - all of them statistically significant **[86].** Regarding the FAB test, and confirming one of our initial hypotheses, we observed a similar phenomenon. The FAB test performance in our study presented significantly worse scores in the following domains: similarities (conceptualization), conflicting instructions (sensitive to interference), and go/no-go (inhibitory control), which

demonstrated a significant executive dysfunction in all (50) bipolar patients as shown in **Table 11.**However, when we divide these patients into two distinct groups with ≤ 3 years and ≥ 10 years after the onset of the disease, we can observe that a phenomenon is repeated in the analyzed data. The analyzed group with less than ≤ 3 years of disease, despite presenting lower mean values of scores in all domains compared to the control group, were not significant. However, when we compared the mean scores of the domains in patients with more than ≥ 10 years since the onset of the disease with the control group, we found a decrease in the FAST test scores in all domains, however, it was statistically significant in the following domains: similarities (conceptualization), conflicting instructions (sensitive to interference), go/no-go (inhibitory control) and motor series (motor programming) as shown in**Table 12**. These data reinforce the idea that the cognitive loss occurs gradually through the years, raising the hypothesis that the impact of the disease already is observed at the beginning of the disease, with probable neuroanatomical and possibly biochemical alterations due to the process of neuroinflammation and neuroprogression of the disease. Thus, our results as shown in **Table 11-12**, reinforce the idea that EF alterations have a significant impact on the daily functionality of these patients. Since few studies up to date used the FAB test for patients with BD, we found it difficult to correlate our results with previous studies. For this purpose, we compared the results found in other studies, researching different psychiatric pathologies with altered EF, which also observed similar results **[17];[18];[19].** However, our results differed from other studies that also evaluated the components of EF in euthymic patients with BD, and who performed poorly in mental flexibility, unlike our study **[88];[89];[90].** Furthermore, other domains such as inhibitory control **[91],** and conceptualization **[29];[90],** remained preserved in these studies, nevertheless were different from our results. Even so, our results are in line with previous studies demonstrating a substantial proportion of bipolar patients who experienced unfavorable general functioning, and present a significant degree of morbidity and dysfunction associated with BD, even during euthymic periods **[37];[92].** In another study on the relationship between cognitive and occupational function in euthymic patients, it was reported that, over six months, cognitive measures at the time of symptomatic recovery, particularly in the domains of working memory/attention and processing speed, were strongly associated with concurrent occupational recovery **[87].** These findings suggest that a decline in cognitive function over time may be accompanied by a functional decline in occupation despite the euthymic state of the patients. Data from two meta-

analyses demonstrated that cognitive changes persist during euthymia; even though there is a variation in the results concerning the domains involved, and the effect size produced **[93];[16]**. There are many discrepancies between authors regarding the performance in many different neuropsychological tests related to EF by bipolar patients. For example, patients in the manic phase may have difficulty adapting to conceptual changes, as can be seen in the Trail Making Test, as well as, during the depressive phases, demonstrating that bipolar patients have a poorer performance especially in verbal fluency tests when compared with unipolar patients. Also, in the euthymic phase, changes in EF were observed with several persevering errors in the Wisconsin Card Sorting Test. Thus, using different tests, to assess the EF, it was observed that the degree of commitment and the size of the effect can be quite diverse between the various domains.In summary, different EF were not equally impaired in euthymic BD patients **[94];[95];[96].** It became significant in our research because we tried to evaluate the possible confounding variables that could interfere with the result found in the correlation between the FAB and FAST tests. A characteristic of the confounding variable is that it influences both the dependent and the independent variables, which can cause a spurious association. In our study, clinical variables such as (gender, age, length of illness), showed little effect on executive performance, except the study time, which showed some correlation with the FAB test as seen in **Fig. 10**, which will be discussed next.

As previously described, this research showed that there are significant differences in years of study between healthy control patients and euthymic patients as seen in **Table 1**. The average years of studies showed that the more the disease progresses, the shorter the study time. This data seems to reflect the impact of the disease on the cognitive functions of patients as seen in **Fig.3-4-7,** and consequently the functionalityof the patients. When comparing the two groups (≤ 3 years and ≥ 10 years of the disease) we can observe the permanence of statistical differences between them, as seenin**Table 4**, reinforcing the hypothesis that the disease has a strong impact on the patient's life, since the beginning. However, our study did not take into account some significant variables, as described by Shoeyen et al. **[97],**whoobserved that the main clinical variables that were significantly associated with lower levels of education in euthymic patients, were associated with: the age of the patient during his/her first episode, the number of rapid cycling, and who had more than four depressive episodes. To resolve this issue, our group is starting a new study where these variables reported above will be included and evaluated. Another

point that was observed was the level of education between the groups. While the control group had the majority of subjects (60%) with graduate and postgraduate education, the euthymic patients with ≤ 3 years of the disease, presented a level of education up to high school and graduated (84%), and euthymic patients with ≥ 10 years of the disease, presented a level of education up to high school and primary school (66%).Ourfindings are similar, compared to a nationwide Danish register study [98], reporting lower educational levels in BD compared to the general population. In a survey that compared bipolar patients to a healthy control group, where IQ levels were similar, it was observed that patients with BD completed fewer years of education than controls. Although more than 60% of both groups entered college, only 16% of bipolar patients received a university degree. In contrast, 47% of control patients completed college. Although the educational level did not differ between patients who started the disease earlier or later, nor due to substance abuse [99]. Another research demonstrated that more education and shorter illness duration remained significantly associated with functional recovery. One more year of education was associated with a 1.45 times higher chance of functional recovery, and being ill one year longer was associated with a lower chance of functional recovery [100]. More recently, Baune and Malhi, [101], observed a slightly different result, where patients with BD had the same level of education, however, had a significantly lower social and occupational function than the general population. Curiously, in our research, we also observed a shorter time concerning the years of education in the bipolar patients, which produced a greater impact on occupational activities; as seen in **Table 1**. Thus, the level of education is interrupted due to crises during BD, and the reduction in the level of education may contribute to the later functional disability in this disease. Thus, many studies showed that there is an inverse correlation between the degree of education with the social, occupational function, and risk of disability [102];[103];[104]. Also, other studies had shown that bipolar patients' household income was below 10%, and many of them were on disability pension in comparison with the general population, [98];[105];[106]. Thus, our results are according to literature reinforcing the previous studies.

Another variable related to cognitive functions and functionality is age. It was interesting to note that our study did not observe an association between the loss of functionality (FAST), and cognitive functions (FAB), comparing the age of the patients, as can be seen in **Table 1-5; Figs. 5-4.** Although there was a difference in the mean age between the groups of euthymic patients (≤ 3

years and ≥ 10 years of the disease) which can be observed in **Table 1.** When we adopted a median (< 41 and ≥ 41 years old) by comparing the younger euthymic patients with the older ones, we did not observe any important differences, which supports our hypothesis that it might not be the age of the subjects studied that will determine the effect on the FAB or FAST tests, but most likely the time of having the disease. We know that many of the younger patients (< 41 years old) in our euthymic group have had the pathology for more than 10 to 15 years, while many older patients (≥ 41 years old) had recently been diagnosed with the disease; less than two or three years ago. Again we need to better clarify the issue of the impact of the number of crises of depression and mania on the evolution of the disease, by collecting more data, although it was not our initial intention. Thus, our partial results are supported by many authors in the literature that showed cognitive deficits, including EF, memory, and attention, and do not seem to be strictly a later effect caused by the years of the disease. Furthermore, it showed that young people who had a recent manifestation of BD, had cognitive deficits that resemble that of older patients, and these deficits can be observed even during euthymia [107];[78];[108];[109]. Recently, in important research, Martino et al. [110],evaluated a sample of 51 euthymic bipolar patients, who were followed up for a mean period of 73 months. They suggested that the longitudinal trajectory of cognitive deficits in BD is relatively independent of the number of episodes or time spent ill, and there were no differences between these patient groups in any clinical or neurocognitive variables at baseline. Also, Pavuluri et al. [111], followed pediatric patients with BD for 3 years. They observed that all neuropsychological profiles remained impaired, especially EF and verbal memory even though the patients were treated and in remission. In a meta-analysis of pediatric patients with BD, it was concluded that the effect sizes of the tests in the different domains indicated greater deficits among the BD group, compared to the healthy controls, although they varied greatly in the effect size. i.e. verbal learning and memory ($Z = 4.65$, nine studies); EF ($Z = 4.07$, nine studies); and attention ($Z = 3.81$, eight studies) [112]. However, our results differ from other researchers showing controversies in the literature about the cognitive impairment associated with BD. In a meta-analysis, Samamé et al. [113], described that bipolar patients' performance in 14 cognitive measures remained stable after a mean follow-up period of 4.62 years. When the meta-analysis was restricted to controlled studies, no patient-control differences were found regarding longitudinal cognitive outcomes. Also, Cacilhas et al. [114], found a significant correlation between age and

functionality through the FAST test in BD patients. They demonstrated that BD was an important effect modifier on the natural age effects in general functioning, further characterizing BD as a chronic and impairing disease.

We must remember that this study was conducted with a clinical sample (or prevalence sample), which might tend to overestimate the morbidity, cognitive deficits, and functionality of patients with BD. We included in our sample patients with less than two years and more than ten years of length of illness and with very different numbers of previous affective episodes. We must also point out that, in our work, we use BD I / II patients in the same group. However, meta-analyses indicate that people with BD II also have cognitive deficits in the same way, but slightly less severe than those seen in BD I **[115];[116].** Possibly, the results of our tests would have been different if we had categorized our population into two subgroups (type I and type II). Concern to the patients with BD I may reflect greater severity of the disease symptoms, and therefore the effects of drugs such as mood stabilizers and antipsychotics, which are more commonly prescribed for BD I than II, and in larger doses, would produce iatrogenic effects in their EF, as noted by Balanzá-Martínez et al. **[117],** and with greater impacts on verbal memory and processing speed as well. However, whether these discrepancies are partly related to the long-term treatment of these patients or not, is not yet fully understood. A study demonstrated that patients treated with antipsychotics had worse results in the Trail Making Test **[118].** However, in another study with a sample of 44 bipolar patients on monotherapy with lithium, it was found that changes in EF, especially in domains that required inhibitory control, were independently related to the severity of symptoms and the medication used **[119].** Also, another longitudinal research with a sample of 15 euthymic patients treated with lithium monotherapy, were assessed for cognitive impairment twice over a 2-year follow-up. Repeated measures showed that the euthymic group was cognitively impaired in EF, which was the main long-term neuropsychological deficit of BD, though it did not worsen over 2 years. Furthermore, the results showed that the persistence of these cognitive deficits did not appear to be influenced by any clinical or pharmacological variable, remaining stable over time **[102].** A possible alternative hypothesis of our findings is that the common cause of cognitive deficits and adverse clinical course is determined by some pathophysiological alteration (i.e. neurodevelopmental abnormalities) underlying different subgroups of patients with BD. This hypothesis is supported by the involvement of the prefrontal cortex and prefrontal–subcortical pathways, which regulate both mood state and cognitive functioning, and might

predispose to a greater magnitude of cognitive deficits and frequency of episodes **[120];[121].** In contrast, another subgroup of patients without such factors might have relatively preserved cognitive functioning and a lower number of affective episodes. **[122];[123];[124];[125].** To better relate the meanings of these clinical and cognitive changes reflected in the FAB test, we needed to initially discuss and relate the neuroanatomical and pathophysiological changes with the results found. Several studies are linking the impact of different psychiatric illnesses on brain functioning, and its architecture **[126];[127];[128].** Research has shown that BD presents a cyclical and recurrent course. More recently, pathophysiological changes in the brain have been observed, raising the hypothesis that this is a progressive, chronic and disabling disease. The concept of neuroprogression appears to explain this phenomenon, but this concept is still surrounded by controversy **[128];[129];[8];[9].** However, if there is an increase in the allostatic load, it produces a cumulative physiological dysregulation related to the dysfunction of the hypothalamic-pituitary-adrenal axis, altering immunity, thereby activating pro-inflammatory mechanisms with subsequent activation of oxidative stress states **[130].** With this sequence of phenomena, an inflammatory environment is created, inducing a significant risk of cognitive decline **[131];[132];[133];[134].** As previously reported, all these events involve a pathological reorganization in the brain, and therefore, are associated with morphological modifications, such as the volume reduction in the cortex and white matter of the prefrontal cortex **[135];[136];[137];[138];[139].** These prefrontal cortex alterations are possibly secondary to multiple episodes of mania and depression during their lives. In addition to these multiple episodes, the number of hospitalizations and disease duration in bipolar patients might cause changes in their neurocognitive performance, with an impact on their daily functionality and psychosocial aspects **[4];[5];[6];[140].** These structural alterations in the prefrontal cortex, produce cognitive deficits associated with an inferior functional state, similar to what occurs to some neurological patients, indicating that some of the functional impairments frequently reported by BD patients, may be due to cognitive impairment, which may be a vulnerability factor for BD, and can present itself before the onset of the disease and worsen with the progression of the same **[141].** The prefrontal cortex is a heterogeneous region that comprises several specialized sub-regions, in which EF represents only one functional category within the lobes **[142].** This is a region that communicates with the entire brain, receiving and sending projections of all types. It integrates with the

limbic system, reticular system, hypothalamus, and neurotransmitter systems **[143]**, involving the amygdala, the dorsolateral prefrontal cortex, insula, and anterior cingulate areas **[144];[145];[146];[147];[128];[139].** Through neuroimaging, had been possible the comprehension of the neural structure and function underlying cognitive processes and it was possible to differentiate the areas of the prefrontal cortex responsible for the different components of EF, with three main regions: the orbitofrontal, the ventromedial, and the dorsolateral region. The orbitofrontal region projects into the caudate nucleus and is responsible for the inhibition capacity. An injury is characterized by personality change, including behavioral disinhibition and emotional lability. The ventromedial region begins in the anterior cingulate cortex and projects to the nucleus accumbens, mediating motivational behavior. An injury is associated with a decrease in motivation, causing apathy, indifference to pain, lack of motor and psychic initiative. The dorsolateral region projects into the caudate nucleus. Usually, this region is associated with components of EF, namely verbal fluency, cognitive flexibility, planning, decision making, inhibitory control, working memory, reasoning, problem-solving and abstract thinking. An injury in this area, leads to the inability to maintain attention, persevering thoughts, impaired reasoning as well as deficits in mental flexibility **[148];[149];[150];[151].** The same authors observed that the neuropsychiatric manifestations are related to neurocircuitry defects. Impaired EF, impulsivity, and apathy, are characteristics of frontal-subcortical circuit dysfunctions, and neuropsychiatric disorders, such as attention- deficit/hyperactivity disorder, obsessive-compulsive disorder, schizophrenia, and also BD might result from compromised integrity and functioning of these areas and projections. Recently, several researchers have sought to relate the six domains present in the FAB test, with different neural networks, demonstrated in **Table 13,** **[54];[152];[153];[154];[155];[156];[157].** In this study, the anatomical lesions were correlated with all the FAB subtests. Executive dysfunctions and impairment in working memory are related to lesions in the prefrontal dorsolateral cortex. Abulia and apathy are related to lesions of the ventromedial cortex, and disinhibition and mood disorders are related to the orbitofrontal cortex. When applied to the FAB subtest, the conceptualization was more related to the dorsolateral region. The results of the conflicting instructions, and go-no-go subtests, were related to the ventromedial and orbitofrontal cortex respectively. These results found in our work are fascinating because each different region of the prefrontal cortex showed an altered subtest as seen in **Table 13**. Also, a large number of these symptoms described above are observed daily during the care of bipolar patients, mainly during manic and depressive phases. However, the bipolar patients in our study were more than six months in euthymia. Even so, the results showed us significant losses in all functionality domains, as well as in some cognitive domains found mainly in EF as seen in **Table 10-12.** Some cognitive impairments persist even after remission of the symptoms, and many studies have shown that they are neuropsychologically related, at least in part, to the psychosocial difficulties of these patients **[91];[88];[158].** On the contrary, there is little data in the literature about the use of the FAB test in bipolar patients, and it is difficult to correlate this data with the anatomical lesions analyzed. Therefore, further studies using the FAB test are necessary, to better comprehend these results. It is important to note that changes in the connections between the involved structures are critical in the emotional dysregulation and cognitive functions in BD. Researchers observed that some abnormalities in some components of these neural systems are more apparent in adolescence, while other prefrontal regions appear to progress more in young adulthood, suggesting a neurological development model for this disorder **[159];[160];[37];[138];[109].**

Table 13: Prefrontal cortex regions, projections, behavioral mediation and injury, correlate to different domains assessed by the FAB test in Bipolar Patients and their respective level of significance.

PREFRONTAL CORTEX REGIONS	PROJECTIONS	BEHAVIORAL MEDIATION	FAB TEST CORRELATION	p – value of FAB subtests	INJURY
Orbitofrontal	Caudate Nucleus	Inhibition Capacity	Go-No Go Task (Inhibitory control)	$p < 0.05$ *	Behavioral Disinhibition and Emotional Lability
			Prehension Behaviour (Environmental autonomy)	$p > 0.05$	
Ventromedial	Accumbens Nucleus	Motivational Behaviour	Conflicting Instruction (Sensitivity to interference)	$p < 0.02$ *	Apathy Abulia
Dorsolateral	Caudate Nucleus Basal Ganglia	Executive Functions	Similarities (Conceptualization)	$p < 0.03$ *	Verbal Fluency Cognitive Flexibility Planning Decision Making Inhibitory Control Problem-Solving Abstract Thinking
			Lexical Fluency (Mental flexibility)	$p > 0.05$	
			Motor Series (Motor programming)	$p < 0.02$ *	
Dorsolateral	Hippocampus	Memory	not valued	--	Working Memory

Although BD is related to cognitive deficits, these deficits do not appear to be universal. It is estimated that about 30% of BD patients in remission will have levels of cognitive performance within the normal range [161];[162]. Also, longitudinal studies have shown that fluctuations in mood states do not seem to explain many of the cognitive deficits during euthymia [163];[164]. Thus, it becomes imperative to define whether the cognitive impairment presented during euthymia, precedes the onset of the disease, that leads to the hypothesis of alterations in the neurological development, or whether it results from the negative impact of BD on cognition that corroborates the theory of neurodegenerative process (neuroprogression). Some researchers believe in the coexistence of the two hypotheses. From a neuropsychological point of view, longitudinal studies that last more than one year, are practically non-existent, which makes it challenging to confirm the cognitive impairment and determine whether it is stable or progressive [165];[166];[35];[167];[8];[9]. One of the longer longitudinal studies with bipolar patients was performed by Santos et al. [83] which assessed the performance of 80 euthymic outpatients, using a group of neuropsychological tests and demonstrated that cognitive deficits in BD were stable during a follow-up after five years, except in verbal memory, showing that the clinical course during a second follow-up period (longer than 5 years), did not influence the course of cognitive dysfunction. Our research confirmed this same hypothesis raised by the authors above. The changes that occurred both in the functional and cognitive functions showed slight differences in the means of the FAB and FAST tests between the groups of ≤ 3 years and ≥ 10 years of the disease. However, there was a significant difference between control patients and the group that developed the disease more recently. This phenomenon reinforces the idea that the clinical course of the disease did not influence the course in the functionality and cognitive dysfunctions. Another important study conducted by Mora et al. [104], which followed up a group of euthymic bipolar patients by 6 years, and evaluated the functionality through the FAST test, observed that among the clinical factors, longer illness durations were significantly related to slow processing, whereas strong relationships were observed between impoverished cognition and poorer psychosocial functioning over time. Although cognitive deficits remained stable on average throughout the follow-up, they had enduring negative effects on the psychosocial adaptation of the patients. Thus, we can hypothesize that patients with greater cognitive impairment are less able to maintain the treatment of their disease, stopping the use of medications, the clinical and psychotherapeutic follow-up frequently, and as a result, they suffer a worse course of the disease. However, the presence of subtle deficits in cognitive functions provides an indication that cognitive impairment may represent a trace of vulnerability factors in the development of BD that is present before the onset of the disease, but worsens as the disease progresses. Thus, BD is characterized by remarkable heterogeneity regarding cognitive outcomes and probably different potential clinical predictors may be related to such outcomes, i.e., previous mixed episodes, current subclinical depressive

symptoms, previous hospitalizations, and old age, and should be the focus of treatment **[88];[35];[168]; [169];167];[170];[171];[172].** Also, many other studies have shown that euthymic patients continue to have difficulties at work and in their studies, showing low performance or difficulty in maintaining them, although it is less evident, as shown also by our research **[173];[115];[127];[174].**

Finally, one of the main objectives of this article was to correlate whether the data on cognitive deficits observed in euthymic patients can help explain functional deficits. Therefore, we attempt to evaluate the clinical capability of the FAB test in bipolar patients. Studies have shown that the FAB test may have a good capability to discriminate several conditions in different clinical populations, although the evidence is still incipient and scarce in psychiatric disorders, and the results should be interpreted with caution. After performing the Spearman Correlation Coefficient Test, by comparing the FAST and FAB test scores in euthymic patients, our group was able to observe a moderate negative correlation, $r^2 = -0.53$; $p<0.001$. This result represents that 53% of the variation of the FAST test (functionality) is linearly related to the FAB test (cognition and EF), and the remaining 47% of the variation are resulting from other factors that were not considered in this study, like (duration of illness, time of hospitalization, number of manic or depressive episodes, among others). These results are following the literature we studied. When the total group of euthymic patients (n=50) was divided into patients with ≤ 3 years and ≥ 10 years of disease, we observed that the same negative correlation trend was present. However, the values of the Spearman's correlation in both subgroups were lower, seen in the euthymic group with ≤ 3 years $(r^2 = 0.226$; $p<0.01)$, and the euthymic group with ≥ 10 years of disease $(r^2 = 0.352$; $p< 0.001)$ demonstrated in **Fig. 9.** Thus, we can infer two important aspects of this correlation; 1) the disease begins to show cognitive and functional changes from the onset of the first clinical symptoms of patients, even in euthymia for more than 6 months, and 2) the impact of the disease in the early stage is a little less than in patients with ≥ 10 years of the disease, demonstrating that the disease progresses over time, and therefore reinforcing the hypothesis of its neuroprogression. These results are very significant and they are in accordance with other studies.

In a systematic review of 52 studies, cognitive deficits were strongly associated with poor functioning in BD, both in cross-sectional and longitudinal studies **[175].** In a meta-analysis, Depp et al., **[127]** also observed the same correlation between cognitive deficits and functional impairment. The effects did not appear to be modified either by the clinical status, or the age or design of the study. As already reported above, these cognitive deficits tend to become stable over time **[113];[83].** However, a small subset of patients showed a decline over time in cognitive functions as demonstrated by Mora et al. **[104],** after following a group of patients for 6 years. Furthermore, the strength of the correlation between cognition and the functional outcome depends on the tests used. Baune et al. **[175],** noticed minor effects when using the Global Functioning Assessment (GAF) Test. In a meta-analysis, Depp et al. **[127],** observed an overall mean correlation of $r^2 = 0.27$, $p<0.001$, and all of these previous studies corroborate our results.

As stated previously, studies on BD patients have shown that the predictors of cognitive impairment functioning, assessed by FAST, were subclinical depressive symptoms, and previous mixed episodes were strongly associated. These results support the evidence that the significant morbidity and severe clinical course of BD lead to greater cognitive impairments with long-term consequences. Several researchers have demonstrated an apparent linear relationship between the increase in depressive symptoms and functional impairments, even during subsyndromal depressive conditions, which would increase the likelihood of depressive relapses. This is due to a stabilization meantime for bipolar depression, which is 24 weeks, while patients with mania need 11 weeks, and patients with mixed cycling episodes need 40 weeks **[176];[177];[178];[179];[167];[170];[172]**. Rosa et al. **[24]** concluded the same results, indicating that depressive symptoms are associated with a greater negative impact on psychosocial functioning than manic (hypo) symptoms. Other deficits in functioning seem to persist even during remission. These results showed the importance of treating depression and mania early, and the need to develop psychosocial interventions to improve functional results. The use of traditional psychopharmacology associated with psychoeducation has allowed the remission of the clinical symptoms to remain stable for more extended periods, which is an achievable goal for many BD patients. However, it is no longer just about improving the patients or their remitting symptoms; but mostly to improve their recovery. Unfortunately, studies showed that psychoeducation did not alter neurocognitive functioning on a neuropsychological battery test when compared with treatment as usual or cognitive behavioral therapy in altering dysfunctional negative beliefs **[180];[181];[182];[183];[67]**. Although our patients were participating in a psychoeducation group for more than two years, we observed similar results in our study, with many significant alterations in the cognitive and functional domains. Thus, mood stability must come with the improvement of the processing speed, of the memory, and

the EF, in addition to better psychosocial, interpersonal, and occupational functioning. These are fundamental objectives to be achieved.

V.   CONCLUSION

Studying the relationship between neurocognition and functionality, it was possible to extract a set of significant findings. On the one hand, the results obtained from the multidimensional tests of neurocognition, and functionality used from a hetero assessment (FAST and FAB) tests, suggest that the distinction between the different domains of these tests can be useful in euthymic bipolar patients. Also, the results allow us to consider that executive performance plays a central role, not only as a predictor of functional performance, but also as a mediator of the relationship between clinical factors, such as chronicity, and functioning. The possibility of using neuropsychological measures of neurocognitive tasks and functionality, and to assess possible subgroups of bipolar patients, as we did in this research using patients with ≤ 3 years and ≥ 10 years of the disease, we can now better understand the relationships between performance which can contribute so that patients can benefit from psychoeducation programs, and functional rehabilitation, ultimately producing the creation of intervention plans that support the recovery of people with BD.

As far as we know, this is one of the first studies that used the FAB test to assess the influence of various demographic and clinical variables, related to executive dysfunctions in BD. Although we adopted relatively strict inclusion criteria in our study, we recognize that our results should be evaluated with caution due to several limitations, which mainly derived from the administered neuropsychological tests, the sample size, and the cross-sectional design of the study. However, the limitations of the FAB and FAST tests, as well as the sample size, were partially resolved through the inclusion of a healthy control group, and the statistical evaluation regarding the sample sizes. Besides the above mentioned, there is also the clinical heterogeneity of the sample, which included patients with short- and long-term illnesses, who had different levels of education and age, which interfered in the analyzes. Another limitation was our cross-sectional design, where the data did not allow the analysis of the cause-and-effect relationship, and also studying many variables and their different areas of functioning. Regarding the FAST test, we did not control factors that could affect functional outcomes such as psychosocial interventions, familiar support, housing, and financial resources. The last weakness of our work is the lack of a deeper analysis regarding the impact of the treatments and

medications used. As these patients have a chronic disease, they have had several previous treatments that may be related to current cognitive and functional deficits. This will be evaluated in future research that is already being planned. Thus, a larger sample can improve the performance of the FAB test, in addition to a better division into more clinically defined subgroups and a better control of some variables. Furthermore, our group started a new study with bipolar patients who had early and late-onset of the disease, and we are trying to assess the functionality and cognitive impairment of these patient groups, continuing to includeandcontrol more variables.

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

Despite the clinical interest, there is a gap in terms of studies of the FAB test in bipolar patients, impairing the assessment as reliability and as validity that can correspond clinically. Although the FAB test shows some limitations, there is some evidence to suggest that several FAB test domains may have good predictions. In terms of clinical practice, early and differential diagnoses are crucial elements in determining the appropriate treatments and therapies. In this sense, the FAB subscores can offer useful information to increase the accuracy of the diagnosis, which can also be of considerable importance during advanced stages in which the progression of the disease intensifies executive dysfunctions. The total performance of the FAB test can be used as a marker of severe disease, rather than a single screening test. Furthermore, we can evaluate the effectiveness of neuropsychological rehabilitation programs in future studies, measuring the results and the qualitative analysis of their performance, and also associate the impairments observed in cognitive functioning with possible brain dysfunctions. Following these strategies, it is necessary to promote functional recovery, which in many cases is not achieved through the available treatments today, which focus mainly on stabilizing mood episodes and preventing possible relapses. So far, there is no specific therapy or approaches to prevent the onset of this disorder or to treat it at the beginning of the disease. Many techniques have been developed to improve cognition in neuropsychiatric

diseases. However, more recently, new approaches, such as functional remediation and dialectical behavior therapy (DBT), have been used. These techniques cover psychosocial aspects and regulations of emotions **[184];[185];[186]**. Functional remediation seeks to improve aspects related to work, functional and interpersonal skills, increasing autonomy, and reducing financial dependence. On the other hand, the core of DBT is to help people build four essential skills: mindfulness, distress tolerance, interpersonal effectiveness, and emotional regulation. Recently these new approaches have been used to treat patients with BD **[187];[188];[189].** Thus, through this research, our group aims to select patients for a future study about DBT, allowing them to develop new behaviors and skills. Thus, we aim to prevent and minimize the impact of any deficits found in their daily lives through cognitive training, and thus, promote their future reintegration into the community, improving their quality of life and reducing health expenses through the prevention of relapses.

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Soccer and its unfolding in times of crisis Covid-19: Critical review

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Abstract — Many unfolding's concerning the Covid-19 crisis within the soccer context, from the impact on the training of young footballers to high performance. In this paper, it was explored through a critical literature review, the strategic points, and scenarios within soccer and some of its main unfolding's. The aim of the study was to identify the main strands of study on the research developed during 2020 around the topic of Covid-19 and football and, to try to understand the impact that the absence of football practice has on the construction of skills in this generation of young footballers.A systematic literature review based on the PRISMA protocol was used as methodology. Through a deductive analysis three clusters were created: business, health, and wellness and socio-cultural.As main results, the professional soccer scenario had the largest number of studies, followed by professional and amateur soccer. In the field of study analysis area, the field of health and well-being was the one where more studies were found and, the subject's control and transmission and physiological impacts were the most highlighted.This study provides an opportunity to assess how processes within football are being studied in a period of crisis, which has quickly responded to the needs of professional soccer and little or no work force has been shifted to seek solutions for the resumption of soccer practice in the lower ranks. The study also highlights a window of opportunity for the development of studies in the typology of training soccer, it is suggested that in future research work can develop studies in this direction.

I. INTRODUCTION

The (COVID-19) or coronavirus 19, was detected in December 2019 in Wuhan city in China(Huang, 2020). Considered a highly transmissible viral infection it is caused by the virus known as coronavirus severe acute respiratory syndrome (Lu et al., 2020) (SARS-CoV2), whose genomic analysis revealed that it is genetically related to the SARS2 outbreak that infected 8,098 individuals in 26 countries(Shereen, Khan, Kazmi, Bashir, & Siddique, 2020).At the very beginning of the year 2020, the World Health Organization declared COVID-19 a pandemic on March 11, 2020.

During the COVID-19 pandemic, the temporary closure of physical activity and sports facilities, and the widespread cancellation or postponement of sporting events, had a massive impact on social and economic development(Goncalves et al., 2020).Direct impacts on society were identified in the public health sector (Tisdell, 2020). Limitation of people's movement in public spaces, some lockdowns, closing of shops and the inability to

serve people were verified in the first moments of the Covid-19 pandemic's establishment(Mo, Cukier, Atputharajah, Boase, & Hon, 2020).

In sports in general it was no different, from high performance to athletic training sports and more, numerous major sporting events were impacted, cancelled or postponed due to Covid-19(Grix, Brannagan, Grimes, & Neville, 2020). The North American big leagues were strongly affected economically(Ehrlich, Ghimire, Khraiche, & Raza, 2020). A scenario of opportunity for change had been in place since the beginning of 2020.

Soccer, not running away from reality, has also stopped in all spheres from the professional to the formation(Evli, Gidik, & Cerit, 2020; Fabre et al., 2020). The game of soccer has long ago ceased to be just an instrument of entertainment and leisure and has nowadays turned into goods and services and become a product that is marketed to the public and/or fans on a universal basis(Callejo & Forcadell, 2006; Kennedy & Kennedy, 2020).

Besides its economic dimension, there are specific physiological and psychological dimensions of athletes in soccer.The shutting down of major soccer leagues such as the Champions League, European national leagues, Libertadores of América, and other championships around the world had a direct impact on the economic and social relationship in the soccer world. (Reade & Singleton, 2020). The opportunity to see with new eyes the importance of the king sport as soccer is known, was one of the many issues raised in the current scenario (Black, 2020; Moore, 2020).The possibility of a renewed perspective on soccer has also been an issue in this current pandemic scenario (Moore, 2020).

Although many uncertainties still reside in the current moment of soccer, little by little a sign of resumption of activities opened throughout the year of 2020, through protocols met in detail(Polidori, 2020; Sousa, Sousa, Garcia, & Stancati, 2020). Even with small signs of occupation of the soccer fields by fans, who play an important role at this moment both in the economic and social aspects of soccer (Bond et al., 2020).

During the year 2020, the scientific community occupied a great part of its work force to perceive the impacts and how society would behave regarding the installed pandemic situation(Drewes, Daumann, & Follert, 2020; Pillay et al., 2020; Wong et al., 2020). Studies on soccer resumption, physical behavior of footballers, physiological effects, transmission and contagion levels in sports practice were also other subjects raised by the researchers(Carmody et al., 2020; Lopez-Carril & Anagnostopoulos, 2020; Mohr et al., 2020; Mon-Lopez,

Garcia-Aliaga, Gines Bartolome, & Muriarte Solana, 2020).

Starting in May, professional soccer in general restarted training activities with strict security and control norms(Sousa et al., 2020). Starting in June 2020, most of the major leagues will finally return to competition through stricter testing protocols on all soccer players and the application of best practices (Castagna et al., 2020).

On the other hand, non-professional or amateur soccer was left on the sidelines(Drezner, Drezner, Magner, & Ayala, 2021). By orientation of the institutions that regulate and supervise soccer, smaller clubs in the difficulty of adopting the requested measures and best practices, have simply chosen to close down their activities(Rico-González, Pino-Ortega, & Ardigò, 2021).

Because it is a collective and relational process among different agents within soccer, it is important for scientists to better understand the stakeholders involved within this takeover process.Thus, the stakeholder theory proposed by Freeman(1984), allows us to understand how individuals or groups are affected by decisions and attitudes of those in charge of organizations and soccer clubs. In this sense, it is necessary to understand how the interface was carried out and how it manifests itself among internal stakeholders, that is, among individuals who are inside the organizational environment, as well as among external stakeholders, corresponding to individuals or institutions that are outside the organizational environment(Ferkins & Shilbury, 2010; Miragaia, Brito, & Ferreira, 2016; Walters, 2011).

Thus, the studies carried out in soccer as of the definition of the pandemic by the WHO on March 11, 2020, indicate several analyzed aspects, whether social, economic or public health (Drewes et al., 2020; Hunter, 2020; Scoppa, 2021). Another line of research verified was the level of impact on the physical conditions of athletes and referees and the best practices for the return to soccer activities (Castagna et al., 2020; Mon-Lopez et al., 2020; Webb, 2020).

However, there was a gap regarding the impact that the pandemic has caused in training or grassroots sports (Grix et al., 2020).This can lead to the absence of the practice of the sport at the younger levels in the development of the so-called life skills(Kurak & Açak, 2019; Mossman & Cronin, 2019).

According the above, the purpose of this study is to identify the main strands of study on the research conducted during 2020 around the topic of Covid-19 and soccer.Considering the studies identified, the aim of this research is also to identify the main clusters in which the research on this subject was concentrated and to try to

understand the impact that this lack of soccer practice has on the construction of skills in this generation of youngsters.

II.   METHODS

Search strategy

or this study, the methodology followed was a systematic literature review, through a process of agglutination of

data resulting from the review of primary studies (Ato, López-García, & Benavente, 2013).To ensure the quality of the study, the protocol recommended in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement was followed - PRISMA (Moher, Liberati, Tetzlaff, & Altman, 2009). Figure 1 shows the selection strategy used.

| Research conducted on 28 January 2021 |
| Keywords were used (Covid-19* and soccer or football). Selection criteria for inclusion in the study: articles classified as article or review. |

Identification	Identified records Web of Science. (n = 63)	Identified records Scopus. (n =81)
Screening	Articles screened in both databases. (n=144)	Records after removing duplicates. (n =90)
Eligibility	Records excluded based on the analysis of the title, abstract and keywords according to the criteria: i) focus on Covid-19 issues as a central variable; and ii) studies developed in the field of football (n =26). Full-text articles assessed for eligibility (n =64)	
Included	Total articles included for this research. (N=64)	

Fig.1: Diagrama Flow

Data Collection

Due to their long history and scope of journals in the social sciences, we chose to use the Web of Science and Scopus databases (Ankrah & Omar, 2015). The review was conducted on January 28, 2021, using the following criteria(Cucciniello, Porumbescu, & Grimmelikhuijsen, 2017): through the search equation "*Covid-19* and soccer or football*" in the field topic (title, keywords or abstract) and without time limitation (Feng, Zhang, Du, & Wang, 2015).

The first sample resulted in 67 articles in Web of Science and 85 articles in Scopus. Duplicate articles for example, (Bisciotti et al., 2020; Boschilia, Moraes, & Marchi Junior, 2020; Parrish & Lam, 2020; Waliaula & Okong'o, 2020)and articles outside the Covid-19 core study area and soccer for example, (Belleville, Cebula, Jolley, & Bone, 2020; Chen, Garcia, Arumugaswami, & Wirz, 2020;

Goldman & Hedlund, 2020)have been removed. After this process, a total of 64 scientific articles were identified for analysis.

The research protocols used here such as: inclusion and exclusion criteria, within a critical and expressed process was to provide a record for control and checking(Jones, Coviello, & Tang, 2011).As a way to certify the relevance of the studies, inclusion and exclusion criteria were also adopted(Tranfield, Denyer, & Smart, 2003): i) excluding conferences, books, book chapters, editorials, and including only articles and reviews published in peer-reviewed scientific journals, due to the reliability of this source (Jones et al., 2011; Podsakoff, MacKenzie, Bachrach, & Podsakoff, 2005); ii) inclusion of all journals within the selected databases, regardless of impact factor, due to the still introductory phase of development of the

theme to be studied(Jones et al., 2011; Tranfield et al., 2003).

The articles were submitted to the Nvivo software version 12, for a content analysis, as a way to give sustainability in the formation of clustersas shown in figure 2.
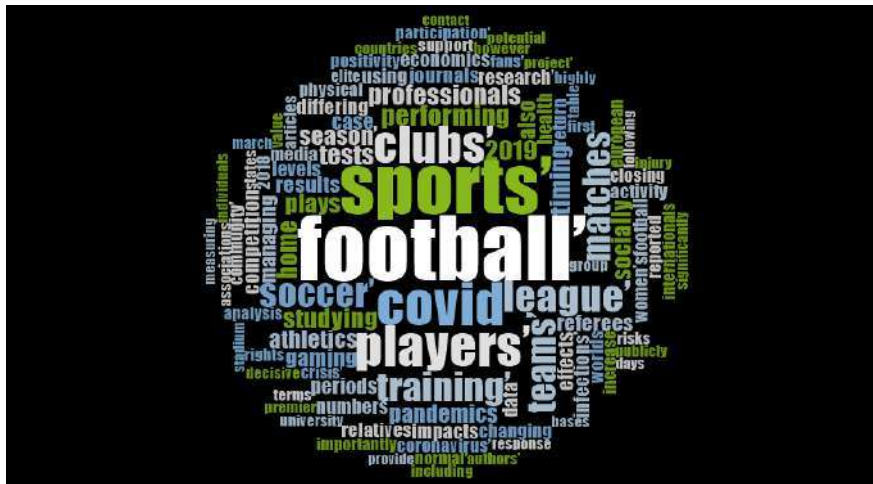
Fig.2: Word cloud from the software NVivo 12

Data analysis procedures

The three hundred (300) most frequent words were selected in the Nvivo12 Software, adding the derived words and with a minimum extension of four letters. To avoid repetition of words that could mask the result, it was decided with the software to prevent words such as: 2020, 2021 and http among others from entering this selection.From these indications, the word cloud was generated that served as the basis and support for the deductive formation of the thematic clusters for this study.Therefore, from the researchers' deductive analysis, three clusters were identified:i; **business** (where the subjects dealt with were management, economic and financial analysis, strategic communication and attendance at stadiums); ii; **health and wellness** (focused on issues of physiological effects on athletes, control and transmission

of the virus and best practices for safe return from activities) and iii; **sociocultural** (focused on issues of gender, social inclusion, general behaviour and social responsibility).

III.   RESULTS

The bibliometric analysis covered the period March 2020 to January 2021. Figure 2 shows the number of publications during this period when dealing with the three football scenarios: professional, amateur and professional/amateur.It is possible to observe through the graph below the emergence and development of this research topic due to the pandemic moment installed since March 2020.
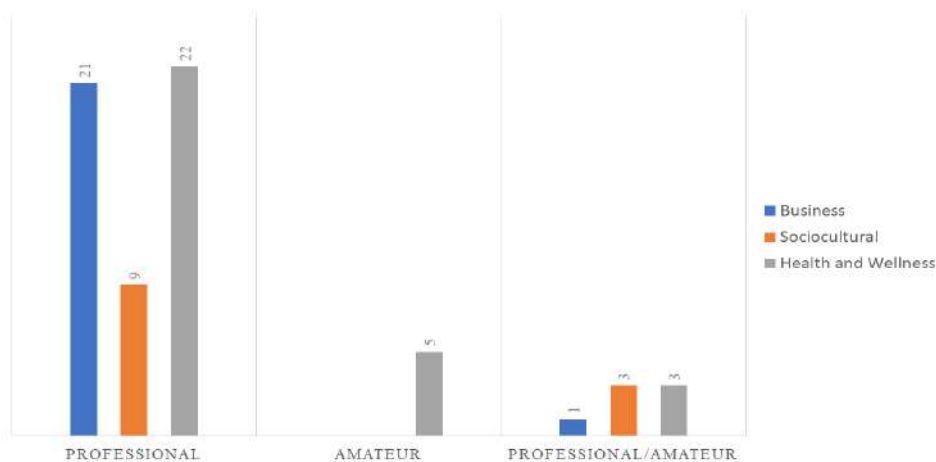
Fig.3: Graph of publications by football scenario within the clusters.

It was observed that most of the studies focused on professional football with 52 publications, followed by the professional/amateur scenario with 7 studies and in third place amateur football with only 5 publications in the period.

For the areas of analysis within the defined clusters as shown in table 1, there was a high concentration of studies in the areas of control and transmission with 13 studies, physiological effects with 11 studies, both within the cluster health and wellness. With 11 other publications we have the area of economic/financial analysis within the business cluster. Within the area of behavioural analysis, referring to the sociocultural cluster, 6 publications were found, which represented 50% within this analysis group.

Table1- Cluster publications by area of analysis

Area of Analysis	Business	Healthandwelness	Sociocultural	Total
Anxiety		2		2
Control and transmission		13		13
Physiologicaleffects		11		11
Football ecosystem			1	1
Gender			2	2
Management	3			3
Social inclusion			1	1
Bestpractices		3		3
Injuryprevention		1		1
Coach-athletesrelationship			1	1
Social Responsibility			1	1
Economy/Finance	11			11
Behaviour			6	6
Contracts	2			2
Communication	4			4
Stadiumattendance	2			1
Total Geral	**22**	**30**	**12**	**64**

For the analysis of stakeholders, divided by external (referees, associations, experts, fans, leagues) and internal (clubs, athlete and coaches), the research carried out observed that the largest number of publications was within the scope of internal stakeholders with a total of 40 studies, with athletes being the main target of these investigations with 31 publications, followed by clubs with 7 studies.

Regarding the external stakeholders, it was verified 17 studies through Table 2. It was also observed a greater number of studies with the fans with 5 publications, followed by referees and leagues with 4 publications each.When the studies were related to both external and internal stakeholders, 7 publications on the studied theme were verified.

Table 2-Publications by stakeholders and scenario in football.

Stakeholders	Profesional	Amateur	Profesional/Amateur	Total
External	**15**		**2**	**17**
Referees	3		1	4
Association	2			2
Experts	1			1

Fans	5			5
Partnersof football	1			1
Ligas	3		1	4
Internal	**31**	**5**	**4**	**40**
Athletes	23	5	3	31
Athletesandcoaches	1			1
Clubs	6		1	7
Partnersoffootball	1			1
Internal/External	**6**		**1**	**7**
Partnersof football	6		1	7
Total	**52**	**5**	**7**	**64**

IV.　DISCUSSION

The results indicate that the theme "covid-19 and soccer" is more centered in the "Business" and "Health and wellness" clusters, and less in the "Sociocultural" cluster. However, the three clusters coexist, and one influences the other. Considering the soccer typology, the results show that most investigations focus mainly on professional soccer, where 52 studies (81%) have professional soccer as their sole theme, while only 5 publications (8%) are directed towards amateur soccer and finally 7 studies (11%) where they involved both amateur/professional typologies.In fact, the moment that soccer is going through is differentiated, situations such as the lack of public, the behavior of internal and external stakeholders, the broadcasting of games on unusual days and times, and the lack of competitions in amateur and training soccer, are directly impacting the game and its direct stakeholders.

4.1- *Cluster* Business

The results demonstrated clearly show a major focus of concern so that the return on professional soccer would be faster, with emphasis on the "business" cluster. On the one hand, the absence of spectators could be one of the factors for the direct impact on business in soccer, but revenues from other sectors helped maintain professional soccer.(Drewes et al., 2020; Horky, 2020). One can also identify that this is since the big sponsors and brands involved in the major leagues exert a certain pressure to return to the games and championships and thus try to achieve a balance in the process of the financial and economic balance of the businesses that involve soccer, whether they are contracts with athletes, maintenance of employees and other stakeholders involved. (Carrick, 2020; Hammerschmidt, Durst, Kraus, & Puumalainen, 2021).

The strength of the traditional media, the big sponsors and investors in professional soccer have done a strong job

behind the scenes for the return of the major championships (Fühner, Schmidt, & Schreyer, 2021). One of the main claims, was that soccer would be within the safest places, due to the protocols adopted, what many call the "soccer bubble".(Carmody et al., 2020; Castagna et al., 2020).However, we did not see this same commitment when the subject was amateur or training soccer. Perhaps because of the lack of financial investment by the authorities, this type of soccer ended up being left behind and on the margin of what was expected as a return for most young people to the sport, which impacted them directly(Doherty, Millar, & Misener, 2020).

It is important to realize here and that reinforces this difference in political and economic support is to understand as fundamental the role that training sport plays for the smaller clubs and the young people who play it (Doherty et al., 2020). Although society still perceives this type of sport as a "hobby" that comes after the "serious" business is over, the absence of sports practice can indeed bring unexpected consequences for future generations.The lack of opportunity and the importance of using evidence-based learning during these times is highlighted here, bringing together existing knowledge cases in various areas (assessment and competence development, the so-called soft skills ...), however needs policy guidelines from the top down to the local context with the challenges faced by sports clubs and the vast majority of young people(Doherty et al., 2020; Grix et al., 2020).

Another point to be analyzed was how the major European leagues and their clubs performed the strategic management regarding the pandemic, responses, turnover and action plans adopted(Górecka, 2020; Kennedy & Kennedy, 2020). On the other hand, according to a study byHammerschmidt et al.(2021), numerous weaknesses of the clubs were revealed due to their financial structure and underdeveloped business and management strategies to

deal with the crisis, even though they are clubs considered healthy and from the five main European leagues from the economic-financial point of view. There is still a lot to evolve in this sense, but what is clear is the lack of a political-economic strategy to adjust actions for the return of amateur and training soccer.

4.2 *Cluster*Health and Wellness

This was the cluster with the largest number of studies found, a total of thirty publications, most within the area of analysis of the control and transmission of the virus and the physiological effects during the pandemic on athletes(Buldu, Antequera, & Aguirre, 2020; Cohen et al., 2020).Because they are the players considered to be the front line in soccer, the players were the most tested in this period(de Albuquerque Freire et al., 2020; Gervasi et al., 2021). This is because there was the intention and the interest that the return of professional soccer was as soon as possible, which culminated in the attempt to create the so-called "bubble" of soccer with the creation of extremely demanding protocols that were met in detail(Côrte, Sousa, Sousa, Garcia, & Stancati, 2020; Rico-Gonzalez, Pino-Ortega, & Ardigo, 2021).

In a first moment, due to a conjunction of factors and the stay-at-home campaign, the main drivers in the decrease of SARS-2 cases in stakeholders involved in soccer were considered with examples of studies conducted in the Bundesliga and the model adopted by the Croatian Football Association(Mack et al., 2020; Primorac, Matisic, Molnar, Bahtijarevic, & Polasek, 2020).

Because of the financial investment that professional soccer has, protocols could be made through clubs, federations, and associations to enable the return of the activities(Drewes et al., 2020; Meyer et al., 2021).However, for amateur and youth soccer the absence or high cost of protocols for smaller clubs has impacted and continues to impact the practice of soccer in this typology of soccer on the world stage(Fabre et al., 2020; Teran et al., 2020). Although, there are still doubts about the levels of transmission in soccer, a recent study monitored two measures of exposure, respiratory and interpersonal contact, two of those that players and referees are subject to during a soccer game, and the result indicates that soccer does not seem to be a high-risk sport(Goncalves et al., 2020).Perhaps one of the accessible situations for the safe return of amateur or youth soccer would be the adoption of best practices, studies already indicate that protocols of this nature have already been applied, since testing at all levels may be financially unfeasible(Côrte et al., 2020; Rico-Gonzalez et al., 2021).

One could perhaps talk about the negligence of the sport's administrators with amateur and youth soccer, however,

what seems to be transparent at this moment is the insecurity due to the risk of not being able to comply with the determinations of the main health agencies (Carmody et al., 2020; Drezner et al., 2021). On the other hand, it is still early to understand the impact that this absence of sports practice can cause in the future formation of citizens, given the importance of the development of the so-called life skills in these younger levels.(Kurak & Açak, 2019; Mossman & Cronin, 2019).The development of competencies such as time management, communication, leadership, cooperation, highlights the importance of the practice of soccer in the younger age groups(Cronin et al., 2019; Kurak & Açak, 2019)

Another important factor during this pandemic period of withdrawal from sports was to control anxiety levels in soccer athletes (Esteves et al., 2020; Evli et al., 2020). Obviously, athletes who are used to performing a daily training routine and the period of uncertainty about the return of soccer ended up intensely influencing all soccer players, especially the athletes(Evli et al., 2020). Although anxiety is one of the preponderant factors in the athletes' journey in general, in the pandemic context it can be seen from another perspective, which was the uncertainty of when they were supposed to return to their activities (Castro-Sanchez, Zurita-Ortega, Chacon-Cuberos, & Lozano-Sanchez, 2019; Esteves et al., 2020).

4.3 *Cluster*Socio-cultural

In this study group 12 publications were found in the period, and concentrated on issues involving gender, social inclusion issues, the relationship of behaviors of athletes and direct players who are playing without the presence of an audience, and the theme of social responsibility of soccer(Mark D. Biram & Goellner, 2020; Brown, 2020; Parnell, Bond, Widdop, & Cockayne, 2020).

The pandemic moment was also an opportunity to review positions and especially growth opportunities for issues on gender and social inclusion (Mark D. Biram & Goellner, 2020; M. D. Biram & Martinez-Mina, 2020; Brown, 2020). The power imbalances that have marked politics and are rooted in the historical marginalization of women's sports were put on the agenda(Mark D. Biram & Goellner, 2020). Much due to the history in which women's soccer has always been left in the shadow of men's soccer when it comes to awards, income opportunities and better contracts (Mark D. Biram & Goellner, 2020; Norman, Rankin-Wright, & Allison, 2018).

Although there are still many kinks to work out, one can already see greater visibility for women's competitions, fairer salaries, and some prominent positions held by women in the soccer context (Meier & von Uechtriz, 2020). At this point, this change is due to the fact that

sports policies have been created in this sense to minimize these gender differences in soccer, one of them and perhaps the most important is the creation of competitive teams within clubs(Meier & von Uechtriz, 2020; Pfister, 2015). With the stoppage of the major women's leagues due to the pandemic, the subject gained important contours for the discussion of the evolution of women's soccer (Desjardins, 2021; Valenti, Scelles, & Morrow, 2020).

Another subject much discussed in this cluster was related to the social behavior of soccer's main stakeholders(Moore, 2020; Scoppa, 2021). The change in the behavior of the referees, for example, with the absence of the public, reflected directly in the lower number of cards applied during the games draws everyone's attention(Bryson, Dolton, Reade, Schreyer, & Singleton, 2021; Sors, Grassi, Agostini, & Murgia, 2020). It is assumed and even accepted that the absence of the public may have brought greater tranquility to the decision making of the referees, this can also be reflected in the results in which the home team had a lower number of wins in this period, different from what it was before the pandemic installed (Inan, 2020; Matos, Amaro, & Pollard, 2020; Sors et al., 2020).

As soccer is a relational social structure that involves several stakeholders, be them internal or external, the pandemic directly affected the whole structure (Parnell et al., 2020). Of course, the issue of confinement has affected a lot, but the return of only part of this structure, also affects the possibilities of global service of the whole structure, how to explain to the fans that there are games, but you cannot watch them in person? In this sense, many clubs have readjusted their way of communicating with fans through digital social media platforms such as instagram, twitter, facebook, broadcasting games through streaming, among others(Lopez-Carril & Anagnostopoulos, 2020; Parnell et al., 2020).

Last and not least, was the possibility to reflect on the importance of soccer in this environment, where the speech of Liverpool's manager Klop resonated positively and made countless reflections come from it: "soccer is the most important thing of the least important things.The truth is that a total stoppage of leagues and championships had never been seen before, not even during World War II, which shows that we still have a lot to evolve for a more efficient crisis management that can respond in a more agile manner(Tovar, 2020).

It was also possible through the data analyzed here, to develop a framework about the areas, stakeholders that were most impacted in the period studied. It can be seen in the figure 4. This can be a subject for future studies on how to deal with crisis situations.
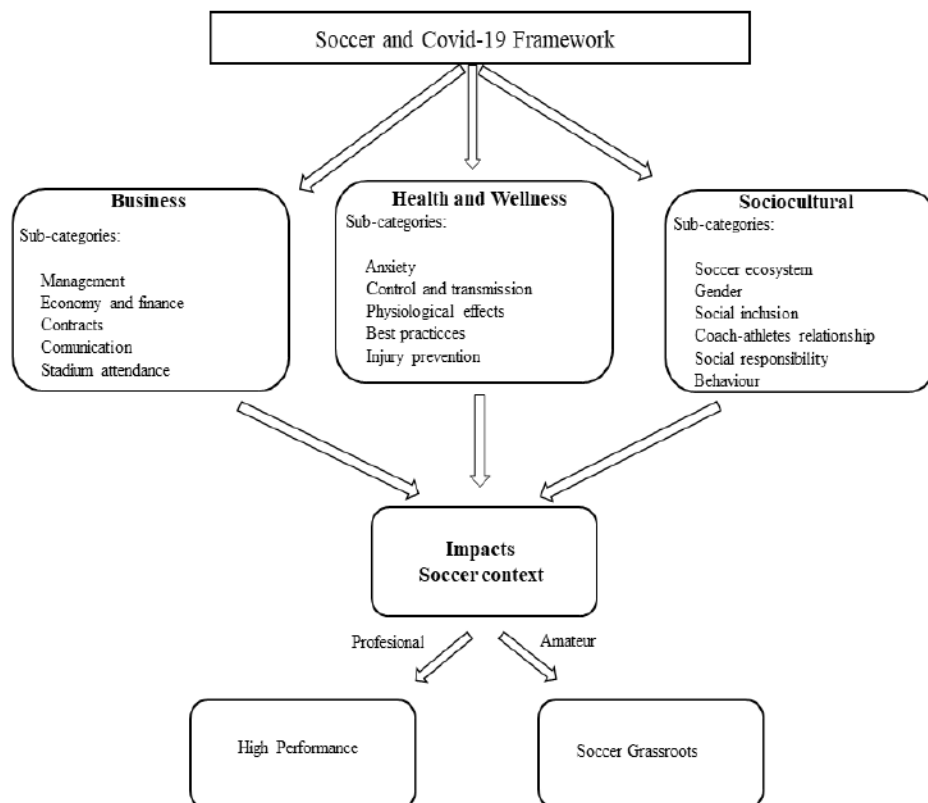
Fig.4: Framework of impacts on soccer areas and stakeholders

V.   CONCLUSION

The present study performed a critical analysis of the pandemic moment and soccer and used as methodology a systematic literature review in the Web of Science and Scopus databases.It was developed in the period from March 2020 to January 2021, which comprised the onset of the pandemic, referring to the Covid-19 topic in soccer, and the direct impact on its stakeholders.The importance of better understanding how the scientific community has conducted its studies on this topic was highlighted.Furthermore, for the research criteria used, it was evidenced that the major focus of the studies was on professional soccer while amateur and training soccer was sidelined during this period.

Three thematic clusters around the topic "Covid-19 and soccer" were identified deductively (Business; Health and Wellness and Sociocultural), and it was found that most of these studies were concentrated in the "Health and Wellness" cluster, and had their research focused on a specific internal stakeholder, the athletes. In turn, the smallest number of publications was gathered in the "Sociocultural" cluster. By analyzing the results of this study, it is possible to realize the importance of a broader observation in the sense that it involves both internal and external stakeholders in the soccer field. In this study it became evident that more studies related to internal stakeholders have been developed, particularly with athletes, which to some extent can be considered normal, since athletes are the main players in this process. Another important aspect is to verify the possibility of returning to soccer activities with the main focus on training athletes.Clearly left aside during the pandemic. In this way, the study offers an opportunity to evaluate how the processes within soccer are being studied in a period of crisis, which quickly responded to the needs of professional soccer and little or almost nothing was shifted to seek solutions to resume soccer practice in the lower ranks. This absence of sports practice may have a future impact on these generations who have been deprived of the possibilities of developing the skills that soccer provides. In this sense, sports public policies should be the front line for the resumption of sports practice in the lower ranks, because it is one of the essential points, due to its importance in several scenarios within soccer, especially because of the possibility of developing both hard skills and soft skills.This opens an important window of study on this safe and effective resumption at these levels of training when in crisis situations.Therefore, this study is an important tool in the analysis of the evolution and development of possibilities to increase and rescue the practice of soccer in a uniform and safe way even in a pandemic situation through well-structured protocols for everyone's safety.

VI.   LIMITATIONS AND FUTURE RESEARCH

Despite the methodological rigor used in this study, there are some limitations that can be pointed out because of the inclusion/exclusion criteria defined in the sample selection, which end up conditioning the results of this type of study.When only studies published as articles or reviews were considered, the final sample size turned out to be smaller.Thus, in future investigations, the criteria can be extended to published studies by including books and book chapters.

Since the results showed that the studies on Covid- 19 and soccer, have had professional soccer as their focus, it opens a window of opportunity for the development of studies in the typology of training soccer, it is suggested that in future research work can develop studies in this direction.Thus, analyzing how to safely resume activities in these levels, and what are the best practices to be adopted to work efficiently in the youth soccer levels, is a need for future research.

Following the same approach, it is fundamental to analyze how the Federations, Football Associations, and Public Power can be the main partners and responsible for the validation and control of the practices adopted by clubs, coaches, and athletes.And last and not least, try to explore the covid-19 and soccer theme in more depth with external stakeholders, since there are still few studies.One such example can be the study of the relationship and interface between clubs and their fans through the media, since due to the digital transformation that society is going through, the use of digital technologies is often used as a means of approaching these two actors. In addition, other external stakeholders such as members, parents, sponsors, should be part of new lines of research, in order to understand their influence on the internal processes of the so-called soccer world.

ACKNOWLEDGEMENTS

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Burnout Syndrome- Stress in Health Care Professionals Working to Fight Covid-19 in Public Hospitals

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Abstract — Objective: The research had as general objective to analyze the incidence of Burnout Syndrome in health professionals of two public hospitals that provide care to patients with Covid-19 in two realities in the Legal Amazon. Materials and Methods:Exploratory, descriptive study, with a cross-sectional design and a quantitative approach. The data collection instruments used in this study were: a) Maslach Burnout Inventory (MBI) Questionnaire and Questionnaire of sociodemographic, professional and psychosocial factors profile. The MBI is composed of three factors that are called Emotional Exhaustion EE, Depersonalization DE and Professional Achievement RP. The research subjects were 140 health professionals from two public hospitals. The research project complies with Resolution 466/12 of the National Health Council of Brazil, taking into account the ethical aspects of research in Brazil. Main results: Health professionals working to combat the Covid-19 pandemic in two public hospitals have high rates of Emotional Exhaustion (EE), Depersonalization (DE) and Low Professional Fulfillment (PR), indicative of high rates of burnout. Individual or associated psychosocial factors are conditioning factors and can directly determine the occurrence of Burnout Syndrome in health professionals, especially at this time of combating the Covid-19 pandemic. Conclusion:

Show the urgency of interventions aimed at these professionals, which aim to reduce levels of occupational stress, increase self-esteem, encourage self-care and build a healthy work environment.

I. INTRODUCTION

The Covid-19 pandemic has generated concern about the mental health of the entire society and, especially, of health professionals who are on the front lines in the fight against the pandemic [1]. According to Schmidt et al [2], in times of pandemic, physical health and combating the causative agent of the disease are the focus of attention of managers and health workers, however, the mental health of these professionals tends to be neglected. The Covid-19 pandemic brought an additional problem for the well-being of physicians, nurses, technicians and nursing assistants and all healthcare professionals. In times of greater pressure, such as the fight against the new coronavirus, these workers forget about their own health [1]. According to Rodrigues; Silva [3] the physical and mental well-being of these professionals is affected, leading to the emergence of disorders related to stress and anxiety such as Burnout Syndrome. According to Rodriguez et al [4], occupational stress appears in the field of health as a real problem among professionals due to the exhaustive characteristics of work. For Faro et al [5], the Burnout Syndrome intensifies in this context, as the excessive workload caused by the new coronavirus grows disorganized. Thus, work overload can cause psychological and social disturbances, and interfere in the quality of life of health professionals [6].

It is undeniable that, given the Covid-19 pandemic, a new scenario of doubts and uncertainties emerged, where it appears that health professionals are more likely to develop Burnout Syndrome, as they deal with intense emotions such as suffering, fear and death , making it more vulnerable to a high degree of stress, in addition to increasing physical and psychological strain. According to França and Rodrigues [7], occupational stress arises from the worker's perception that the work environment is threatening to their physical and/or mental health, because they believe that this environment has excessive demands or because they do not have sufficient resources for their coping. The Ministry of Health of Brazil and the Pan American Health Organization in Brazil [8] recognize that one of the possible effects of chronic exposure to occupational stress is the triggering of Burnout Syndrome or professional exhaustion, a phenomenon that affects professionals who have intense contact with the users of its services, such as health and education professionals, police officers, social workers, among others. The potential effects of occupational stress on the physical and emotional well-being of health professionals has been the object of scientific research in recent years, as it is an important health problem [9]. For Vitorino et al [6], Burnout Syndrome is characterized by emotional exhaustion, depersonalization and decreased personal fulfillment, in response to chronic sources of stress.It is identified as a common phenomenon among many professionals, with a higher incidence in workers who have direct contact with people.

According to McCray et al [10] currently, Burnout is defined by a combination of three factors: emotional exhaustion (depletion of emotional energy due to excessive work demand), depersonalization (sense of emotional distance from patients or work) and low achievement personal (feeling of low self-esteem and low efficiency at work).Briefly Bernhardt et al [11] defines it as the prolonged response to chronic stress at work. Burnout Syndrome is a psychosocial phenomenon that arises as a response to chronic interpersonal stressors present at work [12]. The most used definition of what is Burnout Syndrome is Maslach's; Jackson and Leite [13] and Maslach; Jackson [14] referring to it as a multidimensional syndrome consisting of exhaustion.For these authors, Burnout Syndrome has been recognized as a condition experienced by professionals who carry out activities in which a high degree of contact with other people is involved, including health professionals, whose task involves intense and prolonged attention to people in situations of need or dependence [13].

For Moss et al [15], Burnout Syndrome affects the physical and emotional health of professionals, bringing worrying consequences at individual and organizational levels.. For Carlotto and Câmara [16], at the beginning of any evidence, there is a need to prevent its symptoms.According to Melo and Carlotto [17] and Moss et al [15], prevention strategies for Burnout Syndrome include carrying out individual and organizational interventions or, ideally, a combination of both. According to Silveira et al [18] motivation at work is the result of a series of interactions between individual effort, income obtained, organization and personal goals, while stress is an individual's physiological and behavioral response.

For Gómez-Gascón et al [19], the health professional, when faced with potentially stressful situations, events, people or goals, induces this reaction, which is essential for survival.West et al [20] confirm that depression, suicidal tendencies, poor quality of life, dissatisfaction

with work-life balance, and especially Burnout, have been reported in all medical specialties and in all health-related professions. What is also more serious, according to Cedfeldt et al [21], is that due to the high frequency of such occurrences, Burnout Syndrome causes a negative impact on the conduct of patients, as well as on their health safety.

According to Guido et al [22], studying the stress of health professionals in the hospital environment allows a better understanding of its causes, which helps to elucidate everyday issues related to mental health and frequently faced by these professionals.In the study "Burnout Syndrome in health professionals: updating on definitions, risk factors and prevention strategies", Perniciotti et al [9] confirm that the propensity of health professionals to Burnout Syndrome is well documented, especially those who work in complex and intense environments such as hospitals.The research by Perniciotti et al [9] makes reference to several studies.Corroborating their findings, the studies by Bartholomew et al [23]; Rotenstein et al [24], who identified Burnout Syndrome in physicians from different specialties (25 to 67%), Erschens et al [25]; IsHak et al [26]; Low et al [27]; Rodrigues et al [28]; Shanafelt; Bradley; Wipf and Back [29] who identified in resident physicians (7 to 76%) and Bridgeman; Bridgeman and Barone [30]; Woo; Ho; Tang; Tam [31]; Chemali et.al [32]; Koinis et al [33]; Moss; Good; Gozal; Kleinpell and Sessler [15], who identified Burnout Syndrome in nurses (10 to 70%).

To Zanata; Lucca [12] the clinical picture is varied and can include psychosomatic, psychological and behavioral symptoms among professionals, and produce negative consequences at the individual, professional, family and social levels. In the study by França et al [34] within the scope of health institutions, high rates of absenteeism due to illness stand out, and for Hyeda; Handar [35] attributes presenteeism with consequent commitment to the quality of service provided in institutions. According to Lautert [36]; Lorenz; Benatti; Sabino [37]; Carlotto [38]; Ferreira; Lucca [39] in general, studies on Burnout Syndrome in health institutions assess only one professional category, for example, nursing workers. Nogueira-Martins [40]; Ax [41]; Tucunduva et al [42] refer to studies with medical professionals or analyze health professionals without distinction of profession. In Zanatta's Literature Review study; Lucca [12] on the subject showed that in Brazil there is a lack of studies on the set of health professionals from the same institution, in order to obtain a characterization of mental illness in the context of work as a whole.

The research had as general objective to analyze the incidence of Burnout Syndrome in health professionals of two public hospitals that provide care to patients with Covid-19 in two realities in the Legal Amazon.

II.   MATERIALS AND METHODS

2.1 Study Type

Exploratory, descriptive study, with a cross-sectional design and a quantitative approach. It was developed in two public hospitals for the care of patients with Covid-19 located in the Brazilian Amazon. The criteria for choosing these hospitals was based on the peculiar characteristic of exclusive care for patients with Covid-19. Data collection was carried out over a 3-month period in 2021.

2.2 Data Collection Instruments

Questionnaires with closed questions and multiple choices were used as data collection instruments for this research, in addition to the MBI inventory. The data collection instruments used in this study were: a) Maslach Burnout Inventory (MBI) Questionnaire; b) Questionnaire on the profile of sociodemographic, professional and psychosocial factors.

The Maslach Burnout Questionnaire (MBI) is an inventory consisting of 22 items, where the individual responds to a seven-point Likert scale.After the initial orientation described by the inventory, alternatives are presented, ranging from the condition "never" (0), to the intensity "every day" (6), with which the individual will respond by marking an X in the intensity that best represents what is described in each item. The MBI is composed of three factors that are called Emotional Exhaustion EE (as measured by questions 1, 2, 3, 6, 8, 13, 14, 16 and 20) DE Depersonalization (questions 5, 10, 11, 15 and 22) and Professional Achievement RP (questions 4, 7, 9, 12, 17, 18, 19 and 21). Among all the instruments presented, the MBI is the most used to assess the Burnout Syndrome, regardless of the occupational characteristics of the sample and its origin.

The authors McCray et al [10]; Sanfuents [43]; Aldrees et al [44]; Shirom [45]; Ishak et al [46] confirm that the Maslach Burnout Inventory (MBI) is the most used instrument in the investigation of the disease, as well as in its quantification. About 90% of Burnout investigations were carried out through the MBI [44]. According to Aldrees et al [44]; Arrogant [47]; Ishak et al [46] this questionnaire consists of 22 items, distributed as follows: nine items related to emotional exhaustion, five to depersonalization, and eight to low personal fulfillment.Each marked item is rated on a Likert scale from zero to six (where zero means "never"; one is "a few

times a year"; two is "once a month"; three is "once a month"; a few times a month"; four points to "once a week"; five represents "a few times a week"; and finally six refers to "every day").

According to Ishak et al [46] Burnout is detected according to a cutoff score for each of the three categories: emotional exhaustion ≥27, depersonalization ≥10 and low personal fulfillment ≥33. According to Cialzeta [48] (2013); Aldrees et al [44]; Shirom [45]; walls; Sanabria-Ferrand [49]; Diaz Araya [50] among the three factors present in Burnout, emotional exhaustion was identified as the most prevalent (reaching 54%, according to Aldrees et al [44]), since it is the symptom that most represents the consequences that stress at work can cause for health professionals. And, according to Cialzeta [48]; Aldrees et al [44]; walls; Sanabria-Ferrand [49]; the second most prevalent item is depersonalization, followed by low personal fulfillment. These factors consist of three related dimensions, but independent of each other, which are: a) Emotional Exhaustion (EE) - it is the feeling of exhaustion, both physical and mental, the feeling of no longer having energy for absolutely nothing, of having arrived to the limit of possibilities, lack or lack of energy and feeling of exhaustion of resources. b) Depersonalization (DE) – The professional has not lost his personality, but it has undergone or is undergoing changes, leading him to a cold and impersonal contact with the users of his services (patients, clients, etc.), starting to have attitudes of cynicism and irony in relation to people, showing itself indifferent to what may happen to others; the professional starts to treat patients and clients, colleagues and the organization as objects. c) Professional Achievement (PR) – feeling of dissatisfaction with the work activities they have been performing and with their emotional development, feeling of insufficiency, low self-esteem, professional failure and lack of motivation. The professional reveals low efficiency at work, sometimes feels the desire to leave the job, characterizing a negative self-assessment.

MASLACH BURNOUT INVENTORY QUESTIONNAIRE (MBI)

0 – Never; 1- Once a year or less; 3 – A few times a month; 4 – Once a week; 5 – A few times a week; 6 – Every day.

Nº	PLEASE READ THE FOLLOWING AFFIRMATIONS CAREFULLY, SCORING AS SINCERELY AS POSSIBLE ACCORDING TO THE INTENSITY DESCRIBED:	NEVER	ONCE A YEAR OR LESS	ONCE A MONTH OR LESS	SOMETIMES A MONTH	ONCE A WEEK	SOMETIMES A WEEK	EVERY DAY
1	I feel emotionally drained from my job.							
2	I feel tired at the end of the workday.							
3	When I get up in the morning and go to another workday I feel tired.							
4	I can easily understand how people feel.							
5	I think I treat some people as if they were impersonal objects.							
6	Working with people all day takes a lot of effort.							
7	I deal effectively with people's problems.							
8	My work leaves me exhausted.							
9	I feel that through my work I positively influence the lives of others.							
10	I have become more insensitive to people since I have been doing this job.							
11	I am concerned that this job is hardening me emotionally.							
12	I feel very vital.							

13	I feel frustrated in my work.								
14	I think I'm working too hard								
15	I don't really care what happens to the people I serve.								
16	Working directly with people causes me stress.								
17	I can easily create a relaxed atmosphere for people.								
18	I feel stimulated after work in contact with people.								
19	I have achieved many accomplishments in my profession.								
20	I feel at the limit of my possibilities.								
21	I feel that I know how to properly handle emotional problems in my work.								
22	I feel people blame me in some way for their problems.								

b) Questionnaire of sociodemographic, professional and psychosocial factors profile. It is characterized by a questionnaire with multiple choice questions, divided into questions of sociodemographic data (age, gender, marital status and number of children) and 08 questions of professional data (degree, area of expertise, work shift, length of experience professional).Psychosocial factors have 11 questions about bad behavior of patients, overload of activities, high number of patients per work shift, need for professional updating, execution of bureaucratic activities, multiplicity of roles to play, expectations of family members, lack of resources for materials for work, high number of daily activities, lack of support from coordination and colleagues, little participation in institutional decisions, to be answered according to the intensity that occur, being 1 (always), 2 (often), 3 (sometimes) , 4 (rarely) and 5 (never).

Sociodemographic, Professional and Psychosocial Factors Profile Questionnaire

Mark with an X the answer corresponding to the indicative number applicable to you.

1) Sociodemographic Data: 1) Age: a ( ) up to 25 years old; b ( ) from 26 to 30 years old; c ( ) from 31 to 35 years old; d ( ) from 36 to 45 years old; and ( ) from 46 to 55 years old; f ( ) over 55 years old. 2) Gender: a ( ) Male b ( ) Female. 3) Marital Status: a ( ) Single; b ( ) Married or cohabiting; c ( ) Separated, separated, divorced or widowed. 4/ Number of children: a ( ) None; b ( ) 1 child; c ( ) 2 children; d ( ) 3 children; and ( ) 4 children; f ( ) 5 or more children.

2) Professional data: 1) Position: a ( ) graduation; b ( ) specialization / residency; c ( ) title of master; d ( ) doctorate; and ( ) postdoctoral. 2) Work shift: a ( ) morning; good night; c ( ) late; d( ) all; and ( ) in service. 3) Length of professional experience: a ( ) less than one year; b ( ) 1 to 5 years; c () 6 to 10 years; d ( ) 11 to 15 years; and ( ) 16 years or older. 4) Length of experience with Covid-19 treatment: a ( ) less than 6 months; b ( ) from 6 months to less than one year; c( ) one year; d () more than a year. 5) Number of patients and/or care provided daily: a ( ) less than 10; b ( ) less than 20; c ( ) 20 to 30; d ( ) 30 to 40; f ( ) more than 40. 6. Work exclusively at the hospital: a ( ) yes; b () no.

3) Psychosocial Factors:Analyze and mark with an X, the occurrence of the described phenomena, according to the scale proposed below: Always (1); Often (2); sometimes (3); Rarely (4); Never (5).

The psychosocial factors adopted in the research are: bad behavior of patients or family members; activity overload; high number of patients per shift; need for professional updating; execution of bureaucratic activities; multiplicity of roles to play; family members' expectations; lack of material resources for work; high number of daily activities; lack of support from coordination and colleagues, and little participation in institutional decisions.

2.3 Sampling Number

The research subjects were one hundred and forty (140) health professionals from two public hospitals, randomly selected, as no area of education, title, gender, length of experience in the profession, among other variables, was

prioritized. The freedom of professionals to respond to the survey voluntarily and those who are exclusively dedicated to the treatment of Covid-19 were prioritized. Considering the chronicity and intensity of stress for the manifestation of Burnout Syndrome, the study population consisted of physicians, nurses, technicians and nursing assistants, physiotherapists, biomedical, speech therapists, pedagogical therapists, ambulance drivers and all other active professionals in combating Covid-10 in times of pandemic.

2.4 Inclusion and exclusion criteria and ethical aspects

All health professionals working in the fight against Covid-19 and who signed the free and informed consent form and returned the completed questionnaires were included.The exclusion criterion was not returning the informed consent form and not filling out the questionnaires. The research project complies with Resolution 466/12 of the National Health Council of Brazil, taking into account the ethical aspects of research in Brazil.

III.   RESULTS AND DISCUSSION

The results found in the applied MBI questionnaire were calculated using the Likert scale, ranging from 0 to 6. After the sum of the items, a total value for Emotional Exhaustion (EE), Depersonalization (DE) and Professional Fulfillment (PR) was obtained, with each value obtained being divided by the total number of health professionals, obtaining the average of each factor.

It is observed in Table 1 that the two Hospitals had high rates of Emotional Exhaustion (EE), Depersonalization (DE) and low Professional Fulfillment (PR). They are indicative of high rates of Burnout incidence. All indices above the averages recommended by international and national literature: Emotional Exhaustion (EE) ≥ 27, Depersonalization (DE) ≥ 10 and low Professional Achievement (PR) ≥ 33.

The means found are higher than those found and recommended by the GEPEB - Study and Research Group on Stress and Burnout Syndrome. Group formed by Brazilian and Spanish researchers, who over the years have been developing studies, courses and investigations on processes of stress, burnout, quality of life, resilience and engagement in various professional groups (teachers, psychologists, doctors, nurses, etc.) in order to understand and develop health at work.The findings in the current research are also superior to those found and recommended by Manual Spain and the American Manual.

The Emotional Exhaustion (EE) dimension showed high rates, which may be causing symptoms of exhaustion and frustration. The Depersonalization (DE) dimension also presented a high index that can manifest itself through negative attitudes such as derogatory treatment, cold and distant attitudes and disconnection from the problems of patients and clients and co-workers. The professional's performance is directly influenced by the high rates of Depersonalization found in the research, which express the interpersonal context where the subject's work is developed, and the decrease in personal achievements, represents the self-assessment that the individual performs of his/her occupational and personal performance. Regarding the Professional Achievement (PR) dimension, it can be observed that the health professionals of the two Hospitals had slightly higher PR rates compared to those found in the international and national literature, by the GEPEB group, by the Manual España and Manual Americano.

For Maslach, Schaufeli and Leiter [51] emotional exhaustion is characterized by feelings of being overwhelmed and exhausted of their physical and emotional resources, leading to depletion of energy to invest in situations that arise at work. This dimension according to Maslach and Leiter [52]; Carlotto and Câmara [16] is considered a central quality and the most obvious manifestation of the syndrome, being associated with feelings of frustration in view of the professionals' perception that they are unable to understand the energy to care for patients as they did before [52]; [16]. Maslach, Schaufeli and Leiter [51] explain that as emotional exhaustion worsens, depersonalization or cynicism can occur, which are characterized by a distant or indifferent attitude of the individual towards work, colleagues and patients. These authors argue that depersonalization is considered a response to emotional exhaustion, constituting an individual's coping strategy in the face of chronic stress.

Carlotto and Câmara [16] explain that the gradual loss of empathy and indifference towards work culminates in affective insensitivity and excessive distance from the public that should receive their services, compromising the ability of health professionals to provide quality care to their patients. According to Moss et al [15], this dimension can also be expressed by unprofessional comments directed at co-workers, by blaming patients for their problems or by the inability to express empathy/regret when a patient dies. While the dimension of reduction in personal fulfillment refers to the subject's tendency to negatively assess himself/herself in relation to their skills and productivity at work, which can lead to reduced self-esteem [30]; [15];[51]. In this dimension, the individual

experiences a decline in the feeling of competence and success, as well as in their ability to interact with others [16].

Table 1 shows the values obtained for each public hospital and the general average obtained for all two hospitals (item ALL).

Table 1: Presentation and Comparison of the mean values of EE, DE and PR by Hospital Unit

VARIABLES	H1*	H2**	ALL
	N=50	N= 90	N= 140
EE	34,0	39,0	36,5
DE	16,0	12,0	14,0
RP	36,0	34,0	35,0

H1* Hospital 1   H1** Hospital 2

According to Perniciotti et al [9] the consequences of Burnout Syndrome in health professionals are serious, as moderate and high levels of Burnout Syndrome are associated with: 1) individual disorders, such as post-traumatic stress disorder. traumatic (PTSD), alcohol abuse, psychosomatic complaints, drug use, depression and suicidal ideation; 2) behavioral changes related to job dissatisfaction, lack of organizational commitment and intention to leave work; 3) problems at work, such as absenteeism, worse results in patient safety measures and errors in professional practice. These statements about the consequences of Burnout Syndrome in health professionals are corroborated by important authors such as Moss et al [15]; Dyrbye et al [53]; Lacovides, Fountoulakis, Kaprinis and Kaprinis [54]; Lazarescu et al [55]; Maslach and Leiter [56]; and Moss et al [15].

According to Carlotto and Câmara [16]; Lacovides et al [54]; Moss et al [15]) the consequences of Burnout Syndrome culminate in a decrease in the quality of life of health professionals and in the efficiency at work, negatively impacting patient care. For Waterman et al [57], the occurrence of errors in professional practice also causes harm to the professional, as it is related to loss of confidence, sleep difficulties, reduced job satisfaction, increased levels of occupational stress and damage to the professional image. For Moss et al [15], the abandonment of professional practice increases the turnover of professionals in hospitals, resulting in high organizational costs for the replacement of employees.

Perniciotti et al [9] state that no national studies were identified that point out the organizational expenses attributed to the Burnout Syndrome in health professionals. According to Dewa, Jacobs, Thanh and Loong [58] a study carried out in Canada estimates that the "total cost of

Burnout Syndrome" exceeds the value of 200 million dollars due to spending on early retirement and reduced hours worked for the medical category. According to Hamidi et al [59] a study carried out in the United States shows that 28% of the physicians evaluated with Burnout Syndrome showed an intention to leave their work and after two years 13% actually did so, resulting in costs ranging between 15 and 55 million dollars .

About which professionals are more affected by Burnout Syndrome, Borges et al [1] in their study "Risck Factors For Burnout Sydrome In Health Professionals During The Covid-19 Pandemic, show that nurses, nursing assistants and technicians are more likely to develop occupational stress. In the current scenario, this problem is more likely to be acquired by professionals, since the demand for health services has grown exorbitantly and the global health infrastructure was not prepared for such demand, in addition to the fear of the collapse of the health system. For Borges et al [1], overwork, lack of resources and professionals in many places, the high number of deaths and cases of infected people and the fear of becoming infected are realities in hospital environments today. Also according to Borges et al [1] in their research, work overload, stress, physical exhaustion, depression and compromised social interaction are the main risk factors for the development of Burnout Syndrome in health professionals, as well as suffering psychological, caused by insomnia, anxiety, depression, sadness, isolation from family and friends during the pandemic. Fear of contracting the disease and family members' infection are also major causes of psychological stress. It is noteworthy that, in the specific analysis of sociodemographic data, they indicate that women suffered a greater psychological impact from the outbreak in the pandemic. The hospital environment generates more psychological problems for health professionals. The causes are related to the demand for work in an emergency situation caused by the Covid-19 pandemic. Thus, more attention should be directed to health professionals who are on the front line against the disease, as the importance of these professionals is unquestionable for the social good [1].

Borges et al [1] in their review study found the main stress factors for health professionals in combating Covid-19. Among these factors, the following stand out: Exhaustive workload; Increased number of confirmed and suspected cases; Close contact with infected patients; Distance from family and friends; Lack of personal protective equipment; Risk of contracting the virus and concern about contagion from their family members; Risk of being infected, getting sick or dying, in addition to the possibility and fear of infecting other people; Exposure to large-scale deaths and frustration over the loss of their

patients' lives; The stress and pressure of dealing with your job, plus the risk of getting sick; Aggression itself by people who seek care and cannot be accepted due to limited resources; Limited knowledge of virus prevention and control; Inappropriate feelings of support; Lack of specific medications, and media coverage.

The most prevalent emotional symptoms presented by health professionals in combating Covid-19 are also corroborated by the review research by Borges et al [1]. Among them, depression, fear, lack of energy, insomnia, stress associated with difficulty falling asleep and waking up in the morning stand out, anxiety, compromised social relationships, anguish, insecurity, irritability, sadness and apprehension.

For Barbosa and Beresin [60]; Benevides-Pereira [61] The symptomatic process of Burnout Syndrome can be grouped into four areas: psychosomatic, behavioral, emotional and defensive: Psychosomatic refers to the onset of headaches, muscle tension, gastrointestinal disorders, weight loss, insomnia, asthma and high blood pressure; Behavioral factors are identified as absenteeism from work, violent behavior, impotence regarding interactivity, drug use and dependence, as well as problems in family relationships; Emotional ones are marked by affective isolation, impatience, irritability, concentration and memorization difficulties; And, finally, in relation to defensives, there is the denial of one's emotions, detachment from people and selective attention, with the sole purpose of warding off a negative experience. For Benevides-Pereira [61] the person who presents the Burnout Syndrome does not necessarily have all these symptoms. The degree, type and number of manifestations experienced will depend on the configuration of individual factors (such as genetic predisposition, socio-educational experiences), environmental factors (workplaces or cities with a higher incidence of pollution, for example) and the stage at which the person is in the process of developing the syndrome.

McCornnell apud Guimarães and Cardoso [62], elaborates a scheme about the signs and symptoms in the individual with Burnout Syndrome, as follows: a) Physical signs and symptoms: similar to those of occupational stress, such as fatigue, feeling of intense exhaustion, indifference or coldness, feeling of low performance, headaches, gastrointestinal disturbances, sleep disorders and breathing difficulties; b) Behavior symptoms: serious changes in behavior generally affecting colleagues, patients, patients' relatives and even their own relatives; c) Psychological symptoms: appearance of changes, such as working more intensely,

feeling of impotence in the face of occupational life situations, feeling of confusion and uselessness, irritability, little attention to detail, increased absenteeism, feeling of exaggerated responsibility or out of context, negative attitude, rigidity and low level of enthusiasm.

In the sociodemographic questionnaire, the main factors, as shown in Table 2, were the predominance of females (85%), age from 31 to 45 years (45%), marital status, married (49%) and single (41 %) and professionals with children (75%), with a predominance of one to two children (50%). Comparing these findings with studies in Brazil, we found very similar results regarding the predominance of females in the health area, the age range being lower than in other studies, which can be justified by the emergency entry of newly graduated professionals in the pandemic combat service.

Table 2: Sociodemographic Data: gender, age, marital status and number of children (N = 140)

VARIABLES	Fr%
Gender	
Male	15%
Feminine	85%
age range	
Up to 25 years old	10%
from 26 to 30 years old	15%
From 31 to 35 years old	25%
From 36 to 45 years old	20%
From 46 to 55 years old	20%
over 55 years old	10%
Marital status	
Not married	41%
Married	49%
Separated/Separated/Divorced/Widowed	10%
Number of children	
None	25%
1 son	25%
2 children	25%
3 sons	15%
4 sons	5%
5 or more children	5%

Fr% = Relative frequency

According to studies by Benevides-Pereira [61]; Martinez [63]; Russell and Velzen [64], there is no single agreement on the possibility of a higher incidence of Burnout with regard to sex. Women have had higher scores in Emotional Exhaustion and men in Depersonalization. This fact can be analyzed by the social and cultural characteristics of men, who are not encouraged to show their emotions and after high levels of stress tend to react inappropriately, through Depersonalization. Predominates health professionals between 36 and 45 years old who, due to their age, should already have a greater professional identity. There are scientific reports that professionals under the age of 40 are at higher risk of incidence, as young professionals need to learn to deal with work issues. According to Benevides-Pereira [61], it is important to note that Burnout appears at the beginning of a professional's career, being externalized later with work changes. Sarriera [65] says that Burnout is a state of chronic stress and to reach the state of a syndrome, the body issues several alerts and seeks to combat or compensate, when it is defeated, stress becomes chronic, as a syndrome, which can lead to physical, psychosomatic, psychic or social illnesses. According to Benevides-Pereira [61] and Martínez [63], a stable relationship would be among the lowest incidence of Burnout, as single people or people with unstable relationships have greater emotional exhaustion, low professional achievement and greater depersonalization. There is no consensus on the health professional's marital status in relation to Burnout Syndrome, that is, the predominance of married marital status does not confirm in other studies, which indicate single and young people as a predisposing factor to the syndrome. The number of children also brings controversial results, as this can be a factor that balances the professional, enabling better combat strategies. However, according to Martínez [63], the existence of children makes people who have a stable relationship may be more resistant to Burnout Syndrome, as the general tendency found in parents is to be more mature, stable and a good relationship with the family and children brings greater capacity to face personal problems and emotional conflicts, and to be more secure with family support.

As for the professional variables evaluated in this study, the main factors described in Table 3 were obtained, with a predominance of professionals with primary and secondary education with 35% (nursing assistants), professional secondary level with 25% (nursing technician) and graduates with 15% (nurses and doctors without specialization) and professionals with specialization (15%). Professionals working in two shifts predominate (40%), with professional experience from 6 years to 15 years with (50%), with emphasis on professionals with less

than 6 months of experience (mainly newly graduated doctors), the professionals with little experience in Covid-19 treatment (50% with less than 6 months of experience) and with a predominance of patient care or more than 40 calls for daily care (75%), and 90% do not work with exclusivity in the Hospital Unit, that is, these professionals have a second or third job.

Table 3: Professional Data (N = 140)

VARIABLES	Fr%
Education	
Elementary or Middle Level	35%
Professional Medium Level	25%
University graduate	15%
Specialization	16%
Master's degree	5%
Doctorate degree	2%
Work shift	
Morning	10%
Evening	10%
Night	20%
morning/evening	40%
on-call regime	20%
Professional Experience Time	
Less than 1 year	20%
1 to 5 years	15%
6 to 10 years	25%
11 to 15 years old	25%
16 years or more	15%
Time of Experience with Covid-19 Treatment	
Less than 6 months	50%
From 6 months to 1 year	30%
More than 1 year	20%
Number of Patients or Calls for Daily Service	
Less than 10	0%
Less than 20	5%
from 20 to 30	20%
more than 40	75%
Do you work exclusively at the Hospital?	
Yea	10%

No	90%

Fr% = Relative frequency

According to studies by Benevides-Pereira [61], people with higher education are more predisposed to burnout, with a greater professional perspective or a higher level of responsibility, but professional achievement may be related to the status and recognition of the high level of the profession. Excessive work entails several inconveniences and leaving them susceptible to Burnout. The longer the working time and the greater the workload dedicated to the institution, the more prone to Burnout Syndrome. The length of professional experience is not in agreement with other studies, and some studies describe Burnout as a process of wear that increases over time, while others have a higher incidence in those who enter the labor market, due to little experience and not have even developed adequate strategies to face professional problems. As for the length of experience, Burnout starts to reveal itself from the first year of work in excessive and overwhelming conditions. Although the professional experience of those surveyed is not a factor that triggers the Burnout syndrome, when observed together with the short time working at the institution, it may indicate possible predispositions to the onset of Burnout. According to Benevides-Pereira [61], work overload has been one of the most cited variables as predisposing to Burnout, as it is related both to the quantity and the excessive quality of demands, which exceed the performance capacity. The closer the worker's relationship with the person he or she must professionally assist, the greater the probability of triggering the Burnout process. Among the professionals surveyed, those who do not work exclusively in a single institution (90%) stand out, a factor that can generate a constant adaptive need to adapt to each new work environment. According to Silva and Fogaça [66], the professional having other jobs implies more efforts, more planning and more preparation for different activities, increasing the feeling of mental burden and decreasing the possibility of obtaining pleasure.

According to the data obtained in the research on psychosocial factors, Table 4 can be seen, where the predominant classification and relative frequency of these factors are specified. Psychosocial factors affect professionals from different areas and this reality has generated great interest and concern not only from the international scientific community, but also from government groups, given the seriousness of the consequences, both individual and organizational, presented by Burnout Syndrome, especially as an interference factor in the interpersonal relationships of the health professional.

Table 4: Predominant Classification and Relative Frequency of Psychosocial Factors.

Psychosocial Factors	Classification	Fr%
Misbehavior of patients or family members	Sometimes	45,0%
Activity overload	Often	40,0%
High number of patients per shift	Always	55,0%
Need for professional updating	Always	70,0%
Execution of bureaucratic activities	Rarely	30,0%
Multiplicity of roles to play	Often	40,0%
family members' expectations	Always	80,0%
Lack of material resources for work	Sometimes	35,0%
High number of daily activities	Always	35,0%
Lack of support from coordination and colleagues	Rarely	30,0%
Little participation in institutional decisions	Sometimes	30,0%

Caption: Always (1); Often (2); sometimes (3); Rarely (4); Never (5).

The factor bad behavior of patients or family members was referred to as sometimes (45.0%), being a factor that in this classification may represent a trigger of Burnout. The activity overload factor was referred to as Frequently (40.0%), reinforcing what many studies say that this is a triggering topic for Burnout Syndrome. In several explanatory models, it is the emotional exhaustion factor that is triggered primarily in the Burnout Syndrome process, thus, the physical and mental fatigue resulting from professional activity, the energy depletion resulting from the overload of activities, can be considered as contributing factors for emotional exhaustion and consequently Burnout [67].

The high number of patients per shift was classified as Always (55.0%), a factor that is associated with the high number of daily activities and the high number of patients assisted by the professional and the high number of calls for assistance can trigger Burnout. The factor needing professional updating was represented as Always 70.0%. According to studies by Benevides-Pereira [61], people with high professional motivation are more prone to burnout. The factor execution of bureaucratic activities presented the classification Rarely (30.0%). The multiplicity of roles to play factor was rated Frequently

(40.0%). This factor can contribute to the presence of Burnout Syndrome. The factor expectation of family members was rated Always (80.0%), representing that family support can influence the Burnout indices.

The factor lack of material resources for the work, presented classification Sometimes (35.0%), and the factor little participation in institutional decisions, Sometimes (30.0%) did not present indices that can directly collaborate in the occurrence of the Syndrome of Burnout. In the research carried out, the factor lack of support from the coordination and colleagues presented a classification Rarely (30.0%), which does not seem to contribute to the occurrence of Burnout.

According to Tamayo and Tróccoli [67], the perception of organizational support depends on the same attribution process that people use to define the commitment of others in social relationships. This perception is influenced by the frequency, intensity and sincerity of expressions of praise and approval and by aspects related to payment, job category, job enrichment and influence on the organization's policies. In the understanding of Vasques-Menezes and Soratto [68], social support refers to the social network naturally established between co-workers, neighbors and acquaintances, and can be understood as the help to solve problems, which can be in the sense of allow the discharge of an affective charge. According to Russell and Venzel [64] social support has been identified as the resource that enables the individual to be able to withstand stress. According to current hypotheses, individuals who are related to social support are able to trust others to help them in stressful situations.

IV.   CONCLUSION

The present study concludes that health professionals working to combat the Covid-19 pandemic in two public hospitals have high rates of Emotional Exhaustion (EE), Depersonalization (DE) and low Professional Fulfillment (PR). The results found in the study are indicative of high rates of Burnout incidence. All indices are above the averages recommended by international and national literature. The means found are higher than those found and recommended by GEPEB - Study and Research Group on Stress and Burnout Syndrome. This group is formed by Brazilian and Spanish researchers, who over the years have been developing studies, courses and investigations on processes of stress, burnout, quality of life, resilience and engagement in various professional groups (teachers, psychologists, doctors, nurses, etc.).) in order to understand and develop health at work. The findings are also superior to those found and recommended by Manual Spain and the American Manual.

In the study, there was a predominance of females (85%), aged from 31 to 45 years (45%), married (49%) and single (41%) and professionals who have children (75%), predominantly number of one to two children (50%). Comparing these findings with studies in Brazil, we found very similar results regarding the predominance of females in the health area, the age range being lower than in other studies, which can be justified by the emergency entry of newly graduated professionals in the pandemic combat service. There was a predominance of professionals with primary and secondary education with 35% (nursing assistants), professional secondary level with 25% (nursing technician) and graduates with 15% (nurses and physicians without specialization), professionals working in two shifts (40%), with professional experience from 6 years to 15 years with (50%) and mainly newly graduated physicians, professionals with little experience in the treatment of Covid-19 (50% with less than 6 months of experience and predominantly of patient care or more than 40 calls for daily care (75%), 90% with another job. Individual or associated psychosocial factors are conditioning factors and can directly determine the occurrence of Burnot's Syndrome in health professionals, especially at this time of combating the Covid-19 pandemic.

The scenario found requires a strategic planning policy for health promotion and prevention for these professionals, both by hospitals and by the State Health Department. We hope that this article will contribute to update the available literature on Burnout Syndrome and facilitate the understanding of the nuances that involve its triggering in health professionals, highlighting the importance of evaluating preventive interventions. The urgent need for interventions aimed at these professionals is evident, aimed at reducing levels of occupational stress, increasing self-esteem, encouraging self-care and building a healthy work environment.

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Guidelines for upcycling from a perspective of design management applied in a small factory of women's clothes in Caruaru-PE (Brazil)

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Abstract— Objective: present the guidelines for upcycling from the perspective of design management to minimize the generation of solid waste and add value to the production line. Material and Methods: the research was defined as applied, qualitative, experimental, action-research and bibliographical. The protocol involved in loco research in a small manufacturing company located in Caruaru – PE (Brazil), in order to analyze the production line and propose alternatives for upcycling from textile waste. Results: From the experimentation and literature review, four guidelines are presented relating upcycling to design management: (1) Design Planning, (2) Collaborative Design, (3) Social Design and (4) Design for Education and Communication.

I. INTRODUCTION

It is pertinent to expose the issue of solid waste generation, which presents itself as a serious problem prominent in the textile industry, especially in the clothing industry, the object of study of this research. In addition to the legal regulations that affect companies regarding the pollution generated, the awareness of a more sustainable fashion on the part of the consumer has been an incentive to rethink some industrial fashion practices. For Vezolli (2018) design can solve and create opportunities more sustainable life scenarios.

It is also necessary to have knowledge about how fashion product design management can validate upcycling as a sustainability and value strategy within the fashion market, especially in clothing. Environmental issues must be considered in the design involving the complete life cycle of the product (Vezolli, 2018).

Fashion product design management is the program that directs the design all these stages, ensuring that the objectives of a given project are achieved. Talking about design management is dealing with the deployment of design within the company to help it develop its strategy (Mozota, 2011).

Palmieri & Figueredo (2018) claim that the purpose of design management is in the organizational strategy focused on innovation that drives constant improvements, that is, design management in addition to directing the stages of a project, it also ensures the continuity of innovation strategies so that the design project becomes timeless.

Notwithstanding what was discussed regarding the environmental impact and disposal of textile products, several garment factories in the local productive arrangement (APL) of clothing from Pernambuco go through the same reality. Data from SEBRAE (2012) indicate approximately 18,800 companies distributed across the 19 municipalities that make up the Pernambuco Clothing Pole, 77,2% of the polo companies are in the three main municipalities in the region: Caruaru, Toritama and Santa Cruz do Capibaribe.

There are ways to minimize the effects caused by the disposal of solid inputs in nature. "Reuse, restoration and recycling intercept resources destined for landfills and lead them back to the industrial process as raw materials (Fletcher & Grose, 2011, p.63).

Given the available alternatives, in the view of Paoliello & Souza (2015), upcycling is a concept that has become significant among sustainability strategies, it means the use of a certain material at the end of a product's useful life or waste, to develop new products of greater value, use or quality without expending more energy to recover raw material. In this way the material does not need to go through the chemical and physical recycling processes, the material remains with its previous appearance, but with the shape of a new product. Lucietti, et al. (2018) also claim that upcycling is a recovery process that transforms waste materials into products of better quality and environmental value.

In the fashion industry, upcycling is presented as an alternative for clothes that have reached end of their useful life and for textile materials accumulated in stocks. The result of this process is the design of parts that challenge the general tendency to decrease the value of materials already used (Fletcher & Grose, 2011, p.69). For Morelli & Ender (2017) upcycling acts without undervaluing the waste material, as it increases its yield, alters aesthetic and functional aspects, adds value, and extends its useful life cycle.

It is also worth highlighting the economic factor, as upcycling becomes an economic opportunity for several companies, since one of the upcycling is that the products generated from this tool can have a higher value than the product that served as raw material.

II.   MATERIAL AND METHODS

It is an Applied, experimental, and bibliographical research. It is also action research, as this type of research according to Gil (1991) is carried out with a very close combination of planned action towards the resolution of a social problem.

Data Collection: The research was conducted in a small factory of women's clothes located in the city of Caruaru-PE (Brazil) in 2017.

III.   RESULTS AND DISCUSSION

The first guideline is in relation to the fabric choices that the confection acquires: (1) **design planning** as a differential to minimize impact. It is proposed to acquire fabrics in a planned way, with potential visual harmony

between them so that the waste can be used together resulting in new unique products, differentiated and with the perspective of sustainability.

Furthermore, it is suggested to invest in (2) **social design**, since waste products can be developed by cooperatives located in the region of manufacture to promote the sustainability of needy communities, as well as not disturb the production line of the confection. The factory will be able to direct its residues to the cooperative, which will carry out production processes such as cutting patches, splicing threads, assembling parts and finishing. Involvement with social causes also contributes to a competitive advantage and to the company's purpose.

In this perspective, (3) **collaborative design** is also included. As cooperatives word on the products and request other complementary materials, they are directly influencing the design that will be thought of in the base pieces in the company, aiming at the remnants/inputs. Collaborative design and co-creating are trends that are much discussed nowadays.

And finally, we highlight (4) **design for education and communication**. The intention is to minimize the impact that clothes produce to the environment, promoting a longer shelf life even if it is for another purpose after being clothes. This practice is a great opportunity for consumers to also take their eyes off the common practices of disposing of clothes and start seeing possibilities for new products in their waste.

It is proposes to generate information for people through a company label or website that informs how the consumer can transform the garbage it also produces through simple alternatives. In this perspective, the company assumes the role of co-responsible for the disposal of the clothes, advising the consumer on how to expand its use before disposing of it. This can generate more value to the purchased product, as it gains more alternative use after being clothes.

Another opportunity is the fact that consumers are increasingly engaged and attentive to social and environmental issues, so digital media can be tools for the dissemination of content on social and environmental responsibility or even to affirm the responsible practices of companies inf relation to their consumers.

IV.   FINAL CONSIDERATIONS

Upcycling in the fashion industry has become an increasingly recurrent practice, despite its recent emergence, this concept has transformed the way to generate fashion products. Through the assimilation of the

subject, we observe that upcycling in fashion reflects in a circular economy.

The upcycling propositions presented can be followed by other confections. These aim to promote sustainability practices inside and outside the manufacturing environment. Its was also found that upcycling practices comprise not only the minimization of the disposal of inputs derived from clothing, but they also encourage companies and consumers to adopt more ethical environmental behavior.

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Contribution of community tourism in the neighborhood of Esteu in the Ilha de Moçambique

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Abstract— One of the challenges that the Provincial Government of Culture and Tourism is currently facing is on how to encourage the practice of community tourism (CT), which is historical and cultural heritage assetinstead of only the practice of the beach tourism that is the most common. Thus, the Provincial Directorate of Culture and Tourism, sees community-based tourism as a premise to boost tourism in the Esteu community in the Ilha de Moçambique. Tourism is seen as a true vector for galvanizing the local economy, respecting the conservation of cultural heritage and historical values.

As the analysis focused on which contributions CT has made to the local community, qualitative method has been used as it allows knowing the group from their perceptions and understanding how they conceive and practicetheir life experiences and the meanings of human actions and social life through the interpretation of the reality. Semi-structured interview techniques have been also used as these techniques favor interaction between the interviewer and the interviewee through a script of questions. The observation technique, being a social investigation has been applied because it allows the researcher to have a direct contact in the observation of the behavior and attitude of the residents involved in the CT activity. In addition, documentation analysis has been also carried out on various strategic plans for the development of tourism, as they can bring to the surface what the participants cannot say. To support the study, eleven (11) participants were selected; the choice was based on the intention and coexistence and they were considered the fundamental informants of the study. It is noticed that there is a huge satisfaction of Esteu community residents. Their involvement in community tourism has improved the life quality of their community and the way of living in the society, in an organized way through economic and social benefits such as employment generation and the strengthening of cultural identity.

Resumo— *Um dos desafios que a Direcção Provincial da Cultura e Turismo, vem travando na actualidade é a prática do Turismo de praia o mais comum contra o turismo comunitário (TBC) virado para o património histórico-cultural, como forma de incentivar a prática do turismo na comunidade de Esteu e não apenas o litoral. Aliado a isso, a Direcção Provincial da Cultura e Turismo, olha para o turismo de base comunitária como uma premissa para galvanizar o turismo na comunidade de Esteu na Ilha de Moçambique, visto que o turismo é tido como um verdadeiro vector para galvanização da economia local, respeitando a conservação de valores culturais, patrimonial e históricos. A analise centrou-se sobre que contribuições TBC trouxe para a comunidade local. Foi aplicado o método qualitativo, porque permite conhecer o grupo a partir das suas percepções e entender como concebem e praticam suas experiencias de vida e os significados de acções humanas e da vida social através da interpretação da realidade. Foram usadas as técnicas de entrevista semi-estrutura, esta técnica, favorece uma inteiração entre o entrevistador e o entrevistado através de um roteiro de perguntas, a técnica de observação, tratando-se de uma investigação social permite o pesquisador ter um contacto directo na observação do comportamento e atitude dos residentes envolvidos na actividade do TBC, dizer que também foi realizada análise documental, sobre a vários planos estratégicos do desenvolvimento do turismo, pois estes trazem à superfície o que não pode ser dito pelos participantes. Para suportar o estudo, foram seleccionados onze (11) participantes, a escolha foi pela intenção e convivência e considerados os informantes fundamentais do estudo. Percebe-se que há uma enorme satisfação de moradores da comunidade Esteu, pelo envolvimento no turismo comunitario, visto que a sua participação revolucionou a vida da comunidade e a forma de viver em sociedade de forma organizada e melhoria da qualidade de vida através de beneficios economicos e sociais, geração de emprego e do fortalecimento da identidade cultural.*

Palavra-Chave— *Turismo comunitário; Melhoria da qualidade de vida; desenvolvimento local.*

I. INTRODUCTION

One of the challenges that the Ministry of Culture and Tourism has been facing in recent times is how to encourage and galvanize the practice of community tourism in Esteu community instead of Beach Tourism which is the most common. Community tourism (CT) represents historical and cultural heritage. The Provincial Directorate of Culture and Tourism sees the community-based tourism as a premise for the galvanization of tourism in the community.

This study aims fundamentally to analyze the contribution that community-based tourism can bring to the local development of the community of Esteu in Ilha de Moçambique by offering potentially attractive places such as historical and cultural heritage for practice. This type of tourism includes monuments, historical sites and community culture.

The reason why thisresearch has been conducted is fundamentally due to the existence of tourists and historical attractions on the Island of Mozambique in order to promote awareness on cultural tourism with a focus on community-based tourism as an alternative to conventional or beach tourism. Furthermore, as an employee of the Provincial Directorate of Culture and Tourism, the motivation was to carry out a study regarding the increment of the local economy to improve the life quality of community through the practice of community-based tourism. The involvement of community allows the development of society and contributes significantly to improving the life quality.

A study is part of seeking solutions. So this study aims toencourage the practice of cultural tourism instead of the beach tourism which is common to Esteu local community. Community tourism is the best way to enable the Esteu local community to develop.The experiences of developed countries havebeen showing that community tourism is beneficial. Secondly, this analysis can serve as a consultation for the Provincial Executive Council of Nampula, the District Government of Ilha de Mocambique with greater emphasis in the area of planning and management, academics and others uses.

Finally, the choice of this theme is due to the strong desire to make a contribution to the Tourism sector, in particular in the Department for the Promotion of the Development of Tourist Destinations.

Moreover , these forms of conventional and cultural tourism open up a space for reflection on the impact that the tourist activity produces, and can thus become a factor of transformation for the local community.

II. METHOD

The role of social science is to discover how people interpret differently the world in which they live.

Since the study   focuses on social science the qualitative method has been applied as it allows knowing the group from their perceptions and understanding how they conceive and practice their life experiences and the meanings of human actions and social life through the interpretation of reality. The qualitative methodology also underlies the universe of meanings, based on motives, aspirations, beliefs, values and attitudes, which concern "the interpretative understanding of social action.

In qualitative methodology, the central phenomenon goes to "the understanding of the intentions and meanings, beliefs, opinions, representations, perspectives, that human beings place in their own actions with others and with the contexts in which and with which they integrate" (Beloved, 2014, p.14).

On the other hand, according to authors Bogdam and Biklen (1994), consider that qualitative investigations are distinguished by the following attributions: data sources are natural environments; its analysis is fundamentally descriptive; the processes and results are important to the investigator and the data are analyzed inductively and emphasize the search for the meaning that subjects give to phenomena in their natural contexts. For this study, semi-structured interview techniques have been used for data collection, as it is a main instrument of qualitative research and favors an interaction between the interviewer and the interviewee (Marconi and Lakatos, 2002, p. 92). Herbert, Goyette and Boutin (2010). document analysis has also used as it allows the researcher to have a direct contact in the observation of behavior and attitude of residents involved in community tourism. Also it allows to observe the level of satisfaction of the community involved in tourism activity. Observation technique, the researcher uses this technique to gather real information about a phenomenon, which allows the examination of facts that are intended to be addressedso it "is a data collection technique to obtain information that is not based onmerely seeing and hearing but also allows toexaminefacts or phenomena that one intends to study" (Marconi and Lakatos, 2002, p. 88) Richardson (1999) considers observation as a way to identify objectives that guide a study. The documentation analysis has been also used; this technique was applied to normative documents on strategic policies for tourism development, the government's five-year plan (2020-2024), provincial strategic plan, tourism marketing strategy, five-year report of the Provincial Directorate of Culture and Tourism DPCULTUR (2014-2019). The factors for choosing this data collection technique is that it is very important to make an assessment of the documents used by institutions for example, the minutes and/or reports. When conducting a research, as they bring to the surface what cannotbe said by the participants(Carmo & Manuela, 2008).In order to make this study successful Eleven (11) participants were selected, divided as follows: one (1) community leader, seven (7) community members and one (1) President of the Association of Small Tourism Entrepreneurs of Ilha de Moçambique (APETUR), one (1) District Administrator of Ilha de Moçambique, and one (1) director of the provincial directorate of culture and tourism responsible for the tourism sector.

The criterion for choosing participants wasbased on intention and convenience. For this study 8 participants were selected. It is important tonoticethat the communityis the direct target on the contribution that tourism enhances the local economy andits development. For this reason they were considered the key informants of this research as well as the President of the Association of Small Tourism Entrepreneurs of Ilha de Mozambique, through theconnectionsof community programs, the District Administrator of Ilha de Moçambique, the Director of the Provincial Directorate of Culture and Tourism, theseare decision makersand they are part of the process of tourism development at the Provincial level and represent the Provincial Executive Council of Nampula .

Themain reason that has made the District Administrator of Ilha de Moçambique and Director of the Provincial Directorate of Cultureas participants in the study isthe fact that theyareresponsible for implementing the strategy and public policy for the development of community tourism as a key playerfor local economic development.Sothey are the right people and in right position to provide relevant and necessary information.Also, thePresident of the Association of Small Tourism Entrepreneurs of Ilha de Moçambique (APETUR) is a participant in this study due to the connection of community programs.

Important Fundamentals of Community Tourism
Some concepts about community tourism

Community Tourism is not just a productive activity, itseeks also to emphasize ethics and social relations and values of the specific resources of a territory to establish relationships between the receiving communication and the tourist. (Sampaio, 2006, p. 6) and (Sampaio & Coriolano, 2009),refer that sustainable territorial development comes from the community itself through the coexistence between the residentpopulationin the community and visitors. (Illich, 1976), says community-based tourism provides the social relationship between different ways of life. From the perspective of Sachs (1993), argues that social sustainability allows for equity in the distribution of goods and income to reduce the gap between the rich and the poor.

Coriolano (2003, p. 121) states that people's**motivations to travel have been** for issues related to education and culture, for example: visiting monuments, historical sites, museums, enjoying the arts, acquiring new adventures and experiences. One of the biggest current motivations is to enjoy thenature through ecotourism and the ecotourist who called Adventurer tourists or Guests of nature.

The new typology of tourists", with extensive travel experience, select the best destinations, which value more the spiritual and ecological aspects of travel in search of the reality of nature in the destinations (Montejano, 1996), he adds,that these tourists like an ecologically natural and cultural environment. Therefore, they are free and flexible and spontaneous when selecting a destination.

For Sansolo and Bursztyn (2009), the enhancement of cultural identity and the generation of direct benefits for host communities are sustainable components of this type of tourism. According to these authors, community tourism does not represent just a segment of the market, but enables the new paradigm for tourism. The potentialactivity is not restricted to economic benefits, but alsocontributions to the process of revaluing cultural identity and the maintenance of the way of life of traditional populations.

The development of community tourism occurs when the protagonists of destinations, in this casecommunities, become subjects and not objects of the process, says Irving (2009). In an attempt to outline a conceptualization for community tourism, the author presents some premises that emerge as central elements of the activity: (i) endogenous basis of local initiative and development; (ii) participation and social protagonism in the planning, implementation and evaluation of tourism projects; (iii) limited scale and controlled social and environmental impacts; (iv) generation of direct benefits to the local population; (v) cultural affirmation and interculturality; (vi) sharing and mutual learning between tourists and local communities.

In the understanding of Hiwasaki (2006), the sustainability of community tourism is based on fourgoals:

> (i) community participation in tourism planning and management; (ii) conservation of natural and cultural resources; (iii) economic and social development, based on income generation as economic and social benefits for the local community; (iv) quality in the visitor experience, as a commitment to ensuring the visitor a quality experience and committed to social and environmental responsibility.

The direct benefits to the host communities are fundamentally representative for community-based tourism. Some concept,for instance, argue that community tourism must be committed to sharing the benefits among community members (Maldonado, 2009). In the view of (Singer, 2010; Sampaio et al., 2009),argue that Community-Based Tourism is associated with solidarity economy practices, whose principles are self-management, democracy, participation, cooperation andequitable distribution. The authors state that CT is a driving force for local development. Addition, (Aref et al., 2010), argue that community tourism is seen as a lever for community development. The authors argue that communities should look to tourism for local economic, social, cultural and general development and add that "the process of tourism development in a community it is its owncommunity development process" (p. 157).

For Lenz (2011), community and attractive tourism are the key factor to developing the territory:that is to say, tourism benefits from the synergies that exist in the area and, the activities developed in the territory are carried out through incentives from the activity. As a premise for the integration of various local economic activities,Community tourism provides the strengthening of traditional activities and become itsown attractions.

(Turisol 2008 cit. in Mendonça, 2009,) reinforce that community-based tourism activity should not be seen as an income and wealthgenerating, rather, as an opportunity to improve community organization, local development and co- management to preserve the natural, cultural, and traditional life of communities in its territory (p.300).

Community-Based Tourism represents a promotion of tourist activities based on a model of social, fair and environmentally responsible development. The authors also reinforce that the central characteristic is the structuring of the dialogue between the visitor and the hosts community (Bursztyn et. al. 2009, p.86).

TBC does notonly represent another market segment, but creates the opportunity for a new paradigm, which is more responsible in the planning and execution of activities based on the tourist experienceto less privileged areas from the point of view of economic indicators and the basic offer ofurban infrastructure (Machado, 2007; Irving, 2009; Fabrino, 2013).

For Benatti & Silva, they understand that the practice of TBC in the territory can bring benefits, and encouragement to participate in adequate planning, through contact between the community and tourists or visitors, in a harmonious way of coexistence. (Benatti & Silva, 2011)

The Government of Mozambique's Five-Year Program (PQG) 2020-2024 establishes that:

> "*community involvement in tourism development activities, should boost economic growth, productivity and income generation, as a priority*".

The strategic objective of the PQG, proposes to strengthen the capacity andthe role of tourism asfollows:

> "*factor that boosts the economy, creating projects to stimulate community and cultural tourism in Nampula Province, particularly in Ilha*

de Moçambique, and promote Nampula Province as a touristexcellent destination, with a view to attracting investments and increasing tourism demand by conducting familiarization visits, participating in fairs and carrying out campaigns to promote domestic tourism" (PQG, 2020-2024).

Here from, government action should focus on:

"improving the well-being andthe life quality of the communities ~~in~~ by reducing social inequality and poverty, and creating an environment of peace, harmony and tranquility, with a strong incentive togenerationofincome and create employment opportunities.

The creation of wealth in communities and the reduction of social inequality, promote leisure, business and historical-cultural tourism and expose the country as a privileged destination for tourism, which are the main prerequisites for the creation of basic conditions for economy and social welfare" (PQG, 2020-2024).

Community tourism is a type of tourism developed by the community itself, wherethe local population, organized in association, has effective control of the territory and economic activities associated to the exploitation of tourism, where the community is responsible for planning activities through the management of tourism infrastructure and services;guidance is based on principles to ensure social, economic and environmental sustainability.

PQG (2020-2024), is in line with the Provincial Strategic Plan (2020-2024), which establishes the expansion of community tourism to other areasof Nampula Province,such as Mecuburi, Ribáuè and Malema, these are destinations that have got cultural asset, for the implementation and practice of community tourism (PEP, 2020-2024).

In turn, Resolution Nr. 14 of 4 April 2003 approved the Tourism Policy and Strategy for its Implementation and established the guiding perspective for the growth and development of tourism in the future, support:

(1) Thedevelopment of the country; (2) Assumption of the Governmentat the National, Provincial and Local levels, of the responsibility for defining and controlling the standards for the development of quality in Tourism; (3) Planning and coordination of the development of tourism markets, products and infrastructure in the country; (4) Establishment of an institutional framework for planning and control mechanisms for active participation in the development of Tourism; (6) Recognition of the private sector as a driving force in the development of thetourism

industry; (7) Awarenesson the importance of Tourism and the value of natural and cultural heritage; (8) Training and professionalization of human resources in order to increase the quality of tourism; (9) Promotion of effective community involvement in development programs (MITUR, 2013).

Tourism Marketing Strategy (2006-2013), argues that,

Community tourism contributes job creation, economic growth and poverty alleviation, it serves to preserve and disseminate the cultural values and national pride of the Mozambican people in improving thelife quality (EMT, 2006-2013).

Community-based tourism is important for the communities because the population seeks to undertake tourism in their territory according to their desires and expectations, for political empowerment, to avoid the negative effects generated by the practice of tourism. In this sense, the economic, social and cultural well-being of the local community can be preserved if the role of residents guaranteed (Rodrigues, 2014).

According to Zechner, Henríquez, Sampaio, (2008), community tourism is a social communication strategy for traditional communities, with historical disadvantages, to try to reinvent their way of life. This strategy ~~s~~ should ensure that communities gain the quality and play a leading role in the productive activity chain, bringing local development. Local development should not only involve economic growth,rather the achievement of better living conditions through the available meansin the community or society. Inthis sense, local development is a social process, where the communities involved are managers and decide on the best strategies, plans policies and actions that should be taken for the development of the territory.

Moncayo and Hoyos (2013) show that community tourism is one that develops in geographically defined places, valuing ancestral knowledge and heritage, whose main purposes are to involve a greater number of local people in the tourist production activity. Community members must benefit from cultural, natural and economic resources; promote the permanence of the community in their places so that theycan be proud of their land and traditions. For (Mielke, 2009), tourism is an activity with the potential to improve the living conditions of a community and contributes to a conscious community. On the other hand, (Silva, Ramiro and Teixeira 2009), say that a participatory and inclusive plan should be applied to community-based tourism; following objectives, oriented towards economic activity and local development, in the case of the territory, cultural enhancement and

maintenance of biodiversity, regulations for tourism activity, development of products with a local identity or development of marketing plans, qualification of the workforce and organization of the community to allow the monitoring of tourism results, among other actions.

López-Guzmán, Borges and Castillo-Canalejo (2011) consider that Community Tourism presents itself as an alternative to traditional tourist destinations. This type of tourism allows greater contact with the community and provides new experiences. In addition, Fauré and Hasenclever (2007), highlight that for local development, three pillars of local development should be observed, such as endogenous, territory and institution, these pillars integrate special dimensions of a given destination,with emphasison the economy, socialization, culture and consolidated policies.

Therefore, it is assumed that destinations with potential tourist can develop a strategy to leverage the growth of the local economy and the improvement of the populations' life quality by optimizing their natural, historical and cultural characteristics.

According to Salvatierra and Mar (2012), tourism projects for local development must be focused on the individual and collective interests of the subjects and must be guided by endogenous strategies, assumed by the local community, since they are the local protagonists who intend to develop their territory to generate benefits. For Harwood (2010), ~~states that the~~ community must be involved in planning, construction, maintenance and management activities for the development of their community "this implies the involvement of the local community in controlling the projects in order to obtain the planned results". (Harwood, 2010, p.1910).Besides, the authors argue that community participation in the decision-making process in the implementation of tourism projects is a way for the community to value its identity and historical and cultural heritage, so that the life quality can be improved.

Brief history of the emergence of community tourism worldwide

The emergence and expansion of tourism in modern society are allied to the beginning of industrial capitalism in the 19th century. During this period, manual labor was replaced by industrial work, and society began to have new desires to increase the production of goods and an intention to trade relations. It is from the capitalist modernization that motivationsto travel for leisure, gain the model of contemporary tourism. For Boyer (2003, p . 16), tourism is the set of phenomena resulting from the travel and temporary stay of people outside their place of residence, as the visitor moves, satisfies their cultural need.

By the middle of the 20th century, tourism was an activity practiced by a privileged class with favorable economic conditions for leisure trips. Later, leisure and culture became accessible to the working class in developed countries, especially in the post-World War II period (1950-1980). The activity allows people with reasonable financial conditions to have also the opportunity to practice thismodel of tourism (Zapata et al, 2011).

Community Tourism in Mozambique
Pilot projects in Gorongosa and Maputo
Gorongosa National Park Experience

In 2004 the Government of Mozambique and the US-based Carr Foundation agreed to join efforts to rebuild the infrastructure of Gorongosa National Park, restore its fauna and flora and stimulate economic development. This remarkable initiative opened a new important chapter in the Park's history on the inclusion of the community in economic and local development activities through nature and adventure tourism.

As for fauna, Gorongosa National Park is the largest wildlife conservation area in Mozambique.
Visitors take self-drives in Gorongosa National Park and explore the Park's privileged area in their vehicles. In terms of tourist activity in Gorongosa National Park, there are four (4) different types operated by Bushfind such as car tours within the GNP; the car tourgives a view forwildlife on open land routes in the middle of the Park, where tourists or visitors have the opportunity tocontemplate the existing fauna and flora. This observation is accompanied by a specialized Tour Guide.

Cultural walking tour to a traditional village: the tourtakes approximately 3 hours, visitors take a walk to the Vinho community, this community lives in an organized society and in a traditional village close to the Park's buffer zone and along the way, visitors observe small animals such as monkeys, birds, gazelles and others.Once they arrive in the village of Vinho, touristscan visit the clinic, the school and the water wells built by the Greg Carr Foundationas community assistance program.

Afterwards, tourists can follow the activities of the village, there are selectedresidentsthe in communitytoexplain their livelihood, cultural aspects, the way of cultivation, construction of their houses, medicinal plants they use, among others. Tourists contemplatea traditional system for raising fish in ponds (aquaculture), theycan also purchase fruits, vegetables and handicrafts made by local population, contributing to their livelihood or life improvement within the community.

Trip to a waterfall in the Gorongosa Mountains: the activitytakesall day, starting at 06:30 and between 16:00 and 17:00. During this period, tourists visit the waterfalls of Mount Gorongosa, to reach the water-fall, tourists walk between 2 and 3 hours and once they arrive they can have lunch and listen to some stories told by the guides.

Watching the sunset from a viewpoint: In order see the sunset, tourists are taken by car, on a 50-minute ride to a viewpoint, overlooking the Pungue River as the sunset. The sun advances and the color changes in the sky, tourists are served cold drinks, relax and enjoy the iconic African sunset, while observing all the natural dynamics at the river and the ecosystems onlong the banks.

Experience of the Zinave National Park in Maputo

Note that in the Zivane National Park, nature and adventure tourism is geared towards safari. The community residing in the buffer zone of the Zinave National Park, preserves and conserves the park, avoiding wildfires and agricultural activities in order not to chase awayanimals and the deforestation of the forest.Ascompensation, the communities get benefits from the Zivane Park Administration. To mention only few, Zivane park has built a primary school, two medical centers with maternity hospitals in the cities of Tanguane and Maculuve, and an equal number of water fountains were built for the two communities. Tourists or visitors can walk around the community where they can learn about the community's cultural habits, legends and traditional activities such as chanting, dancing around the campfire and they can spend some amount of money in the community.

Potential Tourism in Ilha de Moçambique

Ilha de Moçambique is the third tourist park in the province of Nampula,behind Nampula city and Nacala-Porto. Ilha de Moçambique has vast tourist potential that ranges from historical monuments, the cultural mosaic, the beautiful and wonderful parades, as well as the gastronomy that are authentic attractions for tourists and visitors, as can be seen in theonlyfew images below:

Image 1. São Paulo Palace

Image 2. Chapel of Nossa Sra. do Baluarte

Image 3 City of Ilha de Moçambique

Image 4. São Sebastião Fortress by air view

Image 5. Nankaramo Beach

Image 6. The Pontoon

According to the Five-Year Report (2014-2019) of the activities carried out by the Culture and Tourism Sector of the Province of Nampula, on the Accommodation and Restaurant Capacity, Ilha de Moçambique has a total of 66 establishments of Tourist Accommodation, Catering and Drinks, 519 rooms, 897 beds, 940 tables, 3,724 chairs as well as 546 direct jobs, as shown in the table below.

Table 1: Accommodation and Catering Capacity

N.O	Quantity	Classification of the stalments	Accomodation capacity		Catering Capacity		Employment posts	
			Rooms	Beds	Tabels	Chairs	M	F
01	01	Hotels	21	32	50	200	27	06
02	03	Residences	92	127	75	300	45	15
03	03	Guest house	120	150	60	180	30	08
04	03	Campysm	45	72	150	600	40	10
05	12	Inns/hostels	78	184	60	240	54	11
06	05	Lodges	100	204	50	200	38	12
07	12	Rooms for rent	63	128	70	280	40	08
08	14	Restaurants and	-	-	140	560	70	28
09	13	Bars	-	-	291	1.164	78	26
Total	-	-	**519**	**897**	**946**	**3.724**	**422**	**124**

Source DPCULTUR, 2021.

The Contribution of Community Tourism in Ilha de Moçambique

Ilha de Moçambique is the epicenter of tourism due to its rich heritage and its vast historical-cultural mosaicforit receives tourists/visitors of different nationalities. Heritage and culture attract tourists as they seek to understand the history of the city where the name of the country originated from, and interacting with the island's tourist guides; they establish a route for the visitor to understand the cultural potential.

The tourist guides are aware of the importance of community tourism, and together they promote the island as Mozambique's preferred tourist destination and in this vision, an organized group of young people took the initiative to take advantage of creating an itinerary of activities to entertain the tourists.

Ilha de Moçambique has got great tourist potential, with emphasis on:

Historical and cultural monuments such as:
• Fortress of São Sebastião;
• Chapel of Nossa Senhora do Baluarte;
• Palace of São Paulo;
• Memorial garden;
• Wharf bridge (the jetty).

Tourist services provided
•A Visit/sightseeing to monuments, historical sites, jewelery;
• Observation of coins and capulanas from the 50's and learn to use the capulana;
• Make/ drawing the face mask from traditional ointment called mossiro;
• Prepare seafood (seafood such as: shrimp, lobster, crab, clam etc.);
• Maritime tour in small craft construction vessels;
• A Visit on Island of Goa if the tourist is curious to know;
• Construction of a house based on local material, if the tourist requests to participate in the activity, the idea is to observe experience how these traditional houses are built;
• Gastronomy, where tourists have the opportunity to enjoy typical dishes;
• Participate in the Teaching and Learning process, on how to prepare typical local food;
• Participate in traditional dances such as the tufo, the Maulide dance;

• Play impales;
• Hear the story of the Island of Mozambique with elders.

Tourist products

• Sand, sea and sun;
• Sewing of handcrafted items such as blackwood sculptures and pottery, production of straw items such as sieves, baskets, mats, painting their faces with Mussiro that is an ointment extracted from a root that women apply to the face and body to makes the skin soft and smooth,
• Adventure and water sports (sport fishing, canoeing, diving and traditional sailing trip);
• Entertainment (tufa, this dance had greater precursion in Ilha de Moçambique. Considered as a religious dance of praise, performed only by rigorously selected women with colorful costumes and accessories with gold cords, rings and bracelets, with the face painted by with a traditional ointment(mossiro) ;
• Traditional dance called "N'sope" combined with tufo dance, instruments are played by men, to the sound of the first beats of the drums, and two strings should be moved in a circle of one always hitting the ground (ground). Meanwhile, each of the dancers enters the middle of the rope and quickly demonstrates all their skills.

Means of transport

The province of Nampula, according to the classification, is the third city and province in the country and the first in the northern region to Cabo-Delgado and Niassa Provinces.

The province has a network of paved roads in good condition, favorable conditions for transporting passengers and tourists, and various means of transport to allow people to move from one point to another.

Tourist/visitor can have access to Ilha de Moçambique, it can be by air over the international airports of Nacala-Porto or Nampula international airport, where they can have access to collective and private land passenger transport, taxi services, as well as car and car rental, aka Rent Car, and departing trip to Ilha de Moçambique.

The trip takes about two hours; also those with low income can travel by public transport with approximate cost of 250.00MT.

The Island of Mozambique, occupies an area of 245 km2, including the islands of Goa, Cena or Cobras, the city is divided into two parts, to the north, the stone city, built of Pedra and Cal where the main monuments are located. and to the south the city of Macuti, where the houses were built of traditional material and covered with coconut leaves "straws", the population is estimated at a total of 65,712 inhabitants according to the 2017 Census, with 34,239 women and 31,437 men, most of the residents live based on fishing, the salt industry and community tourism, small agriculture and handicrafts.

The City of Ilha de Moçambique **is potentially recognized for the construction of its vast architectural and historical-cultural heritage. It was declared by UNESCO, 1991 as a World Heritage Site, for monuments of great value such as the Chapel of Nossa Senhora do Baluarte, the fortressof São Sebastião, Palace of St. Paulo.**

The Island impresses for its rich history and cultural mystique. The island is connected to the mainland by a 3.60 km through a bridge built in the 1960s, its territorial area is divided into two parts, the insular island and the mainland part, the Urban Administrative Post of Lumbo. The connection between the two parts is established by land via the bridge and by sea by small craft vessels.

Tourist activity carried out on the Island of Mozambique

According to DPCULTUR's five-year report (2014-2019), it states that Ilha de Moçambique is a preferred tourist destination for tourists who visit the province and offers a diversity of tourist products, from beaches with crystal clear waters to beautiful architectural landscape with a vast historical and cultural heritage, with great value worldwide.

With its wide mystical range of cultural wealth, Ilha de Moçambique has been highlighted as an Icon of the Nampula Province for its heritage. Today it launches itself in the competitive market, Therefore, it is necessary to draw out viable strategic plans for itsimplementation, taking into account thedissemination for the development of the community. (DPCULTUR, 2019).

With regard to the number of accommodation establishments and food and beverage establishments, it should be noted that the Ilha de Moçambique has a total of 66 tourist establishments, 39 of which are accommodation establishments and 27 restaurants and beverages, as mentioned above.

Tourism Statistics and Tourist Flow in Ilha de Moçambique

The flow of tourists heading to Ilha de Moçambique, with the exception of 2018, has increased considerably due to the celebrations of the 200th anniversary of Ilha de Moçambique, this shows its historical and cultural potential for the heritage of humanity and its importance for the region and naturally for tourists looking to discover the cultural mosaic.

Despite its importance, the arrivals of international and national tourists/visitors inIlha de Moçambique have been fluctuating between 2014 and

2018, and since 2019 their number hasbeen decreasing, as shownbellow in thetable 2.

In the period under analysis, it has been registeredinthe entry book a total of 147,474 guests, of which 88,484 were nationals and 58,990 were foreigners. Likewise, 243,672 overnight stays were recorded, of which 147,680 were national and 95,992 were foreign, according to the tables below:

Table2. Tourism flow,2014-2019

Tourists destiny	Period of tourism flow											
	2014		2015		2016		2017		2018		2019	
	N	E	N	E	N	E	N	E	N	E	N	E
Ilha de Moçambique	9.289	6.193	9.204	6.136	17.719	11.813	30.764	20.510	6.582	4.389	14.925	9.950
Sub-total	**15.482**		**15.340**		**29.532**		**51.274**		**10.971**		**24.875**	
Total	**147.474**											

Table 3: Overnights, 2014-2019

Tourist destination	Night at hotel 2015-2019	
	National	foreigners
Ilha de Moçambique	147.680	95.992
Total	243.672	

According to the Second Action Plan for the Reduction of Absolute Poverty (2001-2005) the Mozambican Government established, as a strategy, to reduce poverty and promote economic growth, as a private initiative of citizens to expand activity and create employment opportunities and increase community income (PARPA I, 2001-2005. p.89).

With the Action Plan for the Reduction of Absolute Poverty for (2006-2009), the Government of Mozambique aims to achieve the objective of revitalizing the conservation areas that constitute a valuable asset of Mozambican society, where natural resources sustain the attraction of the tourism in Mozambique. The tourism and travel industry being the source of income generation worldwide has registered a lot of employment in recent years it has expanded investments and jobs. (PARPA II 2006-2009)

In the characterization of identity, community residents responded that they characterize and identify themselves in the culture and in a welcoming and hospitable people, through social organization, they add by saying that they use the territory and resources as a condition to pass on cultural, social, religious, traditional and economic knowledge. Residents add that the itineraries, drawn up by the community, include activities in large resorts or luxury restaurants, the idea is to show the tourist the cultural habits, the way of life and the typical gastronomy.

The community is aware of the existing assets so they are protagonists in the management of heritage and cultural-historical resources that the islandowns,such as from the diversity of the cultural mosaic, the beautiful architectural landscape of colonial buildings, the historical monuments that include leisure and tourism, cultural, art and craft galleries and jewelry. Tourists/visitors live with the community and participate in activities to gain experiences and learnmore about the habits and culture of the community.

Our interviewee E1, Ms. Amina Cassimo, the President of the Association of Small Tourism Entrepreneurs (APETUR)was asked about the contribution of the implementation of the TBC and about the coordination of activities with the community.Shesaid,*"The association has created a communication network between the tour operators and tourist guides in the community. In this sense, when the tourist requests community services, APETUR communicates to the person in charge of the guides about the services intended by the tourist and this, in turn, communicates the community so Thatthey get ready to provide services to the tourist".*

The President added that community tourism has contributed to *the improvement of the community's income and the involvement of residents in the preservation and conservation of historical and cultural heritage and cleaning along the coast has been noted.*

The residents created a community itinerary to entertain tourist in cultural activities, traditional games, face painting with mossiro, walks in galleries and visits to monuments.

Still, the same first interviewee E1, said, "*Wehave received several compliments from tourists for the contact channel and the gesture of community hospitality between the tourist/residents in the interaction and exchange of new experiences. Neighborhood residents show great satisfaction for the participation in local tourist activities and encourage residents to promote their identity and local cultural habits. Moreover, "COVID-19 has become an obstacle to the entry of tourists in Ilha de Moçambique and may weaken expectations of economic development of the community".*

In turn, the second respondent (E2), the Provincial Director of Culture and Tourism of Nampula, Mr. Abdul Aquiamungo, said, "*The practice of community tourism on the Island of Mozambique, gives tourists the privilege to know the potential of the historical and cultural heritage, as the name of the country originated from. Tourists can gainexperiences about the customs of community life. They can insert themselves in the community; participate in cultural activities, such as, tufo and maulide dances. The tourist can learn how plastic arts and crafts are made, listen to legends and stories told by the elders of the community. They can also participate in the preparation of typical food, fisheryactivities from an artisanal boat, to discover the stories told by people who have lived on the island since the colonial era*.

Questioned about the expansion of community tourism to the interior regions, the Director, argued that *"for the present five-year period, the province did not plan activity, however, it has been covered in the Provincial Strategic Plan (PEP) as inclusion of community tourism from the interior, for the districts of Mecuburi, Ribáuè and Malema in the next five-year period "*. The community tourism activity aims to promote the local economic development of the community, enhancing the historical, cultural and heritage assets and contributing to the economic development of the local community.

Similarly, the third respondent (E3), Mr Luciano Augusto, District Administrator of Ilha de Moçambique, was asked about the contribution of TBC and the participation of the Esteu neighborhood community and the way of life, he commented:

> *"The community is properly organized and manages to take advantage of the income collectedfrom the community tourism activities. They improve their homes, build small stalls to sell handmade products, jewelry, basketwork and there are cases where some residents contribute*

with material place to rehabilitate the community centers for cultural activities and the school where their children study, buy food among other basic needs, they improve the water fountains. In other words, it means that with this activity, the community has been improving.However, he says that due to the COVID-19 pandemic, residents are beginning to resent it because of the weak movement of tourists/visitors, as the tourism sector wasone of the most affectedindustry/ sector,looking at the fact that it is an activity used as a source of income for the sustainability of the community.

Furthermore, another respondent reinforced that *"the contribution of TBC in Ilha de Moçambique are tangible, as it greatly improved the living conditions of the populations, and reduced* <u>Absolute</u> *Poverty"* (E6). The twelfth respondent has also shared the same point of view, as he reaffirmed that,"*of course I have the same opinion that the living conditions of populations have improved"* (E12).

Fromthis study, it can be indeed said; the social, cultural and economic has impact on TBC on Ilha de Moçambique and its advantages are already well known, as can be seen in some examples below:

Economic impact
• Increased income for the community, as result from activities provided to tourists;
• Stimulus for investment and income generation;
• Acquisition of food and some other basic needs;
• Equitable distribution of revenue;
• Poverty level reduction;
• Residents are able to pay their children's school fees.

Social impact
• Improved quality of life;
• Improvement in social development;
• Job creation;
• Crime reduction;
• Infrastructure accessibility;
• Construction of conventional houses, cultural center and art and craft galleries;
• Ilha de Moçambique is connected to the communication and current of the Cahora-Bassa electrical network;
• Construction of new artisanal fishing boats and acquisition of fishing equipment;
• Cleaning and improvement of the water system (source).

Cultural impact
• Valuing local and cultural identity;
• Valuing artistic, historical and cultural heritage;
• Conservation of traditional values.

As conclusion, it can be said that the community has shownto be organized in association. When they earn monetary benefits, they gather and discuss common issues to acquire something that the community lacks such as the improvement of water fountains and work equipment such as fishing nets, gold for jewelry, wood trunks, cotton and paint to improve boats and rehabilitation of a cultural activity center.

III.   DISCUSSION

The results of this study demonstrate that, in general terms, Community-Based Tourism contributes to the growth of the local economy and the development of the community in the City of Macuti, particularly in the Esteu neighborhood on Ilha de Moçambique. Community-based tourism (TBC) brings improvements in community life and service provision to tourists/visitors who seek community services as an alternative to conventional tourism. Community participation in community activities enables direct and indirect benefits to the residents.As consequences of TBC, involvement of members in the participation of service provision in tourist activities has considerably increased, such as number of tourist guides, artisans, and typical gastronomy, maritime transporters of artisanal boats and lodging houses and improvement of the community's life. That is, in fact, with the practice of community tourism, it has allowed the community to have a different perspective on the tourist activity by improving their lives, rehabilitating and building their homes, buying first need products.

In one of previous study, focusing on natural heritage carried out in 2004, the Government of Mozambique and the US-based Carr Foundation agreed to join forces to rebuild the Park's infrastructure, restore its fauna and flora and stimulate economic development. , thus starting a new and important chapter in the Park's history with the involvement of the community in economic and local development activities through nature and adventure tourism. Gorongosa District Administration (2006)revealed*, "Participation in tourism activity revolutionized community life, the way of living in society into an organized way and improved life quality through economic benefits".*

The Government of Mozambique approved, through **Resolution No. 14/2003, of 4 April, the Tourism Policy and Strategy,** with the objective of including Mozambique in the development as a tourist destination and its base product still needs improvement. The Tourism Policy and Strategy have main and fundamental objectives.*"Promotion and development of tourism as an engine of economic growth and in the engagement of the public and private sector as well as communities in*

making offers and services in this area a reality. To make Mozambique a preferred tourist destination; to improve the quality of life of the community and the economy through participation and inclusion" (Resolution nº 14/2003, of 4 April).

In this vision, Government of Mozambique has established strategic tourism development policies to encourage *"community involvement in community tourism, to improve the well-being and life quality of her residents. Reduce social inequality and poverty, and creation of an environment of peace, harmony and tranquility, with a strong incentive to generate income, employment opportunities and promotion of historical and cultural heritage based on its identity"* (Government's Five-Year Program, 2020-2024).

The Provincial Strategic Plan (2020-2030) establishes the promotion of community-based tourism in Ilha de Moçambique as a priority between 2024 and 2030, the province will be focusing on the interior districts, Mecuburi, Ribáuè and Malema (PEP, 2020- 2030). Tourism Marketing Strategy (2006-2013), reinforces that community tourism, contributes to job creation, economic growth and poverty alleviation, serves to preserve and disseminate the cultural values and national pride of the Mozambican people in improving the life quality (EMT, 2006-2013). On the other hand, the Action Plan for the Reduction of Absolute Poverty (2001-2005 & 2006-2009), is a strategy adopted by thegovernment of Mozambique to reduce poverty and foster economic growth, as a private initiative of citizens to expand the activity and create job opportunities, increase the income of communities (PARPA I, II p. 85-87)

This study, besides analyzing the contribution to the growth of the local economy and community development, has also assessed the satisfaction of residents involved in community tourism activities. The residents have been asked about their satisfaction in their involvement in TBC. They were unanimous regarding the benefits that have arisen within the community, with big emphasis on construction of small stalls, the purchasing of foodstuffs, improvement in the construction of their homes and improvement of fishing boats and maritime transport. However, public policies are not disseminated within the community in order to empower the residents in decision making so that that other communities feel involved in the community tourism.

Sachs (1993) argues that social sustainability allows equity in the distribution of goods and income in reducing the gap between the rich and the poor. Community Tourism is not just a productive activity; it seeks to emphasize ethics and social relations, in the valorization of a territory's heritage, historical and cultural

resource and seeks to establish communication relations (Sampaio, 2006). According to Sansolo and Bursztyn (2009), say that, the enhancement of cultural identity and the generation of direct benefits for host communities are sustainable components of this type of tourism. The direct benefits for the receiving communities have a fundamental representation, in the commitment to sharing the benefits that come from tourism among the community members in order to create a good social relationship (Maldonado, 2009). The authors agree on the point that community tourism does not only represent a segment of the market, but enables the new paradigm for tourism. The potential activity is not restricted to economic benefits, rather its contribution to the process of revaluing cultural identity and maintaining the way of life of traditional populations. On the other hand, Moncayo and Hoyos (2013), demonstrate that the community based tourism valuethe ancestral knowledge and heritage, whose primary objective is to involve the participation of community residents in tourism so that they benefit from cultural, natural and economic resources. In so doing, promote the permanence of the community in their places and they feel proud of their land and traditions.

Through Resolution No. 14 of April 4, 2003, the Government approved the "Tourism Policy and its Implementation Strategy", which establishes a perspective oriented to the growth and development of tourism, that is, in raising awareness about the importance of tourism and the value of natural and cultural heritage; Promotion of community involvement in developing programs for tourist activities (MITUR, 2013).

Beni (2002) argues that well-designed and monitored public policies promote the development of sustainable tourism, increasing competitiveness and attractiveness to the tourist/visitor through social responsibility, social mobilization and community participation as a way of including the community to benefit from improving the life quality. Araújo (2010, quoting Dencker 2004), says that, it is the responsibility of the government to develop policies so that the development of tourism takes place in an adequate manner, promoting mutual respect between residents and tourists, in order to allow the participation of the local community in the decision-making through inclusive programs.

The authors refer that inclusive public policies are one of the ways to promote the union of groups, as they help to respond to the needs of members of a given community. Public policies, in general, and particularly those of the tourism sector, are important in local development because they regulate norms that allow us to distinguish the actions that the government intends to carry

out and what it has beencarried out during a certain period, in the short or long term. It also facilitate the development of the sector to ensure the improvement of life for the community, as well as the promotion of tourist activity. The Tourism Marketing Strategy (2006-2013) also reinforces that community tourism, which contributes to job creation, economic growth and poverty alleviation, serves to preserve and disseminate the cultural values and national pride of the Mozambican people in improving the life quality (EMT, 2006-2013).

IV.   FINAL CONSIDERATIONS

This study aimed to analyze the contribution of TBC to the increase of the local economy and the development of the community; it also assessed the satisfaction of residents involved in community tourism activities in the city of Macuti, particularly in the Esteu neighborhood, in the district of Ilha de Moçambique.

The study has been conducted by the fundamental principles of a research work in order to build knowledge, a knowledge capable of helping in the education and valorization of cultural and historical heritage and enabling the participation and expansion of community tourism in all neighborhoods of Ilha de Moçambique. Therefore, although all residents have been unanimous, it was possible to realize that the community is committed to the conservation of its heritage, historical and cultural resource and these cultural assets are unique source of their sustainability. However, they had no idea of the enormous community involvement in the preservation of heritage and culture of Ilha de Moçambique as it is a World Heritage Site.

Therefore, with the inclusion and participation of the community, the lives of residents have improved through the provision of services to the tourist/visitor. The expectation of community members is oriented towards the development of economic and sustainable community tourism by radically changing the lives of residents, in acquisition of various goods for consumption that they were not capable to acquire before. Currently, those engaged in fishing and maritime transport activities acquired fishing equipment and improved their artisanal boats or vessel.

On the other hand, it is clear that there is enormous satisfaction among residents of the Esteu community. The residents are now able to buy school material such as, school uniforms for their children and they also contribute with local or conventional materials for school rehabilitation, maintenance of a water source, improvement of the coverage of their homes (straw, stake, bamboo, rope and nails), purchase essential consumer products and work equipment (glue, paint, wood, nail,

fishing net, saw, construction of small stalls with local material and improve the coverage of the residence.

However, it was also found that the contribution of the TBC to the growth of the local economy and the development of the community, under analysis, has certain limitations and weaknesses because the government does not disclose public and strategic policies for inland regions with cultural potentialand historic heritage. For example, the districts of Mecuburi, Ribáuè and Malema. Community tourism in those districts are weakened and that makes those places not preferred destinations in the province of Nampula for community tourism. Cultural community tourism enables the satisfaction of cognitive needs of experiences where the tourist learns about the way of life, culture and customs of the community.

The community calls for the expansion of community tourism to other neighborhoods on the island and to the inland regions. Non-inclusion can cause political, social and economic problems, because the community will feel marginalized by the government.

However, with the discoveries discussed, it is suggested that functional public policies should be created in order to galvanize inland tourism, favoring the participation and inclusion of the vulnerable community in the management of heritage, cultural and historical resources to improve the life quality residents.

The present study was carried out in the city of Macuti, in the neighborhood of Esteu, in the Ilha de Moçambique district. Therefore, one should not generalize its results to rest of districts with tourist potential according to their assets in the province of Nampula.

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The Role of school Managers in Brazil in Times of Pandemics: The Challenges of Democratic Management for the Quality of Education

O Papel do Gestor Escolar no Brasil em Tempos de Pandemia:os Desafios da Gestão Democrática Para a Qualidade da Educação

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Abstract— A *Covid-19 pandemic has brought immense challenges for all sectors in Brazil and worldwide, or that require coordinated actions in the management of educational institutions, especially in public schools that interrupt or leave a school. In this context, the objective of this article is to bring up the reflection on the role of the school manager as responsible for the administration of all resources: human, financial, material and pedagogical, and his skills in face of the quality of post-pandemic education. In this sense, the Law of Directives and Bases of National Education (BRASIL, 1996), includes the education systems that define the standards of democratic management of public education in basic education, according to the specificities at this time. Thus, a research adopted a qualitative methodology, through Literature Review ((LAKATOS and MARCONI, 2003) and by Documentary Research (MALDANER, 2015; GIL, 2018), where we analyze the current panorama of educational and school management in Brazil, identifying some premises and challenges for the manager, in dialogue with the legislation in force and authors dealing with the theme (DOURADO, OLIVEIRA, 2019; LÜCK, 2017; LIBÂNEO, 2011; PARO, 2006) .in an innovative and efficient way, despite all the problems that the country faces, many school managers can bring reflections on actions of return to educational activities or activities of scientific culture in dialogue with humanists, valuing a search for knowledge and the teaching-learning process of all the actors who play the space called school and security in life.*

Resumo— A pandemia da Covid-19 vem trazendo imensos desafios para todos os setores no Brasil e no mundo, o que demanda ações coordenadas na gestão das instituições educacionais, principalmente nas escolas públicas que interromperam o ano letivo. Neste contexto, o objetivo deste artigo é trazer à reflexão sobre o papel do gestor escolar como responsável pela administração de todos os recursos: humanos, financeiros, de material e pedagógicos, e suas competências frente à qualidade da educação pós pandemia. Nesse sentido, a Lei de Diretrizes e Bases da Educação Nacional (BRASIL,

1996), destaca que os sistemas de ensino definirão as normas de gestão democrática do ensino público na Educação Básica, conforme as especificidades como neste momento de emergência sanitária. Assim, a pesquisa adotou a metodologia qualitativa, por meio da Revisão da Literatura ((LAKATOS e MARCONI, 2003) e pela Pesquisa Documental (MALDANER, 2015; GIL, 2018), onde analisamos o panorama atual da gestão educacional e escolar no Brasil, identificando algumas premissas e desafios para o gestor, em diálogo com a legislação vigente e autores que tratam do tema (DOURADO, OLIVEIRA, 2019; LÜCK, 2017; LIBÂNEO, 2011; PARO, 2006). O estudo aponta que ainda há grandes demandas para a gestão escolar atuar de forma inovadora e eficiente, apesar de toda a problemática que o País enfrenta, muitos gestores escolares precisam trazer à reflexão em suas ações de retorno às atividades educacionais os aportes da cultura científica em diálogo com a humanista, valorizando a busca pelo conhecimento e o processo de ensino-aprendizagem de todos os atores que fazem funcionar o espaço denominado escola e com segurança à vida.

Palavras-Chave— Gestão Escolar; Papel do Gestor; Gestão Democrática;Pandemia-Brasil.

I.   INTRODUÇÃO

Na história da Educação brasileira, as questões concernentes à administração e gestão escolar sempre estiveram vinculadas aos princípios e métodos utilizados na administração de grandes empresas e indústrias, e muitas escolas são transformadas em espaços restritos e fechados um sistema, que se diz articulado ao modelo de "gestão democrática", em que o gestor tem o papelprofissional de gerir e administrar os processos educativos escolares e não escolares na produção e difusão do conhecimento no campo educacional.(LÜCK, 2017).

Entretanto, qual é o perfil da formação deste gestor para gerir uma instituição privada ou pública? Quais são as reais demandas e tarefas deste gestor? Sempre será um desafio cotidianamente para este profissional da Educação, pois lidar com pessoas: professores, estudantes, corpo técnico, comunidade escolar, com os processos administrativos e educativos, alcançar metas e objetivos, e ainda lidar com situações adversas que surgem na escola rotineiramente é um trabalho complexo para o gestor.

Este artigo propõe trazer à reflexão estes dilemas e desafios enfrentados pelos gestores escolares quanto aos encaminhamentos e modos no que tange a sua função enquanto responsável desde a elaboração/reelaboração do projeto político pedagógico que justifique sua importância como um instrumento balizador, orientador, organizador e definidor da proposta pedagógica e da democratização da escola até as ações que demandamo processo de gestão educacional como uma práxis pedagógica administrativa, atuando na coordenação e supervisão de projetos pedagógicos e no gerenciamento de recursos humanos e financeiros da escola.

Em Belém do Pará, assim como no Brasil, já é significativo o interesse acadêmico, em torno deste tema, através de discussões, pesquisas, trabalhos e cursos de pós-graduação, como a proposta do curso de especialização em gestão escolar de várias instituições públicas e privadas. E agora, o gestor se prepara para mais um enfrentamento:

atuar no espaço escolar e garantir a qualidade dos processos educativos frente à Pandemia do COVID 19[1].

A pandemia se alastrou pelo mundo todo e todos os setores da sociedade foram atingidos.Pensarno papel do gestor educacional no Brasil pós pandemia do COVID 19 em diálogo com a qualidade da Educação Básica já é um grande desafio para nós, pesquisadores, assim como para todos os educadores e gestores que trabalham com a Educação no país. Alguns documentos de instituições governamentais e não-governamentais já apontam para a adaptação das escolas neste processo do isolamento provocado pelo COVID-19 e trazem uma série de questões importantes e necessárias que irão nortear o "novo espaço escolar".

O conceito de gestão descreve-a como o gerenciamento, administração, onde existe uma instituição, uma empresa, uma entidade social de pessoas, a ser gerida ou administrada. O objetivo é de crescimento, estabelecido pela empresa através do esforço humano organizado, pelo grupo, com um objetivo específico. (ANTUNES, 2008).

E neste momento, os princípios da gestão democrática na escola será uma das premissas norteadoras para o gestor coadunar os objetivos deste "novo espaço escolar" que se transforma. A gestão democrática se caracteriza como um método de gerenciamento em que todos os grupos têm o poder de opinar em diferentes aspectos desde o planejamento até a implementação e avaliação dos resultados, como afirma Paro (2006).

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[1] COVID 19: No final do ano de 2019, uma pneumonia de causa desconhecida foi detectada na província de Wuhan (China). O que começou como uma doença misteriosa, foi referida primeiramente como 2019-nCoV, doença causada pelo novo coronavírus (SarsCov-2) e se tornou mundialmente conhecida como COVID-19., que ocorreu em 11 de março de 2020, a COVID-19 foi caracterizada oficialmente como uma pandemia mundial. (Fonte: Organização Mundial de Saúde - OMS. Pandemia da doença de coronavírus COVID-19).

Assim, como ponto inicial deste constructo, insere-se a referência de pesquisa e análise sobre a atuação do gestor no âmbito da instituição do espaço denominado: Escola. Como salienta Lück (2009): "Propõe-se que a gestão da escola seja democrática, porque se entende que a escola assim o seja, para que possa promover a formação para a cidadania".

O papel do gestor passa a ocupar uma posição de destaque na agenda de mudanças necessárias frente ao olhar despolitizado imposto às várias décadas na educação brasileira e neste momento que vivenciamos a pandemia. Este gestor na contemporaneidade é o profissional responsável que faz a escola funcionar, quer pública ou privada; ele é essencial ao desenvolvimento social, humano, cultural e profissional de todos os educandos, pois a escola acaba refletindo os pressupostos de sucesso ou insucesso da sua equipe pedagógica e administrativa, especialmente à do seu gestor (LÜCK. 2009).

A gestão democrática está amplamente amparada pela legislação brasileira. A Constituição Federal de 1988 aponta a gestão democrática com um dos princípios norteadores para a educação brasileira. Assim como a "democracia" refere-se à "forma de governo" ou a "governo da maioria"; então, torna-se claro, que as relações cotidianas no âmbito escolar, devem explicitar esta linha de ação, porém sabendo-se que toda gestão, pressupõe uma "ação", e a palavra ação é justamente o oposto da inércia, do comodismo, espera-se do gestor educacional atitudes compromissadas de construir, de fazer e de compartilhar. Então, "Qual é o papel do gestor educacional frente aos desafios para a qualidade da Educação Básica pós pandemia do COVID 19?"

De acordo com os documentos oficiais do Ministério da Educação (BRASIL, 1996; 2020) e do Movimento Todos Pela Educação (1990; 2020), a gestão escolar deverá perpassar por adaptações e novos modelos organizativos, em que estas questões deverão ser vistas como passos para a elaboração de um plano de contingência que possa ser mais benéfico e que contribua para a qualidade da educação de crianças, jovens e adolescentes em todo o país.

Desde à atenção às políticas públicas e anúncios oficiais, que tornam-se importantes instrumentos, bem como a todas as diretrizes que serão estabelecidas nesta nova fase da História da Educação Brasileira, respeitando a Lei de Diretrizes e Bases da Educação Nacional – LDBEN, Lei n° 9394/96 (BRASIL, 1996), bem como as Diretrizes Nacionais da Educação Básica (BRASIL, 2013) até o planejar do "novo espaço escolar" neste cenário, mesmo de incerteza, é importante o gestor estabelecer os elementos necessários para trabalhar com a educação de forma planejada, envolvendo toda comunidade escolar.

Segundo Gadotti & Romão (1995, p. 35), implantar um processo de gestão escolar democrática na escola, justifica-se por duas questões: significa formar para a cidadania e melhorar o que é específico da escola, isto é, o seu ensino. A participação na gestão da escola proporcionará um melhor conhecimento do funcionamento da escola e de todos os seus atores envolvidos; proporcionará um contato permanente entre professores e alunos, o que leva ao conhecimento mútuo e, em consequência, aproximará também as necessidades dos alunos neste momento pós pandemia do COVID 19.

O gestor escolar deve estar em constante formação profissional, pois sua função assume um caráter pedagógico que deve levá-lo a uma contínua atividade de busca e investigação de sua especialidade. Severino (2009) nos remete a uma reflexão sobre a práxis histórica e social, como indivíduos formadores do saber, para a construção do processo de ensino e aprendizagem, enfatizando a postura profissional investigativa para a prática efetiva profissional, pois antes de se tornar gestor, esse profissional é um professor.

A abordagem da pesquisa é de cunho qualitativo exploratório, tendo por base a pesquisa de Revisão da Literatura por meio da Pesquisa Bibliográfica e Documental (MALDANER, 2015; GIL, 2019; LAKATOS; MARCONI, 2019). Este é um trabalho, que agrega na formação de futuros gestores da Educação Básica e Superior, já que somos seres inacabados e em constante transformação pelo processo educativo (FREIRE, 2007).

O artigo está organizado em seções itens. Inicialmente, introduzimos a temática com as inquietações e reflexões acerca de nossos objetivos; na primeira, apresentamos alguns aspectos da trajetória histórica da gestão escolar e da função de gestorna educação brasileira; na segunda, evidenciamos sobre a concepção da Gestão Democrática Escolar, apontando algumas das ferramentas da gestão participativa no enfrentamento da pandemia do COVID 19 no "novo espaço escolar". Finalizando, apresentamos as nossas considerações finais com um "novo" olhar para a gestão educacional no Brasil com foco na Escola Básica.

II.   A GESTÃO ESCOLAR NO BRASIL: O PAPEL DO GESTOR DA EDUCAÇÃO BÁSICA

A "Gestão Escolar Democrática" no Brasil tem seu marco normativo com a promulgação da Constituição Federal de 1988 que institucionalizou a "Gestão Democrática do Ensino Público", sendo dessa forma

assegurada como o princípio da educação brasileira. Entretanto, a "gestão escolar" é uma expressão que ganhou corpo no contexto educacional acompanhando uma mudança de paradigmas no encaminhamento das questões desta área. Em linhas gerais, a "gestão escolar" é caracterizada pelo reconhecimento da importância da participação consciente e esclarecida das pessoas nas decisões sobre a organização, administração, orientação e planejamento do trabalho educacional no interior das escolas. (LUCK, 2011).

Neste cenário, o conceito de gestão vem se reafirmando com o fortalecimento da democratização do processo pedagógico, com a participação responsável de toda a comunidade escolar nas decisões necessárias e na sua efetivação mediante um compromisso coletivo com resultados educacionais cada vez mais efetivos e significativos, pois o gestor educacional deve dialogar, desde à elaboração da proposta pedagógica da escola; do plano de trabalho da instituição; da aprendizagem dos alunos; bem como do estabelecimento de estratégias para gerir a escola; implementando atividades de articulação da escola com as famílias e a comunidade.

Vale ressaltar que este princípio da "gestão democrática", está configurado no Art. 206, inciso VI (BRASIL, 1988):

> Art. 206. O ensino será ministrado com base nos seguintes princípios:
>
> I - Igualdade de condições para o acesso e permanência na escola;
>
> II - Liberdade de aprender, ensinar, pesquisar e divulgar o pensamento, a arte e o saber;
>
> III - pluralismo de ideias e de concepções pedagógicas, e coexistência de instituições públicas e privadas de ensino;
>
> IV - Gratuidade do ensino público em estabelecimentos oficiais;
>
> V - Valorização dos profissionais da educação escolar, garantidos, na forma da lei, planos de carreira, com ingresso exclusivamente por concurso público de provas e títulos, aos das redes públicas;

> **VI - Gestão democrática do ensino público, na forma da lei;**
>
> VII - garantia de padrão de qualidade;
>
> VIII - piso salarial profissional nacional para os profissionais da educação escolar pública, nos termos de lei federal. (BRASIL, 1988, grifos nossos).

Nas constituições anteriores nãohavia menção explícita ao processo de gestão educacional e, muito menos, o uso da expressão "democrática" para qualificá-la. O princípio da Gestão Democrática trata-se,pois, de uma inovação da Constituição de 1988 à organização do ensino nacional. Este princípio ainda figura no Plano Nacional de Educação, Lei 10.172, de 09de janeiro de 2001, assim como no atual Plano Nacional de Educação, Lei 13.005/2014,no qual o é apresentado em dois artigos: Art. 2º "§ VI - promoção do princípio da gestão democrática da educação pública", e no Art. 9º:

> Os Estados, o Distrito Federal e os Municípios deverão aprovar leis específicas para os seus sistemas de ensino, disciplinando a gestão democrática da educação pública nos respectivos âmbitos de atuação, no prazo de 2 (dois) anos contado da publicação desta Lei, adequando, quando for o caso, a legislação local já adotada com essa finalidade. (BRASIL, 2014-2024).

Sendo repetidoem algumas estratégias e estampado na meta 19, do anexo, que faz menção direta aoprincípio:

> **META 19**: Assegurar condições, no prazo de 2 (dois) anos, para a efetivação da gestão democrática da educação, associada a critérios técnicos de mérito e desempenho e à consulta pública à comunidade escolar, no âmbito das escolas públicas, prevendo recursos e apoio técnico da União para

tanto. (BRASIL, 2014 Anexos. Meta 9).

Considerando o princípio da "Gestão Democrática", etimologicamente a palavra *"gestão"* vem do latim *"gentio",* que por sua vez vem de *"genere"* – trazer em si, produzir[2]. Gestão é o ato de administrar um bem fora de si (alheio), mas também é algo que traz em si, porque nela está contido. E o conteúdo deste bem é a própria capacidade de participação – sinal maior de democracia. Gestão é administração, é direção. Gestor é ser Diretor e Administrador.

Como afirma Paro (2003), se estamos preocupados com a gestão das escolas, temos que considerar inicialmente o próprio conceito de *administração ou de gestão,* aqui neste constructo serão admitidas como sinônimos de "gestão escolar". Adotando, assim, o conceito mais geral de administração como "a utilização racional de recursos para a realização de fins determinados" (PARO, 2006, p. 18).

Assim, esta concepção de "gestão" insere-se no universo escolar no Brasil, a partir dos anos de 1990, já no final do século XX, relacionando-se com os novos paradigmas e avanços tecnológicos, impulsionando as organizações a atingir seus objetivos, cumprir suas funções e desempenhar seu papel na sociedade globalizada, constituída de princípios e práticas decorrentes da promoção humana. Logo, sabendo das complexidades, e das dificuldades que as mudanças provocam, uma vez que para se mudar uma ideia/ação que exige ruptura histórica e quebra de paradigmas requer tempo e muita conscientização de todos os envolvidos, ainda nos dias atuais, quando nos deparamos com o "novo normal" da escola brasileira com a Pandemia do Coronavírus em todo o mundo. Quais serão os desafios e as prioridades do gestor escolar em tempos de pandemia?

A exemplo, Lück (2009, p. 188) já discorria em seus estudos que: "[...] nem sempre os membros da escola estiveram preparados para formas complexas de ação e passam a simplificá-la e a estereotipá-las, burocratizando-as e estabelecendo, desnecessariamente, hierarquização e segmentação inadequada". Entretanto, em tempos de pandemia, toda mudança provoca muitas discussões dialéticas no âmbito de qualquer instituição, ao desatar as amarras do lado operacional da administração científica, o gestor escolar percebe-se inserido em um contexto muito maior, cujo dimensão precisa ser incorporada para si, por si, pela instituição de ensino e pelo momento presente de epidemia sanitária.

Se a Administração Escolar era portadora de uma especificidade que a diferenciava da administração científica capitalista, cujo objetivo maior exigia a permanente impregnação de seus fins pedagógicos na forma de alcançá-los, com a Gestão Escolar no dia-a-dia traz um grande desafio: encontrar em meio à rotina escolar, o tempo de dedicação aos objetivos maiores de uma organização que enfrenta novos desafios. O gestor deverá verificar a médio e longo prazos, a realizações de ações que visem a: 1. Planejamento estratégicos; 2. Desenvolvimento de processos e 3. Avaliação dos resultados alcançados. (COLOMBO, 2019).

Percebe-se que a gestão escolar se constituiu participativa numa alternativa à administração centralizada. Um tipo de administração baseada na representatividade. Um conselho formado por representantes eleitos de todos os setores da entidade administrativa, com poderes não só consultivos, mas também normativos e deliberativos que a constituíram, tomando como base Lück (2009), entende-se a administração pública escolar numa perspectiva democrática e participativa ressalta que o gestor escolar é o administrador da dinâmica social, um mobilizador e orquestrador de atores, um articulador da diversidade para dar-lhe unidade e consistência, na construção do ambiente educacional e promoção segura da formação de seus alunos, o gestor exerce a atuação da gestão, que abrange aspectos filosóficos e políticos do país.

Após, a CF (1988) e a promulgação da Lei de Diretrizes e Bases da Educação Nacional – Lei Nº 9394, de 20 de dezembro de 1996, do atual PNE (BRASIL, 2014-2024), conforme exposto em seus textos legais; assim, a escola, como organização social, também pretende ser um espaço democrático, de modo que os profissionais da educação, os alunos, pais/famílias, corpo técnico e de apoio e toda a comunidade do contexto social tenham uma participação crítica na execução e implementação das políticas e dos programas educacionais. Vale ressaltar que dois elementos são essenciais para a concretização desta gestão no espaço escolar:

1. A participação de todos os componentes da comunidade escolar nos processos decisórios;

2. A existência de um amplo processo de informação em que todos tenham conhecimento do que acontece no interior da instituição e de suas relações externas (HORA e SANTOS, 2014, p. 30).

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[2] Dicionário de Política. (BOBBIO, Norberto. Et al. 3 ed. Brasília: UnB, 1986).

A partir destes elementos poderemos garantir uma escola de gestão verdadeiramente democrática, além de precisar considerar que o ideal de formação da escola passa a ser o trabalhador flexível, proativo, a formação por competências e uma gestão da informação e de liderança, quer no momento presente de enfrentamento à pandemia do COVID 19, quer em qualquer tempo/espaço da História da Educação Brasileira.

III. GESTÃO ESCOLAR DEMOCRÁTICA: OS DESAFIOS DO GESTORESCOLAR PARA A QUALIDADE DA EDUCAÇÃO NO BRASIL PÓS PANDEMIA

A concepção de gestão democrática do ensino entrou para o universo escolar recentemente; entretanto desde a promulgação da CF (BRASIL, 1988) e da LDBEN (BRASIL, 1996) houve, no entanto, uma grande evolução que trouxe benesses ao setor educacional. Ao desatar as amarras do lado operacional, o gestor escolar percebeu-se inserido em um contexto muito maior, cuja dinâmica do administrar a escola precisava ser incorporada por todos os segmentos do ensino, pois as dificuldades de sobreviver em um novo contexto social, econômico e político, impelia as escolas de buscarem novos caminhos devido o modelo tradicional de administração escolar que estava vigente.

As necessidades escolares não eram atendidas pelo modelo administrativo tradicional, o que fez com que a escola se modernizasse, mesmo porque, a Educação, por sua essência, é uma atividade de interesse público; logo, escola pública de qualidade para todos é um ideal indiscutível, porém com um enorme desafio em todos os seus meandros. Poisa qualidade da educação remete à definição do que se entende por Educação. Para alguns, ela se restringe às diferentes etapas de escolarização que se apresentam de modo sistemático por meio do sistema escolar. Para outros, a educação deve ser entendida como espaço múltiplo, que compreende diferentes atores, espaços e dinâmicas formativas, efetivado por meio de processos sistemáticos e assistemáticos (DOURADO e OLIVEIRA, 2009).

Entretanto, Dourado (2014) em seus estudos aponta que os desafios para o gestor escolar no País estãoatrelados à análise da gestão educacional, que pode serentendida também por meiode vários recortes e planos. Uma perspectiva importante implica nãoreduzir a análise das políticas e da gestão educacional à mera descriçãodos seus processos de concepção e/ou de execução, importando, sobremaneira, apreendê-las no âmbito das relações sociais em que se forjamas condições para sua proposição e materialidade, principalmente no momento presente d pandemia do COVID 9 em que o Brasil vive.

Para o autor, tal perspectiva implica detectar os tipos de regulação subjacentes a esse processo que irá regular o "novo" projeto de gestão escolar no presente e no futuro com/pós pandemia, pois o conceito de regulação, em que pesemos diferentes significados possíveis; como já afirmava Barroso (2006, p. 13), a gestão escolar poderá ser utilizada "para descreverdois tipos diferenciados de fenômeno, mas interdependentes: os modos como são produzidas e aplicadas as regras que orientam a ação dosatores; os modos como esses mesmos atores se apropriam delas e astransformam."

Desta forma, Dourado e Oliveira (2009) parecem atuais no contexto do plano de gestão da escola na atualidade; a partir das premissas necessárias para as tomadas de decisões pelo gestor escolar, desde a gestão e organização do trabalho escolar, que deve iniciar pelo tratamento da estrutura organizacional compatível com a finalidade do trabalho pedagógico; planejamento, monitoramento e avaliação dos programas e projetos, independentemente do momento de emergência sanitária que o novo Coronavírus impõe no Brasil.

Os desafios para a qualidade da educação continuam e continuarão como marcos desta gestão democrática, pois o gestor precisa da organização do trabalho escolar compatível com os objetivos educativos estabelecidos pela instituição, tendo em vista a garantia da aprendizagem dos alunos; mecanismos adequados de informação e de comunicação entre os todos os segmentos da escola (DOURADO e OLIVEIRA, 2009). Assim, podemos afirmar que a gestão democrático-participativa, inclui:

> [...] condições administrativas, financeiras e pedagógicas; mecanismos de integração e de participação dos diferentes grupos e pessoas nas atividades e espaços escolares; perfil adequado do dirigente da escola, incluindo formação em nível superior, forma de provimento ao cargo e experiência; projeto pedagógico coletivo da escola que contemple os fins sociais e pedagógicos da escola. (DOURADO e OLIVEIRA, 2009, p. 11-12).

O que vem ao encontro de uma atuação para a autonomia escolar, que irá incluir as atividades pedagógicas e curriculares, os tempos e espaços de

formação; disponibilidade de docentes na escola para todas as atividades curriculares, apropriadas ao desenvolvimento dos conteúdos; processos avaliativos voltados para a identificação, monitoramento e solução dos problemas de aprendizagem e para o desenvolvimento dos educandos e da instituição escolar.

Entretanto, é esta gestão escolar, como o próprio nome diz, refere-se à esfera de abrangênciados estabelecimentos de ensino (BRASIL, 1996). O que atribui um significativo númerode incumbências às unidades de ensino, focalizadas em seu gestor. Esta perspectiva assinala um momentoem que a escola passa a configurar-se como um novo foco da política educacional e de enfrentamento às novas demandas (VIEIRA, 2017).

Ainda em diálogo com Dourado e Oliveira (2007), seja pela elaboração e a execução de uma proposta pedagógica, que é a primeira e principal das atribuições da escola, devendo sua gestão orientar-separa tal finalidade. Assim como:

> [...] Por meio das novas tecnologias educacionais e recursos pedagógicos apropriados ao processo de aprendizagem; planejamento e gestão coletiva do trabalho pedagógico; jornada escolar ampliada ou integrada, visando a garantia de espaços e tempos apropriados às atividades educativas; mecanismos de participação do aluno na escola; valoração adequada dos usuários no tocante aos serviços prestados pela escola.(DOURADO e OLIVEIRA, 2009, p. 14).

Portanto, apesar das medidas de biossegurança, a pandemia do COVID 19 abalou a estruturas da Educação Brasileira, as escolas foram uma das primeiras áreas da sociedade a sofrerem com os impactos do novo coronavírus. Com o avanço da doença nos estados brasileiros, as aulas presenciais foram migradas para o Ensino a Distância (EaD), com atividades disponibilizadas em plataformas on-line. Entretanto, a maioria das escolas públicas foram fechadas e este momento da experiência EaD, inédita no país, mostra uma necessidade de reavaliar o papel da tecnologia na educação, o acesso da população à uma internet de qualidade e a importância do trabalho do professor e do gestor na construção da aprendizagem.

Libâneo (2011) já apontava que qualquer gestor ou diretor da escola pública é um coordenador e tem a responsabilidade de integrar, reunir esforços, liderar, concatenar o trabalho de diversas pessoas; logo em sua visão, a tarefa do gestor/diretor visa a:

- Dirigir e coordenar o andamento dos trabalhos, o clima do trabalho, a eficácia na utilização dos recursos e meios, em função dos objetivos da escola;
- Assegurar o processo participativo de tomada de decisões e, ao mesmo tempo, cuidar para que essas decisões se convertam em ações concretas;
- Assegurar a execução coordenada e integral das atividades dos setores e elementos da escola, com base nas decisões tomadas coletivamente;
- Articular as relações interpessoais na escola e entre a escola e a comunidade, incluindo especialmente os pais. (LIBÃNEO, 2011, p. 159).

Assim, a forma como é dada tais atividades pertinentes para este profissional da educação, o gestor, e como a legislação brasileira impõe, se processa a partir da criatividade com que se elabora tais funções; pois a transformação e a informação social e cultural provocam um tipo de liderança, provocando na escola e na sua organização situações que de imediato trazem algumas angústias e desconforto para os liderados. Assim, o processo do gestor passa a ser uma liderança, que requer revisão nos aspectos referente à organização política, pedagógica, administrativa, curricular, didática, funcional e na função social, visando acompanhar o desenvolvimento futuro da própria escola.

A gestão escolar vem impondo desafios há décadas. É uma questão muito complexa para a gestor analisar e tomar decisões neste contexto que o País está vivenciando, pois o isolamento e o distanciamento social alteram a organização educacional do ensino, no caso a organização do trabalho pedagógico, algumas escolas, a maioria da rede privada, continuou com o calendário escolar via aulas *on-line.* Entretanto, a rede pública paralisou as atividades em todo os estados da federação.

De acordo com o Ministério da Educação – MEC (BRASIL, 2020), a Educação no Brasil é organizada

tradicionalmente no âmbito presencial, com aulas dentro do espaço da instituição escolar, onde os alunos e professores se encontram durante 200 dias letivos.Neste momento, nós temos uma alteração dessa rotina educacional, que tem um tempo e espaço escolar determinados. Também ocorreu uma aproximação e a adoção de recursos tecnológicos para suprir essa relação que era presencial, com aulas dialogadas entre professores e alunos.

Porém, o contato que durante anos foi presencial entre professor e aluno agora é mediado pela tecnologia e as chances dessa nova concepção permanecer por alguns meses se torna cada vez mais plausível diante do quadro da pandemia crescente na maioria dos estados brasileiros. Mesmo com a programação para antecipação do recesso escolar do mês de julho adotada por alguns estados, inclusive Mato Grosso do Sul, os números de contaminados pelo novo coronavírus ainda não recuaram, o que indicou a permanência dos alunos em casa e o retorno seja reprogramado para final de agosto de 2020.

No rol dos desafios apontados pelo MEC para o retorno gradual das atividades nas escolas brasileiras estão o difícil acesso a internet no Brasil por grande parte da população, além da falta de um ambiente adequado para o estudo dentro de casa e a orientação que o aluno necessita para cumprir as tarefas, principalmente, os estudantes da Educação Básica, com uma reorganização de calendário, grade curricular, lotação de professores e outras demandas que já são geridas pelo gestor escolar, só que agora, com as especificidades das medidas pautadas em protocolos de biossegurança para todos os atores que fazem a escola funcionar.

Segundo a Pesquisa Nacional por Amostra de Domicílios Contínua – tecnologia da informação e Comunicação (PNAD Contínua TIC) 2018, do Instituto Brasileiro de Geografia e Estatística (IBGE, 2019), 46 milhões de brasileiros não tem acesso a internet. Em áreas rurais, o número é ainda maior, cerca de 53,5% dos moradores estão distantes da rede.Dos desconectados, 41,6% não sabem usar o serviço, enquanto 34,6% não tem interesse. As condições socioeconômicas são responsáveis por 11,8% da população distante da internet, enquanto 5,7% acha o equipamento necessário para o uso, como celular e tablets, caros demais.

Outro problema a ser enfrentado trata da qualidade da internet, que não é das melhores em todo o país. Neste cenário, a educação precisa encontrar um caminho, pois a escola presencial é insubstituível, por ser o lugar onde as relações humanas acontecem de forma democrática e dialógica. Porém, esse status não diminui também a importância da Educação a Distância. Segundo

Souza (2020), a EaD tem uma importância principalmente em algumas regiões do Brasil, que é difícil a chegada do da escola presencial.

O que os gestores podem pensar em usar a EaD de forma complementar e não substitutiva da educação presencial, pontua Souza (2020), que defende ainda que uma alternativa é estender o ano letivo de 2020 para 2021, mantendo o conteúdo escolar programado para as turmas. Conforme a LDBEN (BRSIL, 1996), em situações de calamidades, sobretudo climáticas e econômicas ou quaisquer questões locais, o gestor pode reorganizar o calendário escolar, e fazer isso de forma presencial, não substituindo com atividades a distância; entretanto elencando os conteúdos mis necessários para o processo de ensino-aprendizagem dos alunos a cada ano escolar.

No entanto, alguns autores apontam que este recursoao ser utilizado na Educação Básica como em qualquer etapa do ensino, poderá aumentar as desigualdades sociais; a pesquisadora Andreia Nunes Militão, professora da Universidade Estadual de Mato Grosso do Sul (UEMS) e líder do Grupo de Estudo e Pesquisa de Políticas Educacionais e Formação de Gestores e Professores da UEMS (2020) relata em seus estudos que outra alternativa viável é aumentar as horas de aula quando o ensino presencial retornar.E usar como complemento deste ensino, as atividades em plataformas a distância ou trabalhos de pesquisa em casa.

Militão (2020) pontua ainda que:

> [...] A escola presencial é insubstituível, por ser o lugar onde as relações humanas acontecem de forma democrática e dialógica. Porém, esse status não diminui também a importância da Educação a Distância, pois EaD tem uma importância principalmente em algumas regiões do Brasil, que será difícil o retorno da escola presencial. O que podemos pensar é usar a EaD de forma complementar e não substitutiva da educação presencial. (MILITÃO, 2020, p. 03).

É preciso repensar o papel do gestor escolar neste momento de pandemia, Rivas (2003) já destacava duas questões fundamentais para se pensar a escola, e hoje, suas ideias devem estar cada vez mais presentes, por se tratar deste momento de pandemia: a cultura científica e a

cultura humanística. A cultura científica, que é a cultura da pesquisa, da busca, de verdades provisórias apoiadas em argumentos. E o lugar da socialização, para que a escola se firme como o espaço onde se aprende a resolver conflitos na base do diálogo, onde se aprende a conviver com as diferenças de forma solidária e humana.

A cada ano letivo que se inicia, os gestores escolares enfrentam na escola uma série desituações que exigem deles a tomada de decisões assertivas que contribuam para aminimização dos riscos administrativos e pedagógicos. Essas ameaças podem setransformar em verdadeiras tragédias a ponto de ameaçar a vida dos educandos, de suasfamílias e dos profissionais da educação. Daí a grande preocupação dos gestores escolares com essa gestão do saber, do conhecimento, do saber se colocar no lugar do outro e em garantir que a escola seja um ambiente seguro e agradável para todos.

A gestão da cultura científica já faz parte da rotina da escola, pois:

- Despertar o interesse pelas ciências e tecnologias;
- Esclarece os problemas propostos pela ciência e tecnologia na vida cotidiana, e favorece a formulação das respostas às perguntas feitas pelos alunos, ao mesmo tempo em que o seu raciocínio científico é desenvolvido;
- Sinaliza as várias fontes da informação ou do conhecimento científico, avaliando o seu interesse e contribuição, tendo em vista o fomento da cultura científica dos futuros cidadãos. (RIVAS, 998 *apud* UNESCO, 2003).

A concepção de humanismo para a educação na contemporaneidade tem sido apresentada por alguns autores como Delors (1999) ao apresentar os quatro pilares da Educação, com a perspectiva de um novo paradigma para a educação. Diante desse imperativo, que vivemos na atualidade, o gestor deve perceber possíveis interfaces das concepções de uma educação humanista promulgadas pela UNESCO e o Plano Nacional de Educação (BRASIL, 2014).

Conforme destacou Delors (1999) em sua pesquisa, o gestor deverá refletir também sobre os saberes e competências necessários para esta retomada da educação. Essas ações não podem, no entanto, dissociar-se por estarem imbricadas, constituindo interação com o fim único de uma formação holística do indivíduo, que tem como objetivos fundamentais uma educação para a inteireza do ser e o despertar da consciência para uma cultura de paz. O que vem afirmar que a prática pedagógica deve preocupar-se em desenvolver estas aprendizagens da cultura humanista e da cultura científica sempre no espaço escolar.

Assim, deve se considerar que estas aprendizagens são apenas aportes teóricos para o professor, para o coordenador e para o gestor escolar; entretanto, a atuação do gestor no ambiente escolar deve ser uma ação colaborativa, participativa, democrática e de aprendizagem sempre, ou seja, uma ação educativa planejada, articulada com todos os participantes da escola, em momentos de estudos, proposições, reflexões e ações.

Neste preâmbulo, o gestor irá atuar e assumiras incumbências atribuídas aos estabelecimentos de ensino, conforme está previsto naLDBEN (BRASIL, 1996):

> Elaborar e executar sua proposta pedagógica; administrar seu pessoal e seus recursos materiais e financeiros; assegurar o cumprimento dos dias letivos e horas-aula estabelecidas; velar pelo cumprimento do plano de trabalho de cada docente; prover meios para a recuperação de alunos de menor rendimento; articular-se com as famílias e a comunidade, criando processos de integração da sociedade com a escola; informar os pais e responsáveis sobre a frequência e o rendimento dos alunos, bem como sobre a execução de sua proposta pedagógica" (BRASIL, 1996, Art. 12, Incisos I a VII).

Apesar deque os desafios do retorno às aulas neste momento de Pandemia ainda constituem sérios problemas para o gestor e para todos os atores que fazem a escola, pois todos os trabalhadores em educação tem enfrentado uma luta árdua de vida com a propagação do

Coronavírus no País: aulas remotas, retorno de atividades, apesar do fechamento das escolas para atendimento presencial, acompanhado de redução salarial e da precarização deste setor; além da pressão de governos para o retorno às aulas presenciais, sem que a pandemia da Covid 19 esteja sob controle e sem que haja segurança sanitária necessária para a reabertura das escolas, o que representa um risco a saúde de todos: gestores, professores, técnicos, alunos e famílias dos estudantes, e de toda uma gama de relações que se fundam a partir do funcionamento de uma escola pelas cinco regiões que formam a Estado Brasileiro.

Ainda, há que se repensar este retorno escolar, pois a gestão escolar deve estar alinhada à gestão educacional, como bem aponta Vieira (2004), por meio da política educacional vigente quer da gestão municipal, estadual ou federal, para juntas enfrentarem e solucionarem as demandas necessárias neste caos da pandemia, com uma proposta pedagógica dialógica, em que ambas articulam-se mutuamente, dado que a primeirajustifica-se a partir da segunda, por meio de planejamentos, acompanhamentoe de avaliação para assegurar um retorno digno e de qualidade aos alunos, incluindo todas e todos no processo de ensino-aprendizagem.

IV. CONSIDERAÇÕES FINAIS

Podemos concluir que os desafios do papel do gestor escolar são bastantes complexos nas instituições de ensino, independentemente do momento de pandemia que se vive, pois deste a promulgação da LDBEN (BRASIL, 1996), a gestão escolar vem procurando se firmar democrática e participativa em todos os Estados da federação; assim como toda gestão de bens públicos e dos recursos humanos disponíveis nas escolas, o gestor escolar deve traçar estratégias para que os objetivos e metas sejam alcançados, aliado ao espírito de liderança para gerir os diversos recursos.

É de suma importância observar que no decorrer da História da Educação Brasileira, no que tange a gestão, vem se configurando alinhada ao princípio legal e moral como um conjunto de técnicas, estratégias, métodos organizacionais que determinam o complexo campo da gestão democrática, que tem como propulsor dessa engrenagem um líder nato e não por chefe que impõe condições como nas políticas institucionais que são implementadas pelos governantes, limitando a autonomia e o conhecimento em um meio que deve ser de constante evolução e aprendizado profissional para o processo de ensino-aprendizagem dos alunos, que devem o foco do trabalho pedagógico.

Neste contexto um "novo" olhar para a gestão escolar no Brasil se faz necessário, em se tratando de uma nova conjuntura que se apresenta. Gerir um processo sistêmico com um contexto pandêmico, obsta uma postura desafiadora para esse gestor. Em vez, de um novo olhar, deve buscar sempre um olhar ampliado e humano. As investidas dos poderes constituídos, forçam um recomeço letivo, sem o balizamento dos especialistas, que defendem ações criteriosas e responsável. O posicionamento do gestor nesse momento, pouco se percebe, talvez não interesse a mídia dominante, mas na sua comunidade tem uma reverberação positiva diante dos enormes desafios que todos vão enfrentar.

Prima-se por um gestor comprometido com a sua comunidade escolar local, para o enfrentamento cotidiano. Gestar uma escola em tempo pós-pandêmico tem sido um verdadeiro desafio e uma incógnita a ser respondida pelos governantes.

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Effect of Microbes on Drilling Fluid Formulation

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Abstract— Microorganisms square measure thought of to have an effect on the properties of drilling fluids. This work self-addressed the subsequent sections: the character of Micro-organisms, microbic Mechanisms that have an effect on Drilling Fluids, Implications of microbic Contamination and Identification. This work focuses on the likelihood of utilization of microbes as basic material for lubricant. This analysis assess by means that of straightforward however relevant laboratory, the properties of the microbes cultivated from banana skin within the micro-biological laboratory and compared with commonplace drilling fluid. The results were analyzed exploitation applied mathematics and graphical ways. Water based drilling muds were developed with the microbes and characterised to work out the properties like density, rheology and pH within the laboratory and compared with those of the standard laboratory mud. Results showed enhancements in sure properties, but it verified unsuitable in different properties in comparison to straightforward drilling fluid.

I. INTRODUCTION

The existence of natural water setting ensures, regardless of however harsh, some variety of micro-organism. These micro-organisms exists in many thousands of species and new species are bound to be discovered at the speed of over 1000 each year [1]. Natural populations will range from some hundred organisms per cubic decimetre of fluid to well in far more than a billion per cubic decimetre. Micro-organisms form a formidable force when put together capable of destroying nearly each organic existing. The role of micro-organisms is basically the reduction of complicated matter to a lot of easy kind, bringing back this energy as building blocks of life.

Drillinq fluids are perpetually exposed to giant numbers and kinds of micro-organisms although it was often thought that drilling fluids and their additives possessed low susceptability to microorganism attack. However in the wake it became clear by their terribly nature and sophisticated organic structure, it is this evident that they are ideal environments for a range of micro-organisms.

Natural gums, carboxymethylcellulose (CMC), lignins, liqnosulphonates, tannins, and many other compounds which are added to muds are all found to be susceptible to biodegradation also synthetic polymers such as polvacrylamides are not immune to attack either [2]. The source water used to prepare the mud, wind blown dust and dirt, rain, human contact, and possibly even some of the materials which are used to prepare the mud are few means by which these micro-organisms could enter the drilling mud. Its degree of existence is then favoured by factors such as: temperature of the re-circulating mud, composition of the water used to make up new mud, chemical nature of the mud system itself, the length of time that is required to drill the hole, and type of micro-organisms which become established and time [3]. The microbes utilize xanthan gum, a common drilling mud additive. Also, drilling fluids are highly alkaline and

contain high concentrations of specific heavy mineral salts (such as BaSO4, LiBr). Thus, these drilling fluids may affect both the core microbiology and the inorganic geochemistry (e.g., pH, specific cation and anion concentrations, etc.) of interstitial water and also trace element geochemistry of igneous rock core (e.g., lithium isotopic composition). The rising demand for use of drilling fluids in the deep offshore, these shift makes for the determination of the effects of bacteria and fungi on formulated drilling mud. This work will be a guide of great relevance since it causes a great turnaround in Drilling Fluid Technology.

II.   LITERATURE REVIEW

2.1   Classification of Conventional Drilling Fluids

Drilling fluids are mainly composed of a mixture that includes different liquids, gases, emulsions, and solids, some of them dispersible some not [4]. Drilling fluids are a vital component during the well construction process to reach reservoirs with different characteristics while carrying out the cuttings generated and providing a medium to stabilize the wellbore wall. Its origins can go as early as the third century BC when in China water was first used to 'softening' the underground layers to drill wells of hundreds of feet in depth [5]. Its modern history started in Spindletop Field in south Beaumont, Texas in 1901 when a kind of muddy water was used to drill through unconsolidated sands [6]. Nowadays, Industry has already understood that the correct design and application of drilling fluids depends mostly on the characteristics of the formations to drill, especially when its average cost can be about 5% to 15% of the total cost to drill a well [7] [8]. Therefore, with improvements in research, different additives have been developed and tested to enhance the drilling fluid performance in order to satisfy the requirements of each specific reservoir while reducing costs associated with non productive times.

Drilling fluids are often classified based on their fluid phase alkalinity, dispersion, and the type of chemicals used. In the classification according to [9] drilling muds are usually classified according to their base material into liquids composed by water-based drilling fluids (WBM), and non-aqueous based drilling fluids (oil-based, OBM and synthetic-based, SBM), gas or a gas/fluid mixture (Pneumatic-based drilling fluids) However, WBMs may contain oil and OBMs may contain water [10].

OBMs generally use hydrocarbon oil as the main liquid component with other materials such as clays or colloidal asphalts added to provide the desired viscosity together with emulsifiers, polymers, and other additives including weighting agents.

Water may also be present, but in an amount not usually greater than 50 volume percent of the entire composition. If more than about 5% of water is present, the mud is often referred to as an invert emulsion, that is, water-in-oil emulsion. WBMs conventionally contain viscosifiers, fluid loss control agents, weighting agents, lubricants, emulsifiers, corrosion inhibitors, salts, and pH control agents. The water makes up the continuous phase of the mud and is usually present in any amount of at least 50 volume percent of the entire composition. Oil is also usually present in minor amounts but will typically not exceed the amount of the water so that the mud will retain its character as a water-continuous phase material. OBM and WBM have been the main conventional systems that oil & gas industry has used to drill nearly all formations.

2.2   Properties of Drilling Fluids

Rheology is the science that studies the relationship between the flow of matter and the deformation experience. In drilling operations, rheology is one of the most important characteristics to describe the drilling fluid behavior at various flow conditions. The drilling fluid rheology and analysis can have a further impact on the capabilities to increase the hole cleaning efficiency, borehole stability, and ROP if not designed properly.
Different rheological models tried to describe the behavior of the drilling fluids at dynamic conditions. When shear stress and shear rate in the drilling fluid are directly proportional the fluid behavior will be linear and can be defined as a Newtonian fluid (e.g. water, alcohols) in which its slope described a constant effective viscosity (cp). On the other hand, when the relationship does not follow the same proportion, the fluid will behave as a non-Newtonian fluid. Most drilling fluids fit the last group.

2.3   General Consideration of Filtration in Drilling Fluids

Drilling fluids are usually composed of liquid and solid phases. Filtration refers to the invasion of the liquid phase into the formation when the drilling bit exposes new formation and the drilling fluid comes in contact with it. Initially, a small volume of mud can invade the formation before the actual filtration process takes place, this volume is known as mud spurt. However, there are certain cases were the bridging materials in the drilling fluid cannot control the fluid invasion and total lost circulation is experienced [11].

Bridging agents of a certain size can plug the pores in the near-wellbore region and cause damage to the formation [12]. These bridging agents should be at least 1/3 to 1/7 of the average pore size of the formation [13]. Larger particles cannot plug the pores and the mud flow will sweep them again into the main fluid stream. Smaller

particles will tend to invade the formation creating an internal filter-cake that can generate a skin factor. The appropriate selection of the primary bridging agent will permit the particles to efficiently plug the smaller pores and eventually the other particles in the drilling fluid can be trapped forming a low-permeable seal that reduces the filtrate invasion into the formation. [14].

Filtration occurs under both dynamic and static conditions during drilling operations. Filtration under dynamic conditions occurs while the drilling fluid is circulating. Static filtration occurs during connections, trips or when the fluid is not circulating. It is logical to think that thinners and durable filter-cakes can have lower permeabilities than thicker and erodible filter-cakes. The thinner the filter-cake the less volume of filtrate that invades the formation. Nevertheless, there are some factors that affect both, the build-up of the filter-cake and the filtrate invasion [14, 15]. Some of these factors are: time and temperature, differential pressure, compressibility of the filter cake, permeability of the filter-cake, viscosity of drilling fluid and filtrate, solids composition and percentage, and particle size distribution.

2.4   Temperature Effects on Drilling Fluids

One of the most challenging problems for drilling fluids is the temperature operational range of the chemicals use to mixed it. The temperature at the bottom of the hole increases as the well deepens, and it is important that the drilling fluid maintains acceptable rheological and filtration properties.

These properties of the mud are strongly related to the temperature effects and under downhole conditions may be very different from the ones measured at the surface leading to misinterpretations that can generate future undesirable wellbore conditions (e.g. wellbore instability, tripping difficulties). When drilling fluids are exposed to high temperatures, the portion of the fluid that is at the lower part of the wellbore becomes excessively thick, a situation that becomes worse under static conditions in which the prolonged heating may cause the drilling fluid to experiences a solidification process [16].

The effect of temperature on drilling mud can be attributed to the complicated interplay of several causes, some of which are more dominant than others. Factors such as reduction in the degree of hydration of the polymers, reduction of the viscosity of the suspending medium, increased dispersion of clay particles, and an increase in the degradation rate of additives. Since all these processes take place in the drilling fluid simultaneously as the temperature is varied, an interpretation of the observed results will only be possible in cases whereby some of the effects are predominant and as such be easily identified. One immediate effect of high temperatures is the

detrimental effect on drilling fluid rheology, which can increase cuttings settling and affect the hydraulic capabilities as well as experiencing some degree of flocculation in the drilling mud. The latter will lead to a poor quality-filter cake, thick enough to increase the risk of differential stuck pipe due to the larger contact area between the drill string and the filter cake.

On the other hand, the poor permeability condition of the filter-cake will increase the filtrate into the formation. Thermal degradation of filtrate control-additives and viscosifiers aggravate the problem previously described. As an example, at temperatures below 300 °F, starches in the drilling fluid start to experience hydrolysis and depolymerization of thinners or irreversible chemical reactions can take place leading to a complete degradation of the drilling mud [17].

Finally, the temperature should be treated as one important contaminant in drilling fluids. It is complicated to assimilated such condition, however, its detrimental effect on polymer hydration, clay flocculation, and rheological problems as described previously are a few points that support this claim. The most interesting part of all of this is that temperature has no treatment. The initial design of the drilling fluid with the appropriate chemicals is the only preventive solution to the problem.

III.   MATERIAL AND METHODS

3.1   Materials

The following materials and equipment were used for this research work includes:

MSterile cotton Q-tip-style swabs or similar swabs, Disposable latex gloves, Sterile agar plates (Petri plates filled with a bacterial food preparation, usually Luria broth mixed with agar), Sterile collection tubes filled with 20 mL of sterile water (for a back-up in case you need to re-isolate your bacteria samples), Erlenmeyer flask, bunsen burner, A black permanent marker, Proper receptacle for disposing of swabs, tubes, gloves, and plates after use, Air oven, Mortar and p, sieving mesh, spatula, electric weighting balance, Whatman 50 filter paper, measuring cylinder, Hamilton Beach Mixer, Bariod Mud balance, pH indicator strip, Beakers, Marsh Funnel, Rheometer.The chemical reagents used for this work are as follows: Distilled Water (H_2O), sugar, peptone water, lactophenol blue, Durhams tubes, alcoholic, alpha napthtol, aqueous KOH, Safranine, Barite, Caustic soda, Xanthan gum, Soda ash, Polyanionic cellulose, Potassium chloride, local clay, sodium hydroxide, and borax.

3.2.   Methodology

3.2.1.   Preparation of Microbes

The microbes were cultured prior before adding into the drilling fluid system. The microbes was in liquid form so was used as the continuous phase in the system.

3.2.2   Mud Formulation

Three mud samples were prepared which comprised of bacteria and fungi as the continuous phase, caustic soda, bentonite, soda ash material. The weighting materials are added to achieve the required density.

Sample A: Standard Water-based mud Sample B: Water-based mud with bacteria strain. Sample C: Water-based mud with fungi.

The additives, concentrations and their functions in drilling fluid are shown in the Table 1 below.

Table 1: Sample A, B, and Standard (Std)

S/No.	Additives	Composition	Property
1	Base fluid	350ml	Based fluid
2	Potassium Chloride	18.0g	Inhibition control
3	Borax	4.0g	Preservative
4	Xanthan gum	2.8g	Viscosifier
5	Polyanionic cellulose	2.0g	Filtration control
6	Barite	76.8g	Weighting agent
7	Soda ash	0.2g	Calcium ion remover
8	Caustic Soda	0.2g	Alkalinity control
9	Bentonite	2.8g	

3.2.2.1 Procedure

The following steps were taken for formulation of the mud samples (Std, A and B);

1. 76.8grams of barite was dissolved in 350ml of water and property mixed using electric mixer for a time period of 10 minutes

2. The resultant mixture was left for 24 hours for proper yielding.

3. The 350ml of barite solution was placed in the electric mixer.

4. Agitation was done with the correct measurement of each material additive added at 3minutes interval.

5. After about 1hour agitation, the resultant mud was used for different mud testing.

6. This procedure was repeated for the conventional mud where distilled water was replaced with bacteria and fungi culture respectively.

3.2.3   Mud weight determination

i. The lid of the mud balance was taken off and the cup was filled with the already prepared mud from the samples and carefully positioned on a mud balance.

ii. The balance arm was placed on the vase, with the knife edge resting on the fulcrum of the mud balance.

iii. The rider was moved until the graduated arm was leveled as indicated by the level vial on the beam.

iv. The mud weight was read at the edge of the rider.

v. Wight of mud samples were recorded in lb/gal.

Fig.1: Mud balance instrument Missouri S&T.

3.2.4   Rheology of Drilling Fluids

Rheology is the science that studies the relationship between the flow of matter and the deformation experience. In drilling operations, rheology is one of the most important characteristics to describe the drilling fluid behavior at various flow conditions. The drilling fluid rheology and analysis can have rheology and gel strength test. Rheological characteristics and drilling fluid gel strength properties provide vital information about the drilling fluid capacity to transport cuttings and also to suspend the same cuttings in the fluid column at static conditions. To determine the rheology behavior and gel strength of the drilling fluids under this research

100 an OFITE Viscometer model 800 was used (Figure 3.2). This viscometer has 8 different

speeds 3, 6, 30, 60, 100, 200, 300, and 600 RPM.

Figure 2. 8-speed OFITE viscometer. Missouri S & T.

From the dial values collected for each shear rate, three values were obtained Plastic

viscosity (PV), yield point (YP) and the gel strengths, which was measured at 3 different

periods of time (10 sec, 10 min, and 30 min). The procedure followed to measure the

rheology (PV, YP) and gel strength is described below:

1. The test cup was filled with the desired drilling fluid up to the scribed line.

2. The leg lock nut was loosed and the cup containing the drilling fluid was raised to the viscometer assembly until the scribed line indicated in the rotor sleeve.

3. Once in position, the leg lock nut was tightening to secure the mud cup in place.

4. The viscometer was then started at 600 RPM until a steady value was reached in the indicator dial. The value was a record and the same procedure was repeated with the other 7 speeds recording the value for each shear rate.

5. For the gel strength measurements, the drilling fluid was stirred at 600 RPM for 10 seconds. The viscometer was then stopped and kept undisturbed for 10 seconds, the viscometer was then initiated at 3 RPM and the maximum value reached in the dial was recorded as initial gel strength. The value was recorded in pascals and lb/100ft2.

6. The 10 min and 30 min gel strength were measured repeating the step 4. The drilling fluid was stirred for 10 seconds at 600 RPM then was stopped and the fluid was undisturbed for the period of time needed. Then the viscometer was then started at 3 RPM and the maximum values in the dial reading were recorded. The tests were performed at 28 °C.

Rheology calculations: The plastic viscosity (PV), represents the resistance of the fluid to flow due to the internal mechanical conditions (Solids) inside the system. That resistance is most commonly affected by the solid concentration, size and shape and their relationship with the viscosity of the fluid phase in the system. It was calculated subtracting the 300 RPM dial reading from the 600 RPM,

$$PV = \theta 600 - \theta 300 \qquad (1)$$

The yield point (YP) is based on the electrochemical interaction between the additives and the other solids present in the mud system while drilling (solids, clays). Also, gives an idea about the drilling fluid ability to carry or transport the drill cuttings to the surface. YP was calculated by subtracting the PV value from the 300 RPM dial reading,

$$YP = \theta 300 - PV \qquad (2)$$

IV.   RESULTS AND DISCUSSION

A comparison of contaminated mud properties by bacteria and fungi in this paper with standard laboratory mud is presented in Table 1. The significant differences in their rheological properties such as plastic viscosity, yield point and apparent viscosity as well as density and pH value necessitate monitoring of these organisms.

Figure 1 notably presents the difference in their rheological properties using shear rate versus shear stress plot. The relationship between shear rate and shear stress for a fluid defines how that fluid flows [5].

Table 2: Mud weight , Specific Gravity and pH from experiment

Sample		A	B	C
Mud Weight	Ppg	9.40	9.85	6.95
	Ib/ft³	70.90	74	52
pH		7	8	9
Specific Gravity		1.13	1.18	0.84

The discrepancy in the shear stress versus shear rate plot between the infested mud and the standard laboratory mud is greatly attributed to the relative presence of these microbes, as the feed on the mud additives.

Sample A, B and C represents Standard mud, Mud formulated with bacteria and mud formulated with fungi respectively.

A comparison of the rheological properties of the three mud in (Table 2) indicates that the microbes improved favourably the rheological properties. Our only fear would be when it gets in contact with the formation

Table 3 Rheological Parameters

	A	B	C
Plastic Viscosity(cp)	14	40	9
Yield Point(Ib/100ft²)	44	95	66
Apparent viscosity(cp)	36	87.5	42
Gel(10 secs)	4	13	10

Table 4: Rheological results for Mud sample A

RPM(Speed)	RPM readings	Shear Rate (Sec⁻¹)	Shear stress (Pa)
600	72	1022	36.54
300	58	511	29.44
200	50	340	25.38
100	38	170	19.29
60	30	102.18	15.23
30	23	51.09	11.67
6	12	10.22	6.09

YP: $36Ib/ft^3$, AV: 36cp, Pv: $14Ib/100ft^2$
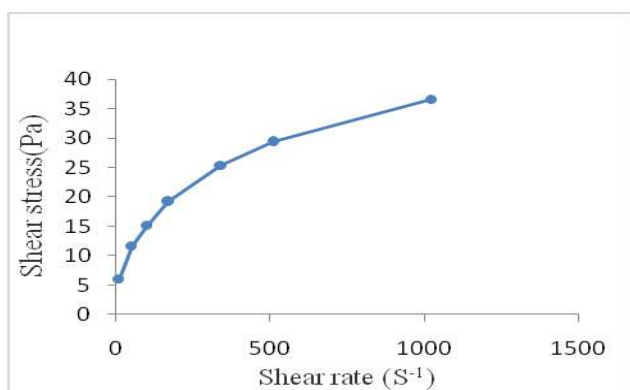
Fig. 3: Plot of shear stress against shear rate for sample A

Table 5: Rheological results for Mud sample B

RPM(Speed)	RPM readings	Shear Rate (Sec⁻¹)	Shear stress (Pa)
600	175	1022	88.8
300	135	511	68.5
200	116	340	58.87
100	84	170	42.63
60	66	102.18	33.5
30	51	51.09	25.88
6	28	10.22	14.21

YP: $95Ib/ft^3$, AV: 87.5cp, Pv: $40Ib/100ft^2$
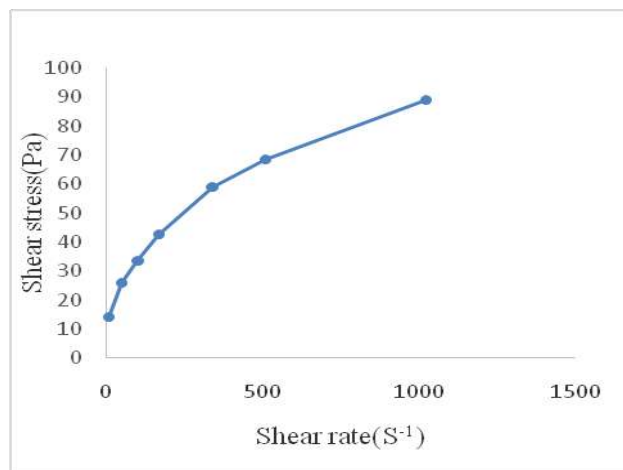
Fig 4: Plot of Shear Stress V Shear rate for sample B

Table 6: Rheological results for Mud sample C

RPM(Speed)	RPM readings	Shear Rate (Sec⁻¹)	Shear stress (Pa)
600	84	1022	42.63
300	75	511	38.06
200	53	340	26.90
100	40	170	20.30
60	37	102.18	18.78
30	24	51.09	12.18
6	11	10.22	5.58

YP: $66Ib/ft^3$, AV:42cp, Pv: $9Ib/100ft^2$

Thus, the apparent viscosity, yield point and plastic viscosity for sample B increased from 36 cp, 44Ib/100ft2 and 14cp to 87.5cp, 95Ib/100ft2 and 40cp while sample C increased to 42cp, 66Ib/100ft2 but the plastic viscosity reduced to 9cp respectively.
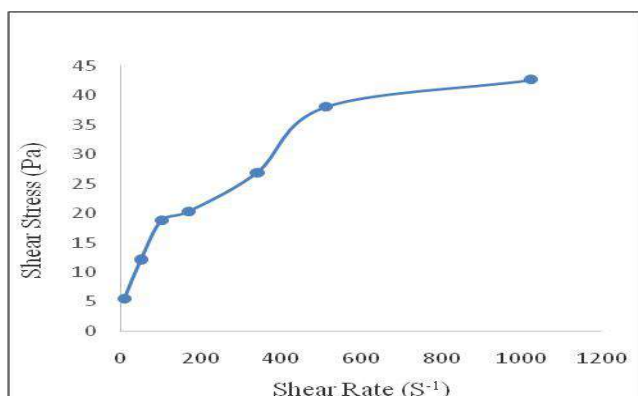
Fig. 5: Plot of Shear Stress (Pa) vs Shear Rate (S⁻¹)

The pH value of both samples was within range acceptable by standard as the stated in Table 2. This increase in pH value was created by an alkaline medium in the bacteria and fungi respectively. A comparison of the effect of Bacteria and Fungi (Table 2)

Worthy of mention is the fact that controlling the formation pressure during drilling operation with drilling fluid is a direct function of the mud density. From Table 2 the results obtained show that the density of Sample B was 9.85Ib/gal outweighing the standard 9.40lb/gal, meanwhile Sample C reduced to 6.95 making it unfit in terms of use as a weighting material.

V. CONCLUSIONS

The microbes at its natural concentration have the required rheological properties to be used as oil well drilling fluid. However, as weighting material, there was a significant improvement in the drilling mud which was formulated from the bacteria over mud formulated from fungi. From the results obtained, it was observed that the rheological properties increased drastically as the apparent viscosity, yield point and plastic viscosity of the sample B increased by more than 11% for sample B and decrease by about 75% for sample C. Also, the pH increased by about 14% and 28% respectively. In this connection, it can be concluded that, at considerable concentration, the exhibits good rheological properties that would compare favourably with those of standard drilling mud from the laboratory.

It is recommended that further research be carried out on the microbes to determine its filtrate loss at different thermodynamic conditions as well as evaluate its presence for filtration control to improve the performance of this clay in order to make it competitive.

ACKNOWLEDGEMENTS

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Oral prosthetic-surgical rehabilitation using guided surgery in the posterior region of the mandible with bone atresia

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Abstract— The placement of dental implants in the posterior mandibular alveolar ridges can become a challenging procedure in case of severe bone atresia, where the bone height is limited between the crest and the lower alveolar canal. The aim of this case study was to introduce an innovative, less invasive, highly accurate and easy surgical technique for lateralization of the lower alveolar nerve in the mandible using a special printed three-dimensional surgical guide for the placement of the implant. This report is about a patient with edentulous mandibular alveolar crests in elements 36 and 37. Customized surgical guides were manufactured using modeling technology to precisely position a rectangular window, discover the canal and subsequently place dental implants. It was concluded that it was possible to perform procedures in regions with a restricted amount of bone and important anatomical accidents, achieving a satisfactory degree of predictability, and success in treatment, in addition to allowing minimally invasive surgical access and with significantly safer and more comfortable postoperative access for the patient.

I. INTRODUCTION

The purpose of restorative treatment, using Osseo integrated implants, is to preserve the integrity of noble intraoral structures in addition to restoring the aesthetics and functionality of the stomatognathic system according to the objective and subjective satisfaction of the treated patient (WARRETH et al., 2017).

Some clinical conditions such as the location of the lower alveolar nerve, the pneumatization of the maxillary sinus, and the limitation of bone heights, such as severe mandibular atresia, directly interfere with bone availability, generating limits on the correct positioning of the implants by anatomical interference of the vascular bundle -nervous (HERNÁNDEZ-SUAREZ et al., 2020).

Several strategies have been developed, aiming to overcome these conditions, such as bone grafting, guided bone regeneration, osteogenic distraction, maxillary sinus lifting, mandibular nerve transposition, for the safe use of implants (SOTTO-MAIOR et al., 2014). Thus, the success of therapy with dental implants is attributed to the achievement of osseointegration, maintenance of the bone level around the crest of the implant, and high percentages of survival of the implants (KOSZUTA et al., 2015).

Thus, it is worth mentioning that these oral rehabilitations on Osseo integrated implants face increasing prosthetic and aesthetic demands, requiring precise prosthetic-surgical planning (LANCIONE et al., 2021).

One of the challenges faced in implantology is the three-dimensional positioning of the implant, which is a major factor in obtaining adequate functionality (OTTONI; GABRIELLA, 2011). It should be noted that the free hand transfer of the planned position to the surgical field is conditioned to the operator's skill, to his emotional

conditions at the time of surgery and, above all, to the making of important decisions regarding the approach point, platform depth and inclination. of the implant (D'HAESE et al., 2012).

In this sense, static guided surgery is based on the use of a rigid surgical guide that reproduces the virtual position of the implant, not allowing intraoperative modification of its position. In view of this, it is possible to assist in the installation and location of osseointegrated implants during the surgical phase, and it is possible to obtain the appropriate angulation and inclination of the implants (COLOMBO et al., 2017).

It is in this context that the present study describes the planning and treatment of an oral rehabilitation on implants using guided surgery in the posterior region of the mandible with bone atresia, in order to optimize prosthetic success.

II.   CASE REPORT

A 40-year-old female patient attended the Advanced Dentistry Center, COA Ilhéus, Brazil, reporting the need for rehabilitation of the posterior mandible by installing implants. On clinical examination, it was possible to observe that the patient had atresia of the posterior mandibles in the region of teeth 36 and 37.

Thus, computed tomography radiography (3D Accuitomo 170, Morita) was requested, in which it was found between the alveolar canal of the mandible to the upper bony edge of the mandible with a 7 mm measurement (Fig. 1). The patient was scanned using a Scanner Omica 2.0 Cerec Dentisply Sirona software version 5.1.3.
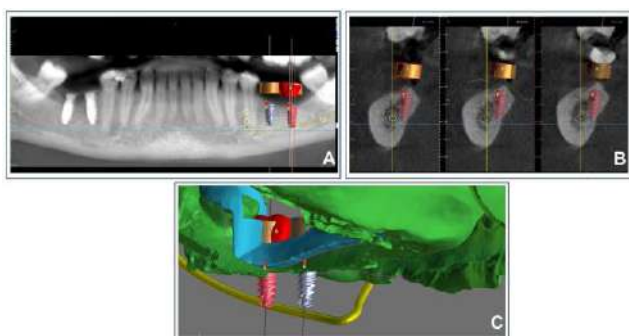
Fig. 1: A) Digital planning. Marked inferior alveolar nerve. B) Outline of the planned implant on the cross section. C) Guide for the virtual bone regeneration procedure.

Considering the severe atresia of the posterior region of the mandible, the direct installation of implants was not possible. The planning was carried out using the files STL, STereoLithography, and DICON, Digital Imaging and Communications in Medicine, where virtually the ideal positioning of the missing teeth crowns was planned. With reference to the virtual planning of the crowns, it was also possible to plan the positions of the implants virtually, seeking a positioning laterally to the alveolar canal in search of the preservation of the noble structures, and consequently avoiding the lesion of the neuro-vascular bundle in this region. Thus, the implants were compensated 1.5 mm lingually to this structure.

Through this planning, the surgical guide was made, printed on resin using the Anycubic Photon S digital printer, with reference to bone milling during surgery.

The patient initially administered 500 mg of amoxicillin 8/8h, one day before the procedure, persisting for another 6 days, 4 mg of dexamethasone 12/12h, for two days, starting on the day of the procedure and 500 mg of 8/8h dipyrone, if pain, orally. Thus, the surgical procedure was continued, with asepsis and antisepsis performed with 10% polyvinylpyrrolidone-iodine (PVPI) in front of and sterile fields affixed. Anesthetic blockade of the left lower alveolar nerve was performed, as well as anesthesia of the lingual, buccal and mental nerve, with the solution of articaine hydrochloride 4% with epinephrine 1:100.000, so that 1 tube was made in the lower alveolar, 1/3 tube in the lingual, 2/3 tube in the buccal and 1 tube in the mental.

After adequate anesthesia, the surgery was performed with the Speed Guide implant connection system guide (Connection, Prosthesis System São Paulo, Brazil). Implants were installed without opening a flap in the surgical field. In the region of tooth 36, the Torq® Morse Cone Implant (Connection, Prosthesis System São Paulo, Brazil) of dimensions 3.75 x 8.5 mm was obtained, obtaining primary stability with a load of 30 N. In the 37 regions, the Morse Cone Flash implant (Connection, Prosthesis System São Paulo, Brazil) of dimensions 3.5 x 8.5 mm was used, obtaining primary stability with a load of 30 N (Fig. 2).

The patient was followed up in the postoperative period 7, 15, 30, 60 and 90 days, with good healing, implant stability, absence of signs of infection and with paresthesia with signs of remission.

The prosthetic phase was performed 3 months after the surgery, through scanning, CAD-CAM system, CEREC for anatomical and functional planning of teeth 36 and 37. The crowns were milled 2 hours before installation in Ivolar Vivadent E-max porcelain in color A2. The crowns were milled using Dentisply Sirona's MCXL milling machine (Fig.3).

Fig. 2: A-B) 3D planning of a free-end situation. Implants inserted approx 2 mm supracrestally. C) Broken guide plate during the surgical procedure.

Fig. 3: A-C) Three-month postoperative images showing normal appearance of the operated regions.
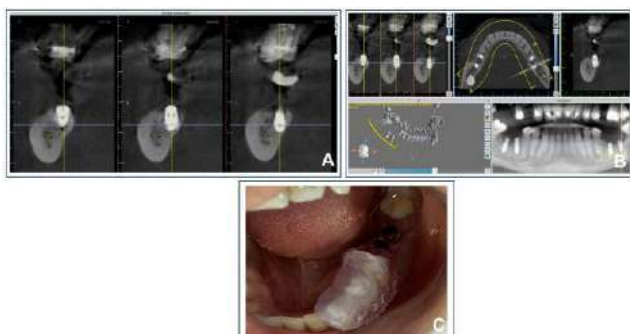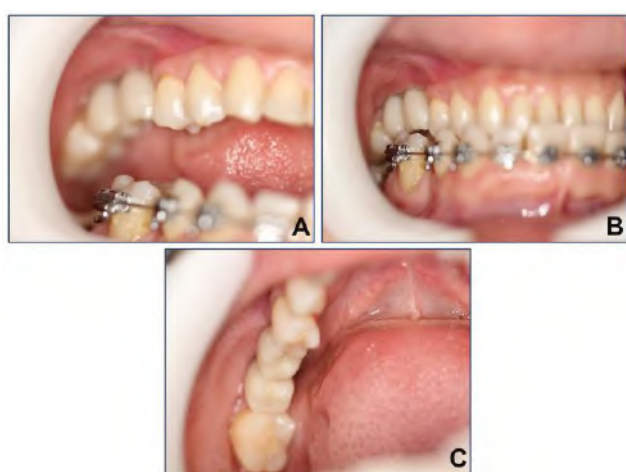
After this period, it was possible to observe that the digital planning of the prosthesis associated with the surgical planning increased the predictability of the result, since the surgical guide indicated the best place for implant placement, without affecting the alveolar nerve, thus reducing the number of complications, as well as the CAD/CAM system provided greater precision in the adaptation of the final restorations, according to the previous planned procedure.

III. DISCUSSION AND FINAL CONSIDERATIONS

Dentistry, on a global scale, has shown evident technological advances, especially in implantology, with the digitization of the manufacturing process of prototyping biomodels, which offers patients a more comfortable, safe and fast service, enabling the execution of great short-term rehabilitation (MÜHLEMANN et al., 2018). Since, previously, only the direct printing technique provided patient models, with the implant placement not very aesthetically favorable (YOU et al., 2019).

With the evolution of digital dentistry, new resources have been used in order to plan, install and rehabilitate patients, boosting implant dentistry and the advent of aesthetic materials for rehabilitation on implants. This is because it allows the virtual molding of an element, scanning of dental preparation, and the production of a prosthesis by the CAD / CAM system, Computer Aided Design & Computer Aided Manufacturing, that is, digital production of the prosthesis on the scanning tooth and the production of the part by a milling machine (CERVINO et al., 2019).

In view of this, the information acquired in three-dimensional reconstructions allows determining the quantity and quality of the available bone and also the simulation of the implant installation in a virtual environment. This provides the predictability of techniques and difficulties that can be encountered during the surgical intervention, reducing the time, the possibility of errors, and the costs of oral rehabilitation (JACOBS et al., 2018).

In this context, since 2016, the sale of intraoral scanners has been growing, especially in radiology laboratories, allowing the professional to take the patient to radiology to obtain a virtual model of the arch, which will be used in an integrated way with tomography, for the production of surgical guides, also integrating all the treatment within a concept of totally digital reverse planning, which allows its continuity in the prosthetic development in a CAD / CAM system, which can be performed in the prosthesis laboratory (FAVERO et al., 2019; MORRIS et al., 2019).

Thus, in this case report, the patient's oral rehabilitation was performed by installing two implants in the posterior atrophic area of the mandible and the respective porcelain crowns, making it possible to achieve the aesthetics and functionality of these elements in harmony with the entire stomatognathic system of the patient.

Such result can be attributed to the digital planning that allowed the placement of implants in the program, as well as the preparation of a high precision surgical guide, leading to the possibility of performing surgeries without flaps, for the placement of implants and prostheses with a satisfactory success rate. (D'HAESE et al., 2017).

In addition, this study evaluated the effects of guided preoperative planning and oral rehabilitation applied by the technique of lateralization of the lower alveolar nerve, due to vertical bone atrophy, which promoted functional restoration, allowing the placement of implants. The virtual design was created according to the preoperative computed tomography and the placement of the prosthesis was performed 3 months after surgery.

It is inevitable to recognize that digital implantology is the sum of several digital methods and techniques that

integrate digital planning and development. In this context, the implantodontist who adopts this new methodology will have a broader view of the treatment and, with the collaboration of the planning center, being able to develop digital workflows integrated with several areas of dentistry (BARONE et al., 2016).

It can be argued that dental implants smaller than 10 mm can be used in posterior mandibles with predictable results. In fact, short dental implants are a valid option for restoring the posterior mandibular regions, as well as vertical bone augmentation combined with standard length implants (ALTAIB et al., 2019).

However, as the objective of the present study was prosthetic-surgical oral rehabilitation using guided surgery in the posterior region of the mandible with bone atresia, the technique of lateralization of the lower alveolar nerve associated with virtual implants of standard length, 8.5 mm was adopted. guide the surgical procedure (LOPS et al., 2012; TANG et al., 2020).

Narrow implants, 3.5 mm, were used, as their successful application to the posterior mandible was previously reported in the scientific literature as an alternative to rehabilitation of the patient in a quick, predictable, and minimally invasive manner (KLEIN; SCHIEGNITZ; AL-NAWAS, 2014).

IV. CONCLUSION

It was concluded that it was possible to perform procedures in a region with a restricted amount of bone and important anatomical accidents, achieving a satisfactory degree of predictability, and success in treatment, in addition to allowing minimally invasive surgical access and with significantly safer and more comfortable postoperative access for the patient. patient.

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The Importance of the Family X School Relationship in School Performance

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Abstract— *Introduction: This article approaches the relationship between family and school. The definition of family, its diverse compositions and its specific role is presented. The particularity of the school and the link between the family and this institution are emphasized. Ideas about this relationship are explored within the educational and social context. Objective: The main objective of this scientific article is to analyze the influence of the family at school and, consequently, on the children's learning. Methods: For this purpose, the bibliographic research methodology was used, in order to substantiate the theme addressed and build the present work. Conclusion: The school tries to guide parents on how to educate their children and, on the other hand, parents participate less and less in school activities as their children progress in the grades. Therefore, in view of the unstable relationship between family and school, school management should seek to facilitate this relationship as it seeks strategies that aim to help dialogue and participation.*

I. INTRODUCTION

This article aims to analyze the importance of family participation in their children's learning process. Thus, we seek to understand how parents can contribute to their children's learning and how the family x school relationship can collaborate in the education of children.

To carry out this research, it was necessary to find a problem that deserved attention in the educational context. Therefore, we define the following issue: What is the importance of the family x school relationship in school performance?

Therefore, it is necessary to define what goals we want to achieve. As a general objective, we want to analyze the influence of the family on school and, consequently, on children's learning. For this, it is convenient to approach the specific objectives, which are: to present theoretical aspects of the influence of family participation in school; highlight the main strategies for adherence to family participation in the school context; and finally, to analyze the results obtained with the

performance of the technical-pedagogical team of the educational institution together with the family.

In academia, this research will be relevant, as it will consist in describing precisely and objectively how the process of sociability and childhood learning works. That said, this work is justified because it is an opportunity to expand the publication on the theme of the family-school relationship in the educational sphere, adding to the already existing ones. Generally speaking, studies that have this theme as a research object prioritize the verification with one of the parts of this relationship, especially parents and teachers.

In the social environment, the research will contribute in the sense of being an instrument that deals with the attribution of the school and teachers in meeting the current requirements together with the family, since this is the child's first group of coexistence and that in this context the education process begins. Family education is essential for living in society, as the family is initially the reference for living in a group.

Therefore, this study was carried out through bibliographical research on the subject. Among the renowned authors on the subject we can mention: Oliveira (2005), Almeida and Alonso (2005), Tiba (1998), Jardim, (2006), Vygotsky (1987), among others, who are collaborating with articles and research projects as a reliable source of assistance for this work.

It should be noted that the experience of being present is of paramount importance for the child's development. Learning is built day after day with family members and teachers who are around the child, contributing to the construction of knowledge.

II.   MATERIALS AND METHODS

This research seeks to deal with the theme in a coherent and objective way through bibliographical research, taking into account that this study addresses the relationship between family and school in the children's learning process. It is noteworthy that the study was concerned with bringing a theme of great relevance in the educational context, which directly influences the quality of teaching. According to Gil (1999, pp65):

> The bibliographical research is developed from material already prepared, consisting mainly of books and scientific articles. Although and almost all studies are required some kind of work, of this nature, there are researches developed exclusively from bibliographical sources.

Thus, use will be made of the research model that uses bibliographic research built through a literature review, based on previously published material, consisting mainly of works and articles available on the Internet to support the highlighted study. For Trujillo (1974, p. 230) "the bibliographic research is not a mere repetition of what has already been said or written on the subject, but provides the examination of a theme under a new focus or approach, reaching innovative conclusions".

It should be noted that this research has a descriptive character, as it seeks to study a topic of great importance in the educational context. For Triviños (1987, p. 110) the descriptive character aims to accurately describe the facts of phenomena in a given reality.

III.   LITERATURE REVIEW

Social Function of School and Family

When observing the institution of school and the family, evaluating their peculiarities, analyzing them with a deeper look, citizens are taken into account, that is, men and women, as social subjects, participants in the history of society, so rooted in the class divisions, which constantly segregate men from the condition of equality. Faced with this reality, the school, as an educating body, faces enormous challenges when it comes to the actions it promotes. "In fact, there are many factors that can influence a child's learning, among them variables from the school, the child itself and the family environment stand out" (FERREIRA; BARRERA, 2010, p. 28). it is clear that the child does not learn by himself, he is mainly influenced by the environment to which he belongs,

The family is a habitual and historical sociocultural environment in the socialization process, it is associated with educational institutions, becoming a place of origin of attitudes, as well as of changes, or paralysis, of the reality in which society places it, since it is from them that the social subjects emerge that will maintain, or alter, both themselves and the reality to which they are inserted (SOUSA; FILHO, 2008).

In this sense, we can observe that a school-family relationship, developed in a committed and responsible way in accordance with the advancement of society, is decisive for the progress of education in a country. For Ferreira and Barrera (2010, p. 53) "school and family are usually defined as the most important environments for socialization". Therefore, there must be collaboration between parents and teachers in the educational process of children and adolescents so that they correspond to the expectations of society.

Currently, according to Sousa e Filho (2008), the school criticizes the lack of monitoring, by the family, of the child's school performance, it also criticizes the excess of freedom given to children by parents and the difficulty in transmitting ethical and essential morals for living in society. On the other hand, we have the family that criticizes the excessive demand made by the school for parents to participate more in the child's learning, and also complains about the absence of a curriculum aimed at transmitting ethical and moral principles aimed at preparing the student for extra room challenges, namely, society and the world of work.

Knowing that human beings are learning all the time, the role of the family is very important, as it is the family who decides what their children need to learn, which places they should go and what is necessary to know so that they can make the right decisions in the

future. Therefore, it is understood that the role to be played by the school goes far beyond the pedagogical teaching of the classroom, and the role of the family goes beyond simply supporting the children, such as food, clothing, housing, etc. Oliveira and Marinho-Araújo (2010, p. 48) summarize that "the school is the institution whose function is to socialize systematized knowledge, that is, elaborate knowledge and erudite culture".

We note that the relationship between the family and the school is, above all, one of the most debated themes nowadays, either by researchers or by managers of educational systems and units around the world. This is due to the fact that affective bonds, self-esteem, self-concept and ways of interacting with society are intimately influenced by parental figures (Dessen and Polonia, 2007).

Marturano (2006 apud FERREIRA and BARRERA, 2010, p. 35), highlights that:

> Researchers' interest in the study of family influence on school learning intensified from the 1950s onwards, and from the 1960s onwards, the influence of family life processes was also investigated, in addition to socioeconomic variables. about school performance.

Over time, the family began to be seen as an integral part of the student's educational background. Until then, the school context did not receive as much attention and was not seen as a potential capable of adding to the teaching-learning process. However, other factors also started to stand out in this process, such as socioeconomic aspects.

Despite the existence of several researches on the subject, Fan and Chen (2001), affirm that there is still, in the scientific literature, a lot of incongruity between the results of researches that seek to analyze the relationship between parental involvement and academic performance.However, Ferreira and Marturano (2002 apud FERREIRA and BARRERA, 2010), analyzing the relationship between family environment and behavior problems presented by children with low school performance, revealed that externalizing behaviors such as hyperactivity, impulsivity, opposition, aggression, deviation and antisocial manifestations tend to occur in contexts of environmental adversity. Such research supports the understanding that the family environment is essential for the child's development.

In this way, the family can be considered the main reference, protection and socialization environment for

individuals, regardless of the way it presents itself in the social environment. The family is responsible for transmitting, from generation to generation, a great influence in the formation of values for the child, values that can be of an ethical, cultural, moral and spiritual character. Therefore, we cannot forget that the family is directly associated with the child's sociability and learning process to which he/she must adapt.

According to Piaget (1987), adaptation is made by assimilating schemes and by accommodating these schemes in new mental structures. And it is from these mental structures that the learning process takes place, that is, anything new that is learned can only be assimilated if there is a sufficient knowledge base for this.

The values experienced in the family environment are able to significantly contribute to the formation of the child's character, collaborating in their socialization and also in school learning. The family is the starting point of the direct relationship with its members, where the child grows, acts, develops and exposes his feelings, experiences the first rewards and punishments, the first image of himself and his first models of behavior, which will become internalizing and shaping your inner world. All this contributes to the formation of your personality, in addition to working as a determining factor in the development of consciousness, subject to future influences. "All of his psychological progress was made, until then, through relationships with others, especially his parents. At first, the child merged with the people around him,

When it comes to contemporary society, the relevance of parents' participation in the education and training of their children is evident. According to Oliveira and Marinho-Araújo (2010, p. 52) "education and school have a close relationship, although this does not configure a relationship of dependence, as there is a distinction between school education and education that takes place outside the school". However, it is possible to notice that lately the family has delegated the responsibility of educating the children to the school, thus not having an integration between the parties with regard to the tasks concerning the children's learning.

> The partnership between the family and the school is of paramount importance for the success in intellectual and moral development and in the formation of the individual in the school age group.
>
> After all, why even today in the 21st century, the school

complains about the little or insignificant participation of the family in the school, in the school life of their children? Was it a mess of roles? Where would be hidden the central point of this dilemma that drags on for years and years? (GARCIA; VEIGA, 2006, p. 12)

There is currently a conflict regarding roles, charges for both parties and new professional obligations. The school, however, has a peculiarity, namely, the attribution of teaching specific contents, however, the participation of parents has been limited to the concern with basic needs while support for teaching remains implicit.

Therefore, it is difficult to imagine that any project of change and innovation that does not pass through the positive consent of the family and communities can prosper. It is necessary to think that the school must be inserted in society, with the participation of all social agents so that the success of learning is democratic.

According to the authors of the researched works, few families are actively accompanying their children, in the sense of adding to their learning, since many fathers and mothers omit to participate in meetings held in schools, some do not care about to know how your child's development is, therefore, a large part of Brazilian families, especially the more popular classes, are absent from the children's education process.

According to Oliveira (2005), there are several perspectives and approaches related to the theme. The works and research on the theme of the family-school relationship were organized into two groups, called sociological focus and psychological focus. In summary, regarding the sociological approach, the family-school relationship is seen in terms of determining environmental and cultural functions. The psychological focus on the family is treated as responsible for psychological training.

The Federal Constitution of 1988 also mentions the subject. The Magna Carta establishes that the family must play an educational role and not just the school to be responsible for educating. Article 205 of the legal diploma under discussion states: "Education, the right of all and the duty of the State and the family, will be promoted and encouraged with the collaboration of society, aiming at the full development of the person, his preparation for the exercise of citizenship and his qualification for work" (BRASIL, 1988).

The relationship between family and school goes far beyond the institutional function they have, they are fully participants in the promotion of human development. According to the Law of Guidelines and Bases of Education (1996) "every child or adolescent has the right to be raised and educated within their family and, exceptionally, in a foster family, ensuring family and community coexistence, in an environment free from the presence of dependent people of narcotics".

The family and the school are fundamental partners in the development of actions that favor the children's school success, forming a team. It is essential that both follow the same principles and criteria, as well as the same direction in relation to the goals they want to achieve. It is noteworthy that "the presence and participation of parents in the school cannot and should not mean that teachers are not responsible for the learning of students and the government with the financing of education" (TANCREDI; REALI, 2001, p.4)

All this happens because the human being is intimately linked to his family, even if this is not his will. The family is directly responsible for offering lessons related to the social part, even if it is not their objective, occurring in a natural way. Almeida and Alonso (2005, p. 76), also bring an essential understanding to the theme:

> The first experience of human beings takes place in the family, regardless of their will or constitution. It is the family that gives you first and last name, that determines your social stratification, that gives you the specific biotic of your race, and that makes you feel, or not, an accepted member. Therefore, the family is the first space for the child's psychic, living, and spiritual formation.

In this sense, it is worth emphasizing that the family transmits several aspects to the child, since it is the first social environment in which it participates. All this influence can be positive or negative, depending on the family context, depending on how experiences are presented to you. Then, the consequences will be visible in the teaching-learning process at school.

Tiba (1998, p.187) makes an interesting note, stating that school education is different from family education. There is no way one can replace the other, as both are complementary. Part of family education cannot be delegated to the school, as it is unique and exclusive,

aimed at building character and standards of family behavior.

The Family in the Teaching and Learning Process

Educational institutions aim at the learning of students, because it is in them that school methodologies are carried out in a positive or negative way. Thus, the family also has a fundamental role, which may or may not contribute to their children's learning. Both the school and the family are responsible for developing the social, affective and physical aspects of children. Therefore, it is opportune to analyze how the relationship between family and school occurs or not, since the integral formation of the individual requires family participation, so that they can have a quality education. Libâneo conceptualizes education as follows: "A set of actions, processes, influences, structures that intervene in the human development of individuals and groups in an active relationship with the natural and social and social environment,

Thus, what happens most of the time is that the family wants to assign responsibilities that end up overloading the school and educators, embarrassing the student's teaching-learning process. According to Brendler (2013), responsibilities should not be transferred, but shared, since they need to be partners, and the school, no matter how hard it tries, will not be able to replace the family. There are two basic types of family models: nuclear and extended family. The nuclear family is made up of father, mother and children. The extended family is one that, in addition to parents and children, is also made up of other close relatives.

Chinoy(2008, p.545) defines family as being "An institution formed by parents and children who live together or not in the same house, or a group of people linked by blood ties, which may include uncles, aunts and cousins, as well as all individuals who come from a common parent". For an intermediation between family and school to exist, it is necessary to know what parents think about their role in their children's education, to show them the importance of their participation in the learning process. The participation of parents can collaborate in the pedagogical methodologies of teachers, and family and school, side by side, will have the responsibility of inserting the child into society, developing their autonomy and their critical sense in relation to the environment to which they belong.

In her research, Brendler (2013) argues that many parents feel powerless in relation to their children's problems in the school environment, so it is essential that there is an open dialogue between teachers and parents, which can occur through simple meetings or in school visits. It is noteworthy that parents are allowed to speak and express their opinions on various issues and it is up to teachers to clearly inform the expectations of learning and planned activities, in order to help parents understand their children's school routine. In this sense, Fernández states that:

> Learning is a process whose matrix is binding and playful and its bodily root: its creative unfolding is put into play through the intelligence-desire articulation and assimilation-accommodation balance (...). Only by observing how the child learns, how the child plays, and then what is the originality of his failure (from which he differentiates himself as a subject), we will be on the way to elucidating why he does not learn (FERNÁNDEZ, 2004, p.48).

Several theorists understand that children's learning is totally linked to play, because when children work with something tangible, they learn from this experience. In this sense, Vygotsky (1998, p.74) makes his contribution stating that "a child's greatest acquisitions are achieved in toys, acquisitions that in the future will become their basic level of action and morality". It remains evident the significant character of play, which is a remarkable tool in student learning.

In this sense, we can take into account that parents can and should motivate children from an early age to experience situations that instigate curiosity. In the context of school learning, playfulness provides a real learning environment, helping teachers to identify the student's learning level, points out Brendler (2013). This is important because it will serve to promote learning that encompasses cognitive and affective aspects.

It is essential to understand the child as a subject, who needs to have guaranteed a rich childhood, in the sense of their cognitive, affective and psychomotor construction. According to Brendler (2013), taking into account the family as the main social institution, it needs to offer conditions minimum for the education of children, who are extremely influenced by the culture and social environment that surrounds them. Thus, the family needs to be concerned about being part of an adequate environment so that it can serve as an influence for their children.

Therefore, it is essential that parents dialogue with their children about the rules that are necessary for life in society, as well as teaching them how to contain their behavior. Parents must also be willing to listen carefully to what their children will argue about misconduct, in order to make necessary interventions to change such behavior. Brendler (2013, p. 23) states that:

> Dialogue often resolves the punishment, but for this it is necessary that parents and teachers become aware of what dialogue is, it is not enough just one person to talk, dialogue involves more people and they need to be willing to express their opinions and accept the other's.

It is visible that most of the students who have problems in the school environment are due to lack of parental dialogue. For these students, that moment is missing when the family gathers to talk about how the day was and make statements about right and wrong according to the family's perception. Paggi and Guareschi clarify about the dialogue with the following:

> Through the practice of dialogue, it is possible to understand and agree on how things should be, that is, what will be ethical at that moment, and in this situation. The most important point here is for people to be willing to talk, open, not wanting to impose positions already taken. That's not to say you can't say what you think. Not only can it, but it should, because that is your point of view, and it will enrich the discussion along with the others. (PAGGI & GUARESCHI, 2004, p.164)

Thus, understanding and respecting the children's opinion, most of the time solves unnecessary punishments. Therefore, it is interesting to question why she is acting with a certain behavior, and from that, suggest another way to solve the problem. Brendler (2013) says that it is not through physical strength that problems will be solved, but through dialogue that the child must understand their anxieties and afflictions. Although not all parents agree on knowing the reason for the misbehavior, it is important that the reason for the punishment is clearly explained to the child so that they understand that their mistakes are open to warning and so that they are not repeated.

In effect, dialogue can solve problems that a punishment would not be able to solve. Therefore, Brendler (2013, p. 24) points out that, "families, rather than imposing rules, should reserve a little of their time to dialogue with their children, a pleasant conversation in which everyone has space to exchange ideas ". Dialogue is an excellent resource for demonstrating to children what attitudes are expected of them and what kinds of behaviors they should avoid.

However, like other social institutions, the family and school undergo several changes that alter their structure, meaning and role in society. We cannot deny that, over time, the attributions of the school were expanded to meet the new demands of the family and society. Therefore, the relationship between school and family must be constantly evolving, as they are practically inseparable in the children's learning process.

IV.   FINAL CONSIDERATIONS

The family's participation in the educational process in the school environment is of paramount importance, both with regard to literacy and the learning of ethical-moral principles necessary for a satisfactory coexistence in society. Most parents imagine that the school is the continuation of the home and expect it to fulfill its function. It is at this moment that the divergences occur, since as of the child's entry into school, the family system has its values put in check.

Therefore, in view of this scenario, it is possible to see what expectations are generated by parents in relation to the work that the school environment develops with the student, in the same way that there are school expectations regarding the participation of parents in the school environment. The family expects the school to solve the students' learning problems, in turn, the school expects assistance from the family so that the problems are solved.

It is also opportune to highlight an essential factor in the teaching-learning process, this factor is based on the family, which has a great influence on students' school life. In this sense, a good relationship is able to exert a positive influence on the student's school performance, however a bad relationship can cause a negative influence on this performance.

We must take into account how important it is to establish boundaries in the relationship between parents and children, teachers and students. The rules must be clear so that they can be complied with and that there is a pleasant and respectful interaction among the members.

These rules must be clarified from the start and must be simple and flexible.

Therefore, the family and the school need to walk side by side in order to optimize the education offered by the institution, looking for resources that will meet the demands experienced in each context. Thus, the educator needs to act as a mediator in this process, seeking to bring in your favor the parents, to think and debate strategies, since dialogue is essential to achieve the goals in this journey. Everyone must be committed to the goal, which is to promote quality education that is capable of enabling social transformation.

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Quality Assessment and Treatment of Hand-Dug Well Water Consumed by Residents of Ajogodo Community in Sapele Local Government Area of Delta State, Nigeria

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Abstract— *This study was designed to ascertain the quality of hand-dug well water consumed by residents of Ajogodo community in Sapele Local Government Area of Delta State, Nigeria and the potentials for use of Moringa oleifera seeds and aluminium sulphate (Alum) for water purification. The first phase of the study focused on hand-dug well water quality assessment while the second phase involved water treatment experiments to ascertain the individual and synergistic water purification potentials of Moringa oleifera seeds and Alum. Assay for physicochemical and microbial parameters was carried out using standard procedures. Results obtained in this study revealed that water quality indicators for the untreated water were above permissible WHO/NSDWQ regulatory limits for potable water. Water samples treated with Moringa oleifera seed powder recorded an improvement in water parameters as compared to untreated samples while water samples treated with a blend of alum and Moringa oleifera seed powder recorded the best performance and significant reduction in Total Solids (155.90±1.37mg/l), Total Suspended Solids (27.20±3.20mg/l), Total Hardness (28.10±0.67mg/l), Biochemical Oxygen Demand (3.65±0.09mg/l), Nitrite (0.15±0.00mg/l), Calcium (17.73mg/l), Magnesium (310.27mg/l), Copper (0.07mg/l), Total Coliform (0.47±0.03cfu) and E. coli (0.30±0.06 cfu). Findings from this study revealed that water obtained from hand-dug wells in Ajogodo community is unsafe for drinking and should be treated before consumption. The use of a combination of Moringa oleifera seed and alum offers an effective and easy option to purify water before consumption.*

I. INTRODUCTION

Water is an essential fluid needed for metabolism in living organisms. It is a major component of the biosphere [1], occupying about 71% of the earth's surface and yet it is one of the scarcest commodities especially in the developing countries of the world. Water is indispensable for man's activities and remain one of the most demanded of all urban and rural amenities [2]. The many usefulness of Water as a resource includes recreation, transportation, hydroelectric power and domestic, industrial and commercial uses [3].

Water seem to be abundant on planet Earth as a whole, but fresh potable water is not always available at the right time or the right place for use by humans or the ecosystem [4]. The quality of water available for drinking is important for the well-being of humans. Water in its natural form is colourless, odourless, tasteless and sparkling in nature [5]. However, water is said to be

contaminated or polluted if the chemical or physical properties are altered [6].

Although more than three quarters of the Earth's surface is made up of water, only 2.8 percent of the Earth's water is available for human consumption [7]. Different sources introduce different forms of contaminants to water bodies such as dissolved gases, minerals, organic and inorganic substances chemicals etc. If not monitored, they can have adverse effect on living organisms. It is common that most people obtained drinking water from groundwater by digging well or drilling boreholes. The water that is available for use by human whether for drinking, irrigation and industrial processes or for recreation must have some required quality in order to make it acceptable [1].

Over 40% of Nigerians depend on either polluted surface waters or wells for their domestic activities. Constant use of heavily polluted water for a long time usually results in health problems [8]. The ultimate use of water is effective in its pure condition; contaminated water adversely affect habitation. Only 60% of the total population of Nigeria had access to safe drinking water in 2002. The problem is more serious in the rural areas as 51% of the citizens live without safe drinking water [9]. In the presence of contaminated water and the insufficiency of safe access to pure water, consequent deadly diseases contribute great threat to life on the planet. Water-related diseases are major concerns in Nigeria as well as developing countries with polluted water problems. [10]. Purnamitta [11] reported health problems associated with prolonged consumption of polluted water, which range from dysentery, diarrhea, abortion, premature birth, viral hepatitis and gastric and duodenal ulcers amongst others [12].

In Ajogodo Community in Sapele L.G.A of Delta State Nigeria, many house owners dig wells and sink boreholes as sources of water for drinking and domestic purposes. Only a few numbers of the community can afford bottle water; majority of the residents rely more on ground water collected from hand-dug wells. Considering the health risks associated with consumption of contaminated water, it is imperative to carry out quality analysis on water obtained from these hand-dug wells to ascertain the microbiological, physical and chemical properties of the water and establish that they are all within permissible limits for safe Drinking Water.

The aim of the present study therefore, is to ascertain the quality of water collected from the hand-dug well under study and the potentials for use of *Moringa oleifera* seeds and Aluminium sulphate (Alum) for water purification.

II. MATERIALS AND METHODS

2.1 Sampling

2.1.1 *Collection of water samples*

Water samples were obtained from hand-dug wells located at Ajogodo Community in Sapele LGA of Delta State, Nigeria. Water samples were collected using amber colored bottles. All samples were preserved using ice packs in coolers and analyzed within 9 hours of sample collection. Commercial bottle water was purchased off-the-shelf and used as Control sample. A total of thirty (30) test water samples were collected and analyzed.

2.1.2 *Preparation of Moringa oleifera seed powder*

Dried *Moringa oleifera* seeds were collected from Rivers State University of Science and Technology, Port Harcourt, Rivers State, Nigeria. Good quality *Moringa oleifera* seeds were selected, de-coated, dried and the kernels were ground to fine powder using a blender.

2.1.3 *Preparation of Alum*

Aluminium sulphate (Alum) was purchase from Choba market in Rivers State, Nigeria. The alum was ground to fine powder and dissolved in de-ionized water.

2.2. Analytical methods

2.2.1 *Measurement of pH*

Measurement of pH was carried out using the ASTMD 1293 [13].

2.2.2 *Determination of Electric conductivity*

Electrical Conductivity was determined using the Conductometric method [14].

2.2.3 *Determination of Dissolved Oxygen*

Dissolved Oxygen was determined using the ALPHA 5210A [15].

2.2.4 *Determination of Biochemical Oxygen Demand*

Biochemical Oxygen Demand (BOD) was determined using the APHA 5210B method [15].

2.2.5 *Measurement of Turbidity*

Turbidity was measured using Nephelometric Method (APHA 2130B) [16].

2.2.6 *Determination of Total Suspended Solids*

Total Suspended Solids was determined according to the APHA 2540-D method APHA [17].

2.2.7 *Determination of Total Dissolved solids*

Total Dissolved Solid was determined using APHA 2540-C method [18].

2.2.8 *Determination of Chloride*

Chloride was determined using ASTM D4458 method [19].

2.2.9 *Metal Analysis*

Metals in water (Sodium, Potassium, Calcium, Copper, Iron, Zinc and Cadmium) were determined using Atomic Absorption Spectrophotometer method [20].

2.2.10 *Determination of Total Hardness*

Total Hardness was determined using a method described by AOAC [21].

2.2.11 *Analysis for microbial parameters*

Samples were analyzed according to APHA standard methods [22].

2.3 Statistical Analysis

Results in this study are expressed as Means ± Standard Error Mean (SEM) while one-way ANOVA was used to test for differences between treatment groups using SPSS version 20. The results were considered significant at p-values of less than 0.05, that is, at 95% confidence level ($P < 0.05$).

III. RESULTS

The various groups involved in the study are defined as in Table 1. The result of chemical, physical and microbiological analyses of hand-dug well water collected from the study area before and after treatment are presented in Tables 2 to 5. Results for experimental samples were compared with Control samples, World Health Organization (WHO) and National Safe Drinking Water Quality (NSDWQ) specifications. Table 2 shows the mean levels of physical characteristics of the samples analysed before and after treatment.

Turbidity values in all the experimental groups were below WHO/NSDWQ acceptable limit for turbidity (5.0NTU) and varied from 0.47±0.33 to 3.10±0.58 NTU. Conductivity values for all the test groups were below WHO/NSDWQ permissible limit 1000µs/cm and varied from 128.00±6.00 to 992.00±4.16 µs/cm.

Biochemical Oxygen Demand (BOD) values for test water samples varied from 3.17±0.09 to 6.91±0.17mg/l and significantly lower (p<0.05) when compared to Control group CW (4.48±0.14mg/l). Chemical Oxygen Demand (COD) varied from 9.30±0.40 to 78.85±0.73mg/l with the untreated group WW (78.85±0.75mg/l) and WWMOA (9.67±0.44mg/l) significantly different (p<0.05) compared to Control group CW (12.21±0.90mg/l). Values recorded for alkalinity, phosphate, nitrates and chloride in all test groups were below the respective WHO/NSDWQ permissible limits.

Results for Magnesium ranged from 10.27±0.23 to 84.22±3.97mg/l and significantly different (p<0.05) when compared to group CW (54.91±1.85mg/l) with the untreated water sample showing values (84.22±3.97mg/l) higher than WHO/NSDWQ standards (50mg/l).

Results presented in Table 5 showed that total Coliform in groups WW, WWMO, WWA and WWMOA varied from 0.47±0.03 to 12.67±1.33Cfu with values for group WW observed to be higher than WHO/NSDWQ permissible limits and also significantly different (p<0.05) from group WW values (1.00±0.00Cfu). *Escherichia coli* (E. coli) in the test groups varied from 0.20±0.00 to 12.00±2.31Cfu with Group WW recording values higher than the WHO/NSDWQ regulatory standard (0.00Cfu).

IV. DISCUSSION

Turbidity is an indication of suspended solids of different sizes present in water thereby resulting in cloudiness which could be as a result of colloidal particles, sewage wastes and industrial waste in water [23]. After treatment, results showed reduction in the level of turbidity of the test water samples. This corroborates findings from a previous study by Mangale [24] where Moringa oleifera seed powder caused decreased water turbidity with increased dosing. Also, Chaudhuri *et al.* [25] also concluded that Moringa oleifera seed extract was effective as a primary coagulant and as an adjuvant coagulant for clarifying turbid or coloured water.

Electric conductivity is an aggregate of chemical ions and dissolved matter in water. Some previous studies had shown that most drinking waters have conductivity of less than 1000µ/cm. The mean value for electric conductivity of the water sample as shown in Tables 4.1 and 4.2 before and after treatment were lower than regulatory values.

Results obtained for Total Solids (TS) before treatment were above regulatory values as shown in Tables 1. After treatment with *Moringa oleifera* seed powder and alum, TS was reduced in all groups except the　　Values are means ± Standard Error Mean. Values with the same superscript (a) are significantly different at (p< 0.05) when compared to control down the group. Values with superscript (b and c) are not statistically significant.

Table 1. Experimental Groups in the study

GROUP	CW	WW	WWMO	WWA	WWMOA
Description/Treatment	Commercial Bottle water	Well water only	Well water + 5g *Moringa oleifera* seed powder	Well water + 5g alum	Well water + 5g *Moringa oleifera* seed powder + 5g alum

Table 2. Mean levels of physical parameters before and after treatment (As compared with Control-Bottled water).

Group	Turbidity (NTU)	E.C(μs/cm)	TS(mg/l)	TSS(mg/l)	TDS(mg/l)
CW	0.47 ± 0.33^a	238.67 ± 2.40^a	333.70 ± 7.69^a	51.16 ± 1.27^a	276.34 ± 6.60^a
WW	3.10 ± 0.58^a	128.00 ± 6.00^a	605.58 ± 16.16^a	480.48 ± 22.46^a	102.52 ± 6.35^a
WWMOA	2.10 ± 0.12^a	256.33 ± 3.28^a	155.90 ± 1.37^a	27.20 ± 3.20^b	128.70 ± 2.00^a
WWA	1.65 ± 0.03^a	914.00 ± 7.02^a	134.50 ± 2.68^a	27.20 ± 4.35^b	108.53 ± 1.68^a
WWMOA	1.80 ± 0.58^a	992.00 ± 4.16^a	141.73 ± 0.95^a	20.06 ± 0.55^b	121.77 ± 0.41^a
WHO (Permissible limit)	5	1000	200	50	500

Values are means $\pm$ Standard Error Mean. Values with the same superscript (a) are significantly different at (p< 0.05) when compared to control down the group. Values with superscript (b and c) are not.

Table 3. Mean levels of chemical parameters before and after treatments

Group	pH	Total Hardness (mg/l)	BOD (mg/l)	COD (mg/l)	Total Alkalinity (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Chloride (mg/l)	Fluoride (mg/l)	CO_2 (mg/l)
CW	6.80 ± 0.03^a	86.36 ± 1.91^a	4.48 ± 0.14^a	12.21 ± 0.90^a	94.08 ± 0.58^a	0.40 ± 0.00^a	8.41 ± 0.08^a	0.03 ± 0.00^a	30.10 ± 0.72^a	0.00 ± 0.00^a	3.30 ± 0.12^a
WW	6.59 ± 0.17^b	183.50 ± 4.36^a	6.91 ± 0.17^a	78.85 ± 0.73^a	117.31 ± 1.06^a	0.85 ± 0.00^a	13.44 ± 0.18^a	0.79 ± 0.14^a	235.87 ± 5.28^a	0.02 ± 0.00^c	8.03 ± 0.03^a
WWMOA	6.82 ± 0.01^c	91.53 ± 1.43^c	3.93 ± 0.15^b	11.90 ± 0.51^b	4.43 ± 0.09^a	0.04 ± 0.00^a	0.37 ± 0.06^a	0.26 ± 0.10^a	62.53 ± 0.82^a	0.20 ± 0.03^a	1.43 ± 0.01^a
WWA	6.69 ± 0.02^b	65.23 ± 2.74^a	3.17 ± 0.09^a	9.30 ± 0.40^b	4.73 ± 0.19^a	0.02 ± 0.00^a	0.19 ± 0.01^a	0.23 ± 0.01^a	81.00 ± 1.11^a	0.24 ± 0.05^a	1.25 ± 0.03^a
WWMOA	6.96 ± 0.01^c	28.10 ± 0.67^a	3.65 ± 0.09^a	9.67 ± 0.44^a	3.47 ± 0.18^a	0.02 ± 0.01^a	0.13 ± 0.00^a	0.15 ± 0.00^a	43.03 ± 1.30^a	0.06 ± 0.01^c	0.54 ± 0.02^a
WHO (Permissible limit)	6.5-8.5	150	4	100	500	5	50	0.2	250	1.5	-

Table 4. Mean levels of metal concentrations before and after treatment (As compared with Control – Bottled water).

Group	Na (mg/l)	Mg (mg/l)	Ca (mg/l)	K (mg/l)	Cu (mg/l)	Cd (mg/l)	Zn (mg/l)	Fe (mg/l)
CW	16.54± 0.86[a]	54.91 ±1.85[a]	30.94 ±0.24[a]	0.24 ± 0.08[a]	0.39 ± 0.74[a]	0.00010 ±0.00[a]	1.37± 0.11[a]	0.02 ± 0.00[a]
WW	43.59± 0.38[a]	84.22 ±3.97[a]	99.33 ±0.36[a]	0.56 ± 0.06[a]	3.72 ± 0.11[a]	0.00123 ±0.00[a]	3.12 ±0.11[c]	0.30 ± 0.04[c]
WWMOA	8.05± 0.22[a]	36.40 ±0.20[a]	54.93 ±1.63[a]	2.35 ± 0.13[a]	0.37 ± 0.06[b]	0.00010 ±0.00[c]	1.22 ±0.10[a]	1.88 ± 0.48[a]
WWA	5.20 ±0.01[a]	27.37 ±4.03[a]	39.47 ±0.77[a]	0.71 ± 0.01[a]	0.28 ± 0.01[b]	0.00010 ±0.00[c]	0.92 ±0.06[a]	0.95 ± 0.16[c]
WWMOA	3.85 ±0.17[a]	10.27 ±0.23[a]	17.73 ±0.43[a]	0.30 ± 0.00[c]	0.07 ±0.01[a]	0.00010 ±0.00[c]	0.47 ±0.06[a]	0.38 ± 0.33[c]
WHO (Permissible limit)	200	50	20	<20	2	0.003	3	0.3

Values are means ± Standard Error Mean. Values with the same superscript (a) are significantly different at ($p< 0.05$) when compared to control down the group. Values with superscript (b and c) are not.

Table 5. Mean levels of microbial load before and after treatment (as compared with control – bottled water).

GROUPS	Total Coliform (Cfu)	E.coli (Cfu)
CW	1.0 ± 0.00[a]	0.10 ± 0.00[a]
WW	12.67 ± 1.33[a]	12.00 ± 2.31[a]
WWMOA	0.50 ± 0.00[b]	0.20 ± 0.00[c]
WWA	0.40 ± 0.00[b]	0.30 ± 0.00[c]
WWMOA	0.47 ±0.03[b]	0.30 ± 0.06[c]
WHO (Permissible limit)	Nil	Nil

Values are means ± Standard Error Mean. Values with the same superscript (a) are significantly different at ($p< 0.05$) when compared to control down the group. Values with superscript (b and c) are not.

untreated water sample. Jahn [26] had earlier noted that *Moringa oleifera* is a natural cationic polyelectrolyte and flocculent chemically composed of basic polypeptides.

Initial values for Total Suspended Solids (TSS) before treatment were above permissible limits which is an indication of contamination. After the treatment, a reduction in TSS was recorded in all the treated groups.

It was observed that the pH of all samples as shown in Tables 4.3 and 4.4 were below the regulatory values but recorded a slight increase after the treatment. The slight increase is as a result of the hydroxyl group release by the

Moringa oleifera seed due to the presence of amino acids in the protein [24].

A reduction Total Hardness and Biochemical Oxygen Demand (BOD) of the water samples was observed after treatment to purify the test water samples. High BOD is due to the presence of microorganisms (high bacteria count) which is an indication of water contamination [27]. According to Muyibi and Evison [28], Moringa seed powder as a polyelectrolyte, removes hardness in water through adsorption and inter-particle bridging. Also, the finding of reduced Total alkalinity after water treatment is in agreement with results of previous study by Mangele [24] where it was observed that alkalinity reduced after the

treatment at 50 mg/l dose of *Moringa oleifera* seed powder.

Chloride concentrations as shown in Tables 4.3 and 4.4 before the treatment was high but after the treatment the level of chloride reduced except group 2 (untreated) in comparison to group 1 (control). In a previous study by Mangale [24]. Chlorides in river water was reduced by three fold after treatment with Moringa seeds. It is because cations from Moringa seed attract the negatively charged chloride ions present in water and neutralize the chlorides.

Metallic ions concentrations analysed such as sodium, potassium, magnesium, copper and zinc and calcium were higher when compared to control before treatment and lower after the treatment. In previous studies by Muyibi and Evison [29]; Rajeswari *et.al.*[30], Cadmium (Cd) was removed (85%) from water using a batch and continuous flow system in a fixed bed column by adding 20 g/L of *Moringa oleifera* seed flour at an initial pH of 6.5. Also, Alum combination with other coagulants gave higher reductions for turbidity, oil & grease, TSS, NH3-N, COD, Zn, Pb, Cu, Mn and Fe in a previous study [31].

The present study also showed that after treatment, microbiological load of test water samples was reduced drastically indicating that *Moringa oleifera* seed powder and/or alum has the potential of reducing microbial load. An antimicrobial factor called glucomoringin (GMG) has been found in MO seeds, which is estimated to remove three log (99.99%) of coliforms in water [32], [33], [34]. Other studies have stated that the antimicrobial qualities of MO seed protein are attributable to membrane fusion [35].
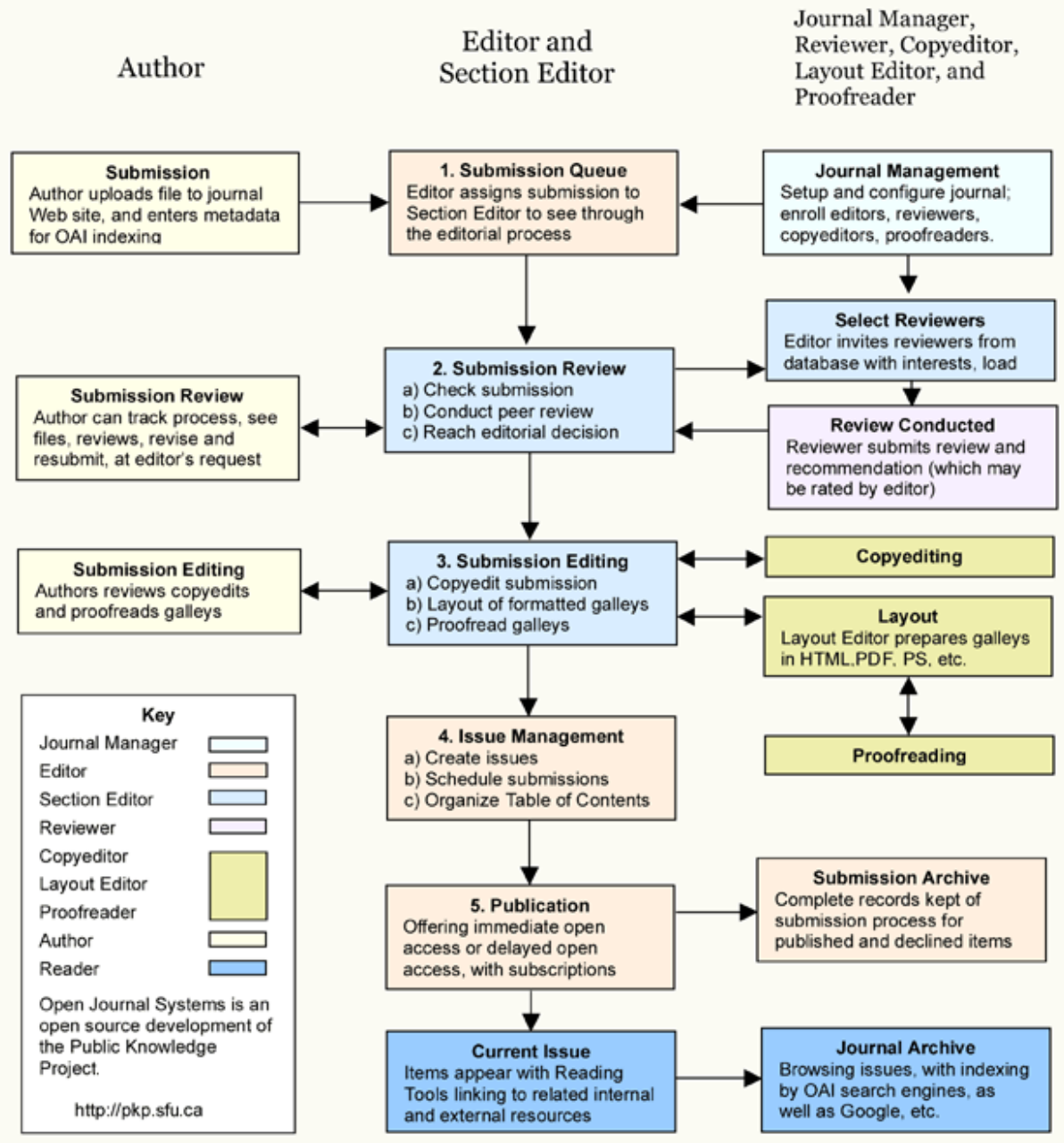
V.   CONCLUSION

This study revealed that quality indicator values for hand-dug well water in Ajogodo Community in Sapele Local Government Area of Delta State Nigeria are not in compliance with regulatory standards, which is an indication of contamination. It is most likely that the activities of the residents in the area such as open defecation, crude oil exploration and production, absence of constructed water drainage resulting in surface runoff into the wells after rainfall etc., continuously affect the quality of water in the wells thus, water obtained from them is unfit for human consumption. The study also showed that aluminium sulphate (Alum) and *Moringa oleifera* seed have potentials for water purification. Since *Moringa oleifera* does not have known toxic effect, it is therefore a safe water purification option for drinking water.

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Layout Editor	
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http://pkp.sfu.ca

4. Issue Management
a) Create issues
b) Schedule submissions
c) Organize Table of Contents

5. Publication
Offering immediate open access or delayed open access, with subscriptions

Submission Archive
Complete records kept of submission process for published and declined items

Current Issue
Items appear with Reading Tools linking to related internal and external resources

Journal Archive
Browsing issues, with indexing by OAI search engines, as well as Google, etc.

~IJAERS Workflow~

Important links:

Paper Submission Link:

https://ijaers.com/submit-paper/

Editorial Team:

https://ijaers.com/editorial-board/

Peer Review Process:

https://ijaers.com/peer-review-process/

Publication Ethics:

https://ijaers.com/publication-ethics-and-publication-malpractice-statement/

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